

Module Manual

Master of Science (M.Sc.) Civil Engineering

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Program description

Content

Civil engineering deals with the erection of buildings of all kind, in particular of structures like bridges and tunnels, structures in hydraulic engineering, water supply, waste and waste water disposal, harbour construction, streets, hall construction, as well as industrial and housing construction, including refurbishment. The master program civil engineering gives graduates the qualification to process difficult projects in the construction practice, including the necessary competences in business and management. Buildings arise by the cooperation of owners, planning offices, contractors, environment, politicians and society. Civil engineering is located in the field between technical and economic constraint, political will and legal conditions. The master program prepares for that. The master program also opens the way to doctoral studies and successful research activities, assuming a sufficient diploma.

The master program civil engineering is associated with the bachelor program "Bau- und Umweltingenieurwesen" and "Allgemeine Ingenieurwissenschaften Vertiefung Bauingenieurwesen" of the University of Technology Hamburg in the sense of a consecutive course of studies. Possible entries from other bachelor programs are based on a catalog of requirements, described in the document "Specific Requirements for the Master Program Civil Engineering".

Career prospects

The graduates of the master program civil engineering are prepared for a leading professional activity in planning offices, at building contractors, building authorities, owners of major immovables and infrastructure, producers of building products, material testing institutions and in research facilities. It aims at activities in extensive and difficult projects, or in research and development. In Germany a great demand exists at this time for civil engineers in particular with good knowledge in structural engineering. The master program is based on this demand.

Learning target

The graduates of the master program civil engineering gain the specialist knowledge and the methods, to plan and erect new buildings, in particular concrete structures, steel structures, structures in water engineering, in foundation engineering, in water supply, waste and waste water disposal, including refurbishment of existing structures. This incorporates the realization of necessary preliminary investigations, the design of structural elements, the development of all necessary proofs and the project management.

The graduates of the master program are able to transfer the acquired knowledge in engineering, mathematics and natural sciences to practical applications and to analyze and solve problems on a scientific basis, even if these are unusual or incompletely defined and comprise complex specifications. The graduates are able to successfully work on research projects in the field of civil engineering. Therefore a comprehensive understanding of the underlying processes and the ability to model and calculate such processes, e.g. with Finite Elements Methods, are necessary.

The graduates for this purpose gain the skills to experimentally determine the necessary properties of soil, materials and components and to deal with construction-specific program systems to calculate mechanical behavior, the hydraulics of systems as well as other physical-chemical processes. They are enabled to work on problems of civil engineering and related disciplines on one's own. They are able to use methods needed for the solution of technical problems and planning procedures. They are able to use new findings in a critical way and to improve methods and new developments.

The graduates can communicate on advanced contents and problems of civil engineering with specialists and the laity. They are able to present their methods and the results of their work in writing and verbally in a comprehensive way. The graduates in addition learn to work on problems in a team in a purposeful way, and to document and present their methods and results understandably with up-to-date presentation methods to other persons. They learn to take the leadership for parts of a project or the whole. They are able to familiarize themselves with a topic and to select suitable methods to solve questions and problems. They are able to acquire the necessary information about a topic on one's own and to put the new information in the context of their knowledge.

The graduates are further qualified to develop concept designs for difficult projects in structural engineering, foundation engineering, bridge design and hydraulic engineering and to plan such constructions under consideration of the available information and restrictions. They can:

- successfully cooperate with expert und inexpert partners from the public administration, the economy and science,
- autonomously define, plan and conduct scientific tasks and to theoretically or experimentally investigate constructions, ground, materials, infrastructure as well as management duties,
- responsibly evaluate and consider the interests of building partners, people concerned and the society as a whole.

Program structure

The master program consists of modules which 6 credit points according to ECTS (CP) except for the master thesis. It is divided into a "Core Qualification", into the five alternative specializations "Coastal Engineering", "Geotechnical Engineering", "Structural Engineering", "Water and Traffic" and "Computational Engineering", as well as the master thesis. The core qualification covers 24 CP, each specialization covers 66 CP and the master thesis covers 30 CP. The program covers 120 CP in 2 years with 4 terms in total.

The core qualification contains a module "Finite Elements Methods" as well as a module "Sustainability and Risk Management" in the 1st term. In addition an open module during the 1st, 2nd or 3rd term from the field "Business and Management" as well as a module from the "Non-technical Courses for Master" are incorporated. The lectures of these open modules are selected from catalogs that are independend from the specific master program.

Each specialization covers 42 CP in the compulsory modules, that are indispensable for the specialization, and 24 CP in the mandatory electives. They contain also an open module and a project work with 6 CP in each case. The compulsory modules excepting the project work are located in the 1st and 2nd term.

The 4th term covers the master thesis. In addition lectures of the open module of the specialization can still be attended in the 4th term. The students must select a specialization and they have the choice to elect different options in the field of "Business and Management", in the field of the "Non-technical Courses for Master" and in the mandatory electives of the specialization.

A term abroad is possible. In particular the 3rd semester is used by the students to go abroad, because in the 3rd term there are no compulsory modules, but only mandatory electives.

Core Qualification

Module M0523: Busin	ess & Management
Module Responsible	Prof. Matthias Meyer
Admission Requirements	None
Recommended Previous	None
Knowledge	
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	 Students are able to find their way around selected special areas of management within the scope of business 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 Responsible	Dagmar Richter
Admission Requirements	None
Recommended Previous	None
Knowledge	
-	After taking part successfully, students have reached the following learning results
Professional Competence Knowledge	The Nontechnical Academic Programms (NTA)
	imparts skills that, in view of the TUHH's training profile, professional engineering studies require but are not able to cover fu Self-reliance, self-management, collaboration and professional and personnel management competences. The departm implements these training objectives in its teaching architecture , in its teaching and learning arrangements , in teach areas and by means of teaching offerings in which students can qualify by opting for specific competences and a compete level at the Bachelor's or Master's level. The teaching offerings are pooled in two different catalogues for nontechn complementary courses.
	The Learning Architecture
	consists of a cross-disciplinarily study offering. The centrally designed teaching offering ensures that courses in the nontechn academic programms follow the specific profiling of TUHH degree courses.
	The learning architecture demands and trains independent educational planning as regards the individual development competences. It also provides orientation knowledge in the form of "profiles".
	The subjects that can be studied in parallel throughout the student's entire study program - if need be, it can be studied in one two semesters. In view of the adaptation problems that individuals commonly face in their first semesters after making transition from school to university and in order to encourage individually planned semesters abroad, there is no obligation study these subjects in one or two specific semesters during the course of studies.
	Teaching and Learning Arrangements
	provide for students, separated into B.Sc. and M.Sc., to learn with and from each other across semesters. The challenge of dea with interdisciplinarity and a variety of stages of learning in courses are part of the learning architecture and are delibera encouraged in specific courses.
	Fields of Teaching
	are based on research findings from the academic disciplines cultural studies, social studies, arts, historical stud communication studies, migration studies and sustainability research, and from engineering didactics. In addition, from the win semester 2014/15 students on all Bachelor's courses will have the opportunity to learn about business management and start- in a goal-oriented way.
	The fields of teaching are augmented by soft skills offers and a foreign language offer. Here, the focus is on encouraging ge oriented communication skills, e.g. the skills required by outgoing engineers in international and intercultural situations.
	The Competence Level
	of the courses offered in this area is different as regards the basic training objective in the Bachelor's and Master's fields. Th differences are reflected in the practical examples used, in content topics that refer to different professional application conte and in the higher scientific and theoretical level of abstraction in the B.Sc.
	This is also reflected in the different quality of soft skills, which relate to the different team positions and different group leaders functions of Bachelor's and Master's graduates in their future working life.
	Specialized Competence (Knowledge)
	Students can
	 explain specialized areas in context of the relevant non-technical disciplines, outline basic theories, categories, terminology, models, concepts or artistic techniques in the disciplines represented in learning area, different specialist disciplines relate to their own discipline and differentiate it as well as make connections, sketch the basic outlines of how scientific disciplines, paradigms, models, instruments, methods and forms of representa in the specialized sciences are subject to individual and socio-cultural interpretation and historicity, Can communicate in a foreign language in a manner appropriate to the subject.
Skills	Professional Competence (Skills)
	In selected sub-areas students can
	 apply basic and specific methods of the said scientific disciplines, aquestion a specific technical phenomena, models, theories from the viewpoint of another, aforementioned specied discipline, to handle simple and advanced questions in aforementioned scientific disciplines in a successful manner, justify their decisions on forms of organization and application in practical questions in contexts that go beyond

Module Manual M.Sc. "Civil Engineering"

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

	ainable Circular Economy			
Courses				
Title		Тур	Hrs/wk	СР
Circular Economy (L3264)		Seminar	2	3
Environment and Sustainability (L0		Lecture	2	3
Module Responsible	Prof. Kerstin Kuchta			
Admission Requirements				
Recommended Previous				
Knowledge				
Educational Objectives		ve reached the following learning results		
Professional Competence				
Knowledge	Students are able to describe single tech Economy as well as environmental and su		field of safety and risk a	assessment, Circu
	 basics in safety and reliability of tec 	hnical facilities		
	 risk assessment and reliability analy 	rsis methods		
	Circularity of material			
	Identification and evaluation of mate	erial flows		
	energy production and supply			
	 sustainable product design 			
Personal Competence Social Competence Autonomy	Students can gain knowledge of the subje	d costs for processes and select economical ect area from given sources and transform rch-oriented duties in for risk management	n it to new questions. Fu	
		impact.		pts accordance w
Workload in Hours	Independent Study Time 124 Study Time			pts accordance w
Workload in Hours Credit points				pts accordance w
Credit points	6			pts accordance w
Credit points Course achievement	6 None			pts accordance w
Credit points Course achievement Examination	6 None Written elaboration	n Lecture 56		pts accordance w
Credit points Course achievement	6 None Written elaboration Elaboration and presentation (45 minutes	n Lecture 56		pts accordance w
Credit points Course achievement Examination Examination duration and scale	6 None Written elaboration Elaboration and presentation (45 minutes	in Lecture 56		pts accordance w
Credit points Course achievement Examination Examination duration and scale Assignment for the	6 None Written elaboration Elaboration and presentation (45 minutes Civil Engineering: Core Qualification: Comp	in Lecture 56	ocus Management and (
Credit points Course achievement Examination Examination duration and scale Assignment for the	6 None Written elaboration Elaboration and presentation (45 minutes	in Lecture 56	ocus Management and (
Credit points Course achievement Examination Examination duration and scale Assignment for the	6 None Written elaboration Elaboration and presentation (45 minutes Civil Engineering: Core Qualification: Comp Bioprocess Engineering: Specialisation C Compulsory	in Lecture 56		
Credit points Course achievement Examination Examination duration and scale Assignment for the	6 None Written elaboration Elaboration and presentation (45 minutes Civil Engineering: Core Qualification: Comp Bioprocess Engineering: Specialisation C Compulsory Chemical and Bioprocess Engineering: Spe	in Lecture 56 in groups) pulsory : - Bioeconomic Process Engineering, Fo	ective Compulsory	
Credit points Course achievement Examination Examination duration and scale Assignment for the	6 None Written elaboration Elaboration and presentation (45 minutes Civil Engineering: Core Qualification: Comp Bioprocess Engineering: Specialisation C Compulsory Chemical and Bioprocess Engineering: Spe Chemical and Bioprocess Engineering: Spe	in Lecture 56 in groups) pulsory : - Bioeconomic Process Engineering, Fo cialisation General Process Engineering: Ele	ective Compulsory Compulsory	
Credit points Course achievement Examination Examination duration and scale Assignment for the	6 None Written elaboration Elaboration and presentation (45 minutes Civil Engineering: Core Qualification: Comp Bioprocess Engineering: Specialisation C Compulsory Chemical and Bioprocess Engineering: Spe Chemical and Bioprocess Engineering: Spe Chemical and Bioprocess Engineering: Spe	in Lecture 56 in groups) iulsory : - Bioeconomic Process Engineering, Fo cialisation General Process Engineering: Elective cialisation Bioprocess Engineering: Elective	ective Compulsory Compulsory Elective Compulsory	Controlling: Elect
Credit points Course achievement Examination Examination duration and scale Assignment for the	6 None Written elaboration Elaboration and presentation (45 minutes Civil Engineering: Core Qualification: Comp Bioprocess Engineering: Specialisation C Compulsory Chemical and Bioprocess Engineering: Spe Chemical and Bioprocess Engineering: Spe Chemical and Bioprocess Engineering: Spe Chemical and Bioprocess Engineering: Spe	in Lecture 56 in groups) bulsory : - Bioeconomic Process Engineering, Fo cialisation General Process Engineering: Elective cialisation Bioprocess Engineering: Elective cialisation Chemical Process Engineering: E	ective Compulsory Compulsory Elective Compulsory eering: Elective Compulso	Controlling: Elect
Credit points Course achievement Examination Examination duration and scale Assignment for the	6 None Written elaboration Elaboration and presentation (45 minutes Civil Engineering: Core Qualification: Comp Bioprocess Engineering: Specialisation C Compulsory Chemical and Bioprocess Engineering: Spe Chemical and Bioprocess Engineering: Spe Chemical and Bioprocess Engineering: Spe Chemical and Bioprocess Engineering: Spe Chemical and Bioprocess Engineering: Spe Environmental Engineering: Specialisation	in Lecture 56 in groups) culsory : - Bioeconomic Process Engineering, Fo cialisation General Process Engineering: Elective cialisation Bioprocess Engineering: Elective cialisation Chemical Process Engineering: E cialisation Chemical and Bio process Engine	ective Compulsory Compulsory Elective Compulsory eering: Elective Compulso y	Controlling: Elect
Credit points Course achievement Examination Examination duration and scale Assignment for the	6 None Written elaboration Elaboration and presentation (45 minutes Bioprocess Engineering: Specialisation C Compulsory Chemical and Bioprocess Engineering: Spe Chemical and Bioprocess Engineering: Spe Chemical and Bioprocess Engineering: Spe Chemical and Bioprocess Engineering: Spe Environmental Engineering: Specialisation Product Development, Materials and Product	in Lecture 56 in groups) culsory : - Bioeconomic Process Engineering, Fo cialisation General Process Engineering: Elective cialisation Bioprocess Engineering: Elective cialisation Chemical Process Engineering: E cialisation Chemical and Bio process Engine Energy and Resources: Elective Compulsor	ective Compulsory Compulsory Elective Compulsory eering: Elective Compulso y Elective Compulsory	Controlling: Elect
Credit points Course achievement Examination Examination duration and scale Assignment for the	6 None Written elaboration Elaboration and presentation (45 minutes Divil Engineering: Core Qualification: Comp Bioprocess Engineering: Specialisation C Compulsory Chemical and Bioprocess Engineering: Spe Chemical and Bioprocess Engineering: Spe Chemical and Bioprocess Engineering: Spe Chemical and Bioprocess Engineering: Spe Environmental Engineering: Specialisation Product Development, Materials and Produ Product Development, Materials and Produ	in Lecture 56 in groups) culsory : - Bioeconomic Process Engineering; Fo cialisation General Process Engineering: Elective cialisation Bioprocess Engineering: Elective cialisation Chemical Process Engineering: E cialisation Chemical and Bio process Engine Energy and Resources: Elective Compulsor ction: Specialisation Product Development:	ective Compulsory Compulsory Elective Compulsory eering: Elective Compulsory Y Elective Compulsory ompulsory	Controlling: Elect

ourse L3264: Circular Economy	
Тур	Seminar
Hrs/wk	2
CP	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
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Kerstin Kuchta
Language	EN
Cycle	WiSe
Content	 This course presents actual methodologies and examples of environmental relevant, sustainable technologies, concepts and strategies in the field of energy supply, product design, water supply, waste water treatment or mobility. The following list 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 M2024: Finite	elements			
Courses				
Title		Тур	Hrs/wk	СР
Finite elements (L3279)		Lecture	3	3
Finite elements (L3280)		Recitation Section (large)	2	3
Module Responsible	Prof. Bastian Oesterle			
Admission Requirements	None			
Recommended Previous	Mechanics I/II, Mathematics I/II, Differential Equa	tions I, Structural Analysis I, Structural Analy	sis II, Structural A	Analysis III
Knowledge				
Educational Objectives	After taking part successfully, students have rea	ched the following learning results		
Professional Competence				
Knowledge	After successful completion of this module, stu	dents can express theoretical, methodologi	cal and practical	aspects of the fini
	element method.			
Skills	After successfully completing this module, students are able to derive, implement and appropriately apply finite element			
formulations.			apply mile cleme	
Personal Competence				
Social Competence	Students can participate in subject-specific and	interdisciplinary discussions, defend their or	wn work results i	n front of others a
	promote the scientific development of colleague	s. Furthermore, they can give and accept pro	ofessional constru	ictive criticism.
Autonomy	Students are able to gain knowledge of the subject area from given and other sources and apply it to new problems. Furthermore, they are able to structure the solution process for problems in the area of the finite element method.			
	they are able to structure the solution process for	or problems in the area of the finite element i	nethod.	
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	Civil Engineering: Core Qualification: Compulsory	/		
Following Curricula				

Course L3279: Finite elements		
Тур	Lecture	
Hrs/wk	3	
СР	3	
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42	
Lecturer	Prof. Bastian Oesterle	
Language	DE	
Cycle	WiSe	
Content	Direct stiffness method, variational formulation of finite elements, requirements for the approaches, convergence conditions, isoparametric concept finite elements for trusses, beams, disks and plates, locking and alternative FE formulations, basics of model building, mathematical and numerical model, assessment and interpretation of calculation results, Singularities, influence of approximation errors, interactions between mathematical and numerical models	
Literature	Vorlesungsskript	

Course L3280: Finite elemen	ts
Тур	Recitation Section (large)
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Bastian Oesterle
Language	DE
Cycle	WiSe
Content	Direct stiffness method, variational formulation of finite elements, requirements for the approaches, convergence conditions, isoparametric concept finite elements for trusses, beams, disks and plates, locking and alternative FE formulations, basics of model building, mathematical and numerical model, assessment and interpretation of calculation results, Singularities, influence of approximation errors, interactions between mathematical and numerical models
Literature	Vorlesungsskript

Specialization Coastal Engineering

Module M0699: Geote	chnics III			
Courses				
Title		Тур	Hrs/wk	СР
Numerical Methods in Geotechnics	(L0375)	Lecture	3	3
Advanced Foundation Engineering	(L0497)	Lecture	2	2
Advanced Foundation Engineering	(L0498)	Recitation Section (large)	1	1
Module Responsible	Prof. Jürgen Grabe			
Admission Requirements	None			
Recommended Previous	Geotechnics I and II, Mathematics I-III			
Knowledge				
Educational Objectives	After taking part successfully, students have reached t	he following learning results		
Professional Competence				
Knowledge	After successfully completing the module, students wil	l be able to		
	describe individual procedures for the geotechni	ical monitoring of civil engineering me	asuras	
	 reproduce exploration and investigation method 		usures,	
	 select suitable types of field and laboratory tests 		e their results	
	 state the differences between various stress and 	-		variants of the stress
	and distortion tensor,		Significance of int	
	 outline the standard and special soil mechanics 	tests used to determine the stress-str	ain behavior of soi	il.
	 describe continuum models and the resulting bo 			,
	 as well as define boundary value problems from 		in such a way tha	t thev can be solved
	unambiguously.	5 5 5	,	2
Skills	Students will be able to			
		6 ft 11-		
	 dimension vertical drains for soil improvement of soft soils, calculate depth compaction using various appropriate methods, apply principles of horizontal bearing capacity of piles, verify the internal and external stability of fluid-supported diaphragm walls, evaluate the boundary conditions for the design of a deep excavation and design the individual components of t excavation, 			
	 perform, evaluate and interpret tests for the description and classification of soils according to applicable standards, 			
	 perform, evaluate and interpret tests for the description and classification of soils according to applicable standards, computationally implement numerical algorithms to solve boundary value problems, 			
	 select and apply the types of analyses depending on the degree of saturation, the impact, and the material behavior 			
	 determine appropriate model parameters for different possibilities and limitations of material models for the grain structur 			
	of soils.			
Personal Competence				
Social Competence	Students can work in groups and support each other in	finding solutions.		
Autonomy	Students are able to assess their own strengths and we and think in terms of processes.	eaknesses and, based on this, organize	e their time and le	arning management
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points	6			
Course achievement				
	Written exam			
Examination duration and				
scale				
	Civil Engineering: Specialisation Structural Engineering	r Compulsory		
Following Curricula	Civil Engineering: Specialisation Structural Engineering Civil Engineering: Specialisation Geotechnical Engineer			
i onowing curricula	Civil Engineering: Specialisation Coastal Engineering: C	• • •		
	Civil Engineering: Specialisation Water and Traffic: Elec			
	Civil Engineering: Specialisation Computational Engine			
	International Management and Engineering: Specialisa		pulsory	
		- 55		

Course L0375: Numerical Me	thods in Geotechnics
Тур	Lecture
Hrs/wk	3
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Dr. Hans Mathäus Stanford
Language	DE
Cycle	WiSe
Content	Topics:
	 Introduction to numerical soil mechanics Introduction to numerical mathematics Finite Element Method (analysis procedures, algorithms) Finite Element Method (application in geotechnical engineering)
Literature	 Wriggers P. (2001): Nichtlineare Finite-Elemente-Methoden. Springer Wriggers P. (2008): Nonlinear Finite Element Methods. Springer Deutsche Gesellschaft für Geotechnik e.V. (Hrsg., 2014): Empfehlungen des Arbeitskreises "Numerik in der Geotechnik". Ernst & Sohn

Course L0497: Advanced Fou	Indation Engineering
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Jürgen Grabe
Language	DE
Cycle	WiSe
Content	 Vertical drains Piles Ground improvement (Deep Compaction, Soil mixing) Vibration driving Jet grouting Slurry wall Deep excavation
Literature	 EAK (2002): Empfehlungen für Küstenschutzbauwerke EAU (2004): Empfehlungen des Arbeitsausschusses Uferbauwerke EAB (1988): Empfehlungen des Arbeitskreises Baugruben Grundbau-Taschenbuch, Teil 1-3, (1997), Ernst & Sohn Verlag

Course L0498: Advanced Fou	urse L0498: Advanced Foundation Engineering			
Тур	Recitation Section (large)			
Hrs/wk	1			
СР	1			
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14			
Lecturer	Prof. Jürgen Grabe			
Language	DE			
Cycle	WiSe			
Content	See interlocking course			
Literature	See interlocking course			

Courses						
Title				Тур	Hrs/wk	СР
Applied Tunnel Constructions (L240	(7)			Lecture	2	3
Introduction to tunnel construction	(L0707)			Lecture	1	2
Introduction to tunnel construction	(L1811)			Recitation Section (large)	1	1
Module Responsible	Prof. Jürgen Grabe					
Admission Requirements	None					
Recommended Previous	Modules from Bachelo	r studies Civil and e	nvironmental engineeri	ng:		
Knowledge	Geotechnics I-II					
Educational Objectives	After taking part succe	essfully, students ha	ave reached the followir	ig learning results		
Professional Competence						
Knowledge	Knowledge of different tunnel construction types as well as special methods and techniques of subsoil construction.					
Skills	Basic knowledge of tunnel design as well as practical skills in structural tunnel analysis.					
Personal Competence						
Social Competence	Capacity for teamwork concerning project management and design of tunnels.					
Autonomy	Promotion of independent and creative work flow in the framework of a design exercise.					
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56					
Credit points	6					
Course achievement	Course achievement Compulsory Bonus Form Description					
	No 5 %	Excercises				
Examination	Written exam					
Examination duration and	120 minutes					
scale						
Assignment for the	Civil Engineering: Spec	cialisation Structura	l Engineering: Elective	Compulsory		
Following Curricula	Civil Engineering: Spec	cialisation Geotechr	nical Engineering: Comp	ulsory		
	Civil Engineering: Spec	cialisation Coastal E	ngineering: Compulsory	/		
	Civil Engineering: Spec	cialisation Water an	d Traffic: Elective Comp	oulsory		
			tional Engineering: Elec			
	THE REPORT OF A			I Engineering: Elective Comp		

Course L2407: Applied Tunne	Course L2407: Applied Tunnel Constructions		
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Jürgen Grabe, Tim Babendererde		
Language	DE		
Cycle	WiSe		
Content			
Literature			

Course L0707: Introduction t	o tunnel construction		
Тур	Lecture		
Hrs/wk	1		
CP			
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14		
Lecturer	Dr. Julian Bubel		
Language	DE		
Cycle	WiSe		
Content	 Definitions Historical development in tunneling Geology for tunneling Hard rock tunneling (construction composite and machines) Tunnelung in temporarly stable soil with conventional construction methods Tunneling in soft soils (form of supports, shield types, compressed air application) Pipe jacking Tunnel Lining, tunnel supporting structures Calculation approaches for supporting structures in shield-driven tunnels Surveying for tunneling Safety requirements Construction Contract Literature and sources 		
Literature	Vorlesung/Übung s. www.tu-harburg.de/gbt		

Course L1811: Introduction t	Course L1811: Introduction to tunnel construction		
Тур	Recitation Section (large)		
Hrs/wk	1		
CP	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Dr. Julian Bubel		
Language	DE		
Cycle	WiSe		
Content	See interlocking course		
Literature	See interlocking course		

Courses	
Fitle Construction Robotics (L2867)	Typ Hrs/wk CP Project-/problem-based Learning 6 6
Module Responsible	Prof. Kay Smarsly
Admission Requirements	None
Recommended Previous	Basics of project-oriented programming
Knowledge	
	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Basics of robotics
	Applications in civil engineering
	Kinematics
	Kinducs
Skills	Use of specific hardware
	Development of software routines
	Python programming language
	Image processing
	Basics of localization (LIDAR, SLAM)
Personal Competence	
Social Competence	Teamwork
Social competence	
	Communication skills
Autonomy	Independent work
	Independent decisions
	Independent decisions
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84
Credit points	6
Course achievement	None
Examination	Written elaboration
Examination duration and	ca. 10 Seiten
scale	
-	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory
Following Curricula	Civil Engineering: Specialisation Water and Traffic: Elective Compulsory Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory
	Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory
	Civil Engineering: Specialisation Computational Engineering: Elective Compulsory
	Computer Science: Specialisation II: Intelligence Engineering: Elective Compulsory
	Mechatronics: Core Qualification: Elective Compulsory
	Theoretical Mechanical Engineering: Specialisation Robotics and Computer Science: Elective Compulsory

ourse L2867: Construction			
Тур	Project-/problem-based Learning		
Hrs/wk	6		
СР	6		
Workload in Hours	dependent Study Time 96, Study Time in Lecture 84		
Lecturer	Prof. Kay Smarsly, Jan Stührenberg		
Language	EN		
Cycle	WiSe		
Content	 Introduction: Robotics in civil engineering Presentation of potential topics Programming of algorithms in Python Application of software systems: LINUX distribution, ROS, CloudCompare, Application of hardware systems: Petoi Bittle Dog, Raspberry Pi, Arduino, sensing Topics considered for robotics using the Petoi Bittle Dog: Movement Use of sensors (camera, infrared,) Data structures/data acquisition Programming Topics technically relevant to building inspection: Geodetic evaluations Image processing Localization 		
Literature	Bock/Linner: Construction Robotics		
	Verl et al.: Soft Robotics		
	Pasquale: New Laws of robotics		

Module M0593: Building Materials and Building Preservation

Courses						
Title			Тур		Hrs/wk	СР
Repair of Structures (L0255)			Lectu	ıre	1	1
Mineral Building Materials (L0253)			Lectu	ıre	2	2
Technology of mineral Building Mat	erials (L0256)		Proje	ct-/problem-based Learning	1	2
Transport Processes in Building Ma	erials and Damage Processes (L02	54)	Lectu	ıre	1	1
Module Responsible	Prof. Frank Schmidt-Döhl					
Admission Requirements	None					
Recommended Previous	Basic knowledge about buildir	ig materials, build	ing physics and bu	ilding chemistry, for exam	nple by the m	nodules Principles
Knowledge	Building Materials and Building	Physics and Buildin	ng Materials and Bui	lding Chemistry.		
Educational Objectives	After taking part successfully, s	tudents have reac	hed the following lea	irning results		
Professional Competence						
Knowledge	The students are able to descri	be the components	s of mineral building	materials and their function	on in detail and	d to use them for t
	manufacture of special mineral	building materials	. They are able to sh	ow the characteristics of m	nineral buildin	g materials. They a
	able to describe the manufactu	re, properties and	fields of application	of special mortars and spe	cial concretes	and the correlation
	of their material parameters. Th	ney are able to sho	w the principles of a	nchor technology and desi	gn.	
Chille	The shudents are able to reaf-		- f		These and a bi	
SKIIIS	The students are able to perfor		. ,	-		• •
	mineral mortar and to manufacture this mortar. The students are able to manufacture post installed rebar conn able to recognize damages, to assess possible causes, to use the fundamentals of construction preservation an					
	able to recognize damages, to and strengthening measures.	assess possible ca	auses, to use the fu	ndamentals of construction	n preservation	and to select rep
Personal Competence						
Social Competence	Social Competence The students are able to develop in small grous the mixture of a special mortar. They present their results to the					
	other students. In a critical discussion they defend and adjust their results. The students are able to manufacture their spec					
	building material on the basis o	f this feedback.				
Autonomy	y The students are able to responsibly use the resources of materials and lab equipment for their project and to investigate and					
	get missing components.					
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70					
Credit points	6					
Course achievement	Compulsory Bonus Form		Description			
	Yes 20 % Subject	theoretical an	ıd			
	practica	l work				
Examination	Written exam					
Examination duration and	120 min					
scale						
Assignment for the	Civil Engineering: Specialisatior	n Geotechnical Eng	ineering: Compulsor	У		
Following Curricula	Civil Engineering: Specialisatior	n Coastal Engineeri	ing: Elective Compul	sory		
	Civil Engineering: Specialisatior	n Structural Engine	ering: Elective Comp	oulsory		
	Civil Engineering: Specialisatior					

Course L0255: Repair of Stru	Course L0255: Repair of Structures			
Тур	Lecture			
Hrs/wk	1			
СР	1			
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14			
Lecturer	Prof. Frank Schmidt-Döhl			
Language	DE			
Cycle	SoSe			
Content	Maintenance of structures, repair and strengthening, subsequent waterproofing of structures			
Literature	BetonMarketing Deutschland (Hrsg.): Stahlbetonoberflächen - schützen, erhalten, instandsetzen			

Course L0253: Mineral Buildi	ing Materials
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Frank Schmidt-Döhl
Language	DE
Cycle	SoSe
Content	Components of mineral building materials and their function, binding materials, concrete and mortar, special mortars, special concretes
Literature	Taylor, H.F.W.: Cement Chemistry
	Springenschmid, R.: Betontechnologie für die Praxis

Course L0256: Technology of	Course L0256: Technology of mineral Building Materials	
Тур	Project-/problem-based Learning	
Hrs/wk	1	
СР	2	
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14	
Lecturer	Prof. Frank Schmidt-Döhl	
Language	DE	
Cycle	SoSe	
Content	Design and production of a special mineral building material	
Literature	Taylor, H.F.W.: Cement Chemistry	
	Springenschmid, R.: Betontechnologie für die Praxis	

Course L0254: Transport Pro	Course L0254: Transport Processes in Building Materials and Damage Processes	
Тур	Lecture	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Frank Schmidt-Döhl	
Language	DE	
Cycle	SoSe	
Content	Transport Processes in Building Materials and Damage Processes	
Literature	Blaich, J.: Bauschäden, Analyse und Vermeidung	

Courses				
Title		Тур	Hrs/wk	СР
Design of Prestressed Structures a	nd Concreet Bridges (L0603)	Lecture	3	4
Design of Prestressed Structures a	nd Concreet Bridges (L0604)	Recitation Section (large)	2	2
Module Responsible	NN			
Admission Requirements	None			
Recommended Previous	Detailed knowledge on the design of concr	rete structures.		
Knowledge	Madulaa, Dainfanaad Cananata Churchuraa I	U. Chrysteinel Analysia I. U. Mashanina I. U. Conser	-t- Church uno -	
	Modules: Reinforced Concrete Structures I	+II, Structural Analysis I+II, Mechanics I+II, Concre	ete Structures	
Educational Objectives	After taking part successfully, students ha	ve reached the following learning results		
Professional Competence				
Knowledge	The students know the main bridge types	s, their applications and the various loads. They	can explain the b	asic design meth
	They can explain the design of a prestress	ed bridge.		
CI-ill-	s The students are able to design reinforced or prestressed concrete bridges.			
SKIIIS	The students are able to design reinforced	for prestressed concrete bridges.		
Personal Competence				
Social Competence	The students can design in teamwork a rea	al concrete bridge.		
4	The students are able to desire a grant			
Αυτοποτηγ	The students are able to design a prestres	sed concrete bridge and discuss the problems and	i results with othe	r students.
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 minutes			
scale				
Assignment for the	Civil Engineering: Specialisation Structural	Engineering: Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechni	ical Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Coastal Er	ngineering: Elective Compulsory		
	Civil Engineering: Specialisation Computat	ional Engineering: Elective Compulsory		
	International Management and Engineering			

Course L0603: Design of Pre	stressed Structures and Concreet Bridges
Тур	Lecture
Hrs/wk	3
СР	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	NN
Language	DE
Cycle	SoSe
Content	prestressed structures
	 basis of prestressed structures, field of application differences between reinforced and prestressed concrete structures history of prestressing construction materials: concrete, tendons, ducts, anchorage systems construction: prestressing methods prestressing forces and member forces (friction, elongation) tendon layout time dependant prestressing losses design of prestressed structures design of anchorage region non-bonded prestressing prestressed flat slabs
	Concrete bridges history of bridges design of bridges loads on bridges loads on bridges member forces for slab, T-beam, hollow box, frame and arch bridges precast bridges - precast segmental bridges bearings abutments, columns construction methods damages - checking of bridges
Literature	 Vorlesungsumdruckim STUDiP Rombach, G. (2003): Spannbetonbau. Ernst & Sohn, Berlin Wicke, M. (2002): Anwendung des Spannbetons. Betonkalender 2002, Teil II, S. 113-180, Verlag Ernst & Sohn, Berlin Leonhardt, F. (1980): Vorlesungen über Massivbau. Teil 5: Spannbeton. Berlin Mehlhorn, G. (2007): Handbuch Brücken, Springer Verlag Schäfer, H.; Kaufeld, K. (1997): Massivbrücken. Betonkalender Teil II, S. 443ff, Ernst & Sohn, Berlin Menn, Ch. (1986): Stahlbetonbrücken. Springer Verlag, Wien

Course L0604: Design of Pre	ourse L0604: Design of Prestressed Structures and Concreet Bridges	
Тур	Recitation Section (large)	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	NN	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Courses				
Title		Тур	Hrs/wk	СР
Digital Twinning in Civil Engineerin	g (L3136)	Lecture	2	2
Digital Twinning in Civil Engineerin	g (L3137)	Seminar	2	4
Module Responsible	Alexander Chmelnizkij			
Admission Requirements	None			
Recommended Previous				
Knowledge				
Educational Objectives	After taking part successfully, students h	ave reached the following learning results		
Professional Competence				
Knowledge				
Skills				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 124, Study Time	e in Lecture 56		
Credit points	6			
Course achievement	None			
Examination	Presentation			
Examination duration and	20 min presentation and 5 pages handou	t		
scale				
Assignment for the	Civil Engineering: Specialisation Compute	ational Engineering: Compulsory		
Following Curricula	Civil Engineering: Specialisation Coastal	Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Geotech	nical Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Structura	al Engineering: Elective Compulsory		

Course L3136: Digital Twinning in Civil Engineering	
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Alexander Chmelnizkij, Prof. Bastian Oesterle, Prof. Kay Smarsly
Language	DE
Cycle	SoSe
Content	
Literature	

Course L3137: Digital Twinn	ing in Civil Engineering
Тур	Seminar
Hrs/wk	2
СР	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	Alexander Chmelnizkij, Prof. Bastian Oesterle, Prof. Kay Smarsly
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M0827: Mode	ling in Water Management			
	,			
Courses				
Title		Тур	Hrs/wk	СР
Groundwater Modeling using Modfle		Lecture	1	1
Groundwater Modeling using Modfle Modeling of Water Supply Network		Recitation Section (small) Project-/problem-based Learning	2 2	2 3
Module Responsible		Project-/problem-based Leanning	Z	5
Admission Requirements				
Recommended Previous				
Knowledge				
5	 groundwater hydraulics and transport of s 	substances		
	Pipe Systems			
	Knowledge on urban water infrastructu	res, in particular drinking water systemsand	urban drainag	e systems includin
	special structures			
	Hydraulics of drinking water supply syste	ms and sewer systems		
	Basic knowledge on water management			
Educational Objectives	After taking part successfully, students have rea	ched the following learning results		
Professional Competence		- -		
Knowledge	The students are able to describe the modelling	of groundwater flow and transport as well as ur	ban water infr	astructures. They ca
	carry out systems analyses and can detect tech	nical and conceptual weak points within the sys	stems in case	studies. Besides the
	are able to analyse interdependencies of hydrau	lic and toxic phenomena in soil and water.		
Skills	The students are able to construct and apply s	cientific groundwater models indipendently. The	ey can work o	n different scenarios
	and can compare or assess different solutions for	or existing problems by application of selected s	oftware produ	cts. The students are
	able to use different software solutions (e.g. EPA	NET, EPA-SWMM).		
Personal Competence				
Social Competence	Wird nicht vermittelt.			
A L	Wird night vormittelt			
Αυτοποπγ	Wird nicht vermittelt.			
Workload in Hours	Independent Study Time 110, Study Time in Lec	ture 70		
Credit points				
Course achievement				
Examination				
	30 min			
scale				
-	Civil Engineering: Specialisation Structural Engin	•		
Following Curricula	Civil Engineering: Specialisation Geotechnical Er			
	Civil Engineering: Specialisation Coastal Engineering: Specialisation Water and Traff	•		
	Civil Engineering: Specialisation Water and Tran			
	Water and Environmental Engineering: Specialis			
	Water and Environmental Engineering: Specialis			
	Water and Environmental Engineering: Specialis			

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

Course L0544: Groundwater	urse L0544: Groundwater Modeling using Modflow	
Тур	Recitation Section (small)	
Hrs/wk	2	
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	Course L0875: Modeling of Water Supply Network		
Тур	Project-/problem-based Learning		
Hrs/wk	2		
CP	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Dr. Klaus Johannsen		
Language	DE		
Cycle	SoSe		
Content			
Literature	Mutschmann/Stimmelmayr: Taschenbuch der Wasserversorgung, 16. Auflage. Springer Vieweg - Verlag. Wiesbaden 2014.		

Courses				
Title		Тур	Hrs/wk	СР
Soil Mechanics - Selected Topics (L	0374)	Lecture	2	2
Soil Dynamics (L0452)		Lecture	2	2
Experimental Researches in Geote	chnics (L0706)	Practical Course	2	2
Module Responsible	Prof. Jürgen Grabe			
Admission Requirements	None			
Recommended Previous	Modules: Mathematics I-III, Mechanics I-II, Geotechni	cs l		
Knowledge	Courses: Soil laboratory course, (Applied structural c	ynamics)		
Educational Objectives	After taking part successfully, students have reached	d the following learning results		
Professional Competence				
	Students will be able to,			
	 describe wave propagation in the ground und 			
	 to measure vibrations and to interpret the date 			
	 justify when elastodynamic methods are sufficient of the sufficiency of the		ts must be taken into	account,
	to reproduce the collapse theorems of plastici			
	describe the viscous behavior of cohesive s	oils and computationally account fo	or creep deformation	and rate-depende
	shear strengths			
	 as well as to determine the effect of partial satisfies 	turation on the seepage flow and th	e snear strength.	
Skills	After the successful completion of the module the st	udents should be able to:		
	 to derive and apply the basic equation of a sir 	nple mass oscillator.		
	 to understand the wave propagation in the so 		etect the relevant par	ameters.
	 to know the essential laboratory and field test 			
	 to design machine foundations to dynamic load 			,
	 to measure shocks to perform vibration foreca 			
	 to evaluate shocks in terms of their effect on 			
	 to evaluate possibilities of isolation, 			
	 to understand mechanisms that cause earthq 	uakes and evaluate earthquakes in t	erms of their magnitu	de and intensity,
	 to know methods to determine axial pile capa 			
	 to know the mechanisms that lead to a deformation 	mation accumulation due to cyclic lo	bading and to estimate	e these deformatio
	mathematically,			
	• to distinguish the area of application of the m	ethod of elastodynamics and plastod	dynamics,	
	 to detect the undrained shear strength as a full 	nction of a number of state variable	es,	
	• to capture the visous behaviour of cohesive s	oils and to consider the effects of c	reep and rate-depend	ent shear strength
	calculations,			
	 to consider the impact of the partly saturated 	of a seepage and shear strength.		
Personal Competence				
	Students will be able to work in teams to achieve r	esults on measurement and experi	mental principles and	nresent their resu
Social competence	together at the end of the semester.	esaits on measurement and experii	nentar principles alla	present their resu
	together at the end of the semester.			
Autonomy	Students are able to assess their own strengths and	weaknesses and organize their time	and learning manage	ement based on this
Workload in Hours	Independent Study Time 96, Study Time in Lecture 8	34		
Credit points	6			
Course achievement		escription		
	Yes None Subject theoretical and			
Examination	practical work Written exam			
Examination duration and	135 min			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Engineeri	ng: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engine			
-	Civil Engineering: Specialisation Coastal Engineering			
	Civil Engineering: Specialisation Computational Engi			

Course L0374: Soil Mechanic	s - Selected Topics
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Hans Mathäus Stanford
Language	DE
Cycle	SoSe
Content	selected topis:
Literature	 Stress-strain behaviour (experiments, observations, models) Hydraulic behaviour (experiments, observations, models) Physical modelling (similarity theory, 1g model tests, ng model tests) Limit and safety analysis (collapse theorems of plasticity theory, upper and lower bound analysis, limit equilibrium analysis, numerical analysis) Heat transport (heat conduction, convective heat transport, freezing/thawing) Kolymbas D. (2019): Geotechnik - Bodenmechanik, Grundbau und Tunnelbau. Springer Verlag, 5. Auflage Muir Wood D. (2004). Geotechnical modelling. CRC Press Nova, R. (2010). Soil mechanics. Wiley Verruijt, A. (2012). Soil mechanics. u r l: https://geo.verruijt.net Verruijt A. (2018). An introduction to soil mechanics. Vol. 30, Springer Series Theory and Applications of Transport in Porous Media

Course L0452: Soil Dynamics		
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	dependent Study Time 32, Study Time in Lecture 28	
Lecturer	Anne Hagemann	
Language		
Cycle	SoSe	
Content	mass-spring-damper systems,	
	• wave propagation in soils,	
	dynamic soil parameters,	
	Determination of dynamic soil parameters,	
	• machine foundations,	
	• in-situ measurement of ground motion, ground motion prediction, evaluation of ground motion,	
	• ground motion shielding,	
	introduction into earthquake engineering,	
	• dynamic pile tests,	
	• cyclic accumulation,	
	• plastodynamics	
Literature	 Das B.M.: Fundamentals of Soil Dynamics, Elsevier Empfehlungen des Arbeitskreises Baugrunddynamik. Hrsg. Deutsche Gesellschaft für Geotechnik (DGGT) Haupt W.: Bodendynamik. Vieweg und Teubner Meskouris K. und Hinzen KG.: Bauwerke und Erdbeben. Vieweg Verlag Studer J.A., Koller M.G. und Laue J.: Bodendynamik, Springer Verlag 	

Course L0706: Experimental	Researches in Geotechnics	
Тур	Practical Course	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Dr. Hans Mathäus Stanford, Göta Bürkner	
Language	E	
Cycle	SoSe	
Content	 The students are supposed to: become acquainted with geotechnical model tests, field tests and laboratory tests as well as corresponding measurement techniques. These compromise amongst others inclinometer measurements and geophone measurements as well as high-grade laboratory tests on the stress-strain relationship of soil specimens, e. g. triaxial tests, simple shear tests and resonant column tests. gain insight into current soil mechanical research. plan, coordinate, perform and evaluate soil mechanical tests in a team. discuss, reflect, review and present the obtained results in a group. An important learning target is the introduction to scientific work for students who plan a scientific career, and for those who will work in practice with the responsibility to order corresponding tests and evaluate the results. The practical laboratory work is based on annualy changing problems, which are however related to the experience and results of the preceding year's course group.	
Literature	 Grabe, J. (2004): Bodenmechanik und Grundbau, Band 3 der Veröffentlichungsreihe des Instituts für Geotechnik und Baubetrieb, Technische Universität Hamburg-Harburg. Kolymbas, D. (2007): Geotechnik - Bodenmechanik, Grundbau und Tunnelbau. 2., korrigierte und ergänzte Auflage, Springer Verlag. Normen zu geotechnischen Versuchsgeräten und Versuchsverfahren: DIN 18135:2012-04: Baugrund, Untersuchung von Bodenproben - Eindimensionaler Kompressionsversuch, Deutsches Institut für Normung, e. V. DIN 18137-2:2011-04: Baugrund, Untersuchung von Bodenproben - Bestimmung der Scherfestigkeit - Teil 2: Triaxialversuch, Deutsches Institut für Normung e. V. 	

Courses				
Title		Тур	Hrs/wk	СР
Noise Protection (L1109) Urban Infrastructures (L0874)		Lecture Project-/problem-based Learning	2 2	2 4
		Project-/problem-based Learning	Z	4
-	Dr. Dorothea Rechtenbach			
Admission Requirements	None			
Recommended Previous	 Knowledge on Urban planning 			
Knowledge	 Knowledge on measures for climate protection 			
	 General knowledge of scientific writing/working 			
Educational Objectives	After taking part successfully, students have reached the follow	ing loarning results		
Professional Competence	After taking part successfully, students have reached the follow	ing learning results		
•	Students can describe urban development corridors as well as	current and future urban environ	mental probler	ns. They are able
Knowiedge	explain the causes of environmental problems (like noise).			ns. mey are able
	Students can specify applications for various technical innovati	ons and explain why these contri	bute to the im	provement of urb
	life. They can, for example, derive and discuss measures for effi			proteinene or and
Skills	Students are able to develop specific solutions for correc			
	development. They can define a range of conceptual and technical solutions for environmental problems for different of			
	paths. To solve specific urban environmental problems they ca	an select technical innovations a	nd integrate t	hem into the urb
	context.			
Personal Competence	T I			
Social Competence	The students can work together in international groups.			
Autonomy	Students are able to organize their work flow to prepare them:	selves for presentations and cont	ributions to th	ne discussions. Th
	can acquire appropriate knowledge by making enquiries indepe	ndently.		
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	e Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering: Elec	tive Compulsory		
	Civil Engineering: Specialisation Coastal Engineering: Elective C	ompulsory		
	Civil Engineering: Specialisation Water and Traffic: Elective Com	npulsory		
	Environmental Engineering: Core Qualification: Elective Compul	sory		
	Joint European Master in Environmental Studies - Cities and Sus	tainability: Core Qualification: Cor	mpulsory	
	Logistics, Infrastructure and Mobility: Specialisation Infrastructu	re and Mobility: Elective Compuls	ory	
	Water and Environmental Engineering: Specialisation Environme	ent: Elective Compulsory		
	Water and Environmental Engineering: Specialisation Cities: Col			

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.

Courses				
Title		Тур	Hrs/wk	СР
Harbour Engineering (L0809)		Lecture	2	2
Harbour Engineering (L1414)		Project-/problem-based Learning	1	2
Port Planning and Port Construction	n (L0378)	Lecture	2	2
Module Responsible	Prof. Peter Fröhle			
Admission Requirements	None			
Recommended Previous	Basics of coastal engineering			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the foll	owing learning results		
Professional Competence				
Knowledge	The students are able to define in details and to choose design approaches for the functional design of a port and apply then			rt and apply them
	design tasks. They can design the fundamental elements of a port.			
CI-III-				
SKIIIS	The students are able to select and apply appropriate approa	ches for the functional design of po	115.	
Personal Competence				
Social Competence	The students are able to deploy their gained knowledge in	applied problems such as the funct	tional design	of ports. Additiona
	they will be able to work in team with engineers of other disc	plines.		
Autonomy	The students will be able to independently extend their know	ledge 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 examinat	on includes tasks with respect to	the general u	understanding of
scale	lecture contents and calculations tasks.			
Assignment for the	Civil Engineering: Specialisation Structural Engineering: Elect	ive Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering: E	ective Compulsory		
	Civil Engineering: Specialisation Coastal Engineering: Compu	sory		
	Civil Engineering: Specialisation Water and Traffic: Elective C	ompulsory		
	International Management and Engineering: Specialisation II.	Civil Engineering: Elective Compuls	onv	

Course L0809: Harbour Engineering	
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Peter Fröhle
Language	DE
Cycle	SoSe
Content	 Fundamentals of harbor engineering Maritime transportation and waterways engineering Ships Elements of harbors Harbor approaches and water-side harbor areas Terminal design and handling of cargo Quay-walls and piers Equipment of harbors Sluices and other special constructions Connection to inland transportation / inland waterway transportation Protection of harbors Breakwaters and Jetties Wave protection of harbors Fishery and other small harbors
Literature	Brinkmann, B.: Seehäfen, Springer 2005

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Course L1414: Harbour Engin	urse L1414: Harbour 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	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L0378: Port Planning	and Port Construction
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Frank Feindt
Language	DE
Cycle	SoSe
Content	 Planning and implementation of major projects Market analysis and traffic relations Planning process and plan Port planning in urban neighborhood Development of the logistics center "Port of Hamburg" in the metropolis Quays and waterfront structure Special planning Law Harbor - securing of a flexible use of the port Dimensioning of quays Flood protection structures Port of Hamburg - Infrastructure and development Preparation of areas Scour formation in front of shore structures
Literature	Vorlesungsumdruck, s. www.tu-harburg.de/gbt

Courses				
Title		Түр	Hrs/wk	СР
Hydraulic Models (L0813)		Project-/problem-based Learning	1	1
Modelling of Waves (L0812)		Project-/problem-based Learning	1	1
Modelling of Flow in Rivers and Est	Jaries (L0810)	Lecture	3	4
Module Responsible	Prof. Peter Fröhle			
Admission Requirements	None			
Recommended Previous	Coastal Hydraulic Engineering I			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the follo	wing learning results		
Professional Competence				
Knowledge	Students are able to define in detail the basic processes t	hat are related to the modelling	of flows in hy	ydraulic engineerir
	Besides, they can describe the basic aspects of numerical m	odelling and actual numerical mod	els for the sir	nulation of flows a
	waves.			
Skille	Students are able to apply hydrodynamic-numerical models to	o practical hydraulic opgingering ta	sks	
JKIIIS	students are able to apply hydrodynamic-humenear models a	, practical hydraulic engineering ta	585.	
Personal Competence				
Social Competence	The students are able to deploy their gained knowledge in si	mple applied problems. Additionaly	, they will be	able to work in tea
	with others.			
Autonomy	The students will be able to independently extend their know	edge 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 3 hours. The examinati	on includes tasks with respect to	the general ι	understanding of t
scale	lecture contents and calculations tasks.			
Assignment for the	Civil Engineering: Specialisation Structural Engineering: Election	ve Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering: El	ective Compulsory		
	Civil Engineering: Specialisation Coastal Engineering: Elective	Compulsory		
	Civil Engineering: Specialisation Computational Engineering:	Compulson		

ourse L0813: Hydraulic Models		
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	DE/EN	
Cycle	SoSe	
Content	 Fundamentals of hydraulic models Model laws Pi theorem of Buckingham Practical examples of hydraulic models 	
Literature	Strobl, Zunic: Wasserbau, Kap. 11 Hydraulische Modelle, Springer	

Course L0812: Modelling of Waves		
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	DE/EN	
Cycle	SoSe	
Content	 Waves, interactions with shallow water and constructions Wave theories Sea state and surges Development of waves Wave spectra Modelling of Waves / phase averaged and phase resolved models Application of a phase averaged model for wave prediction (SWAN) Application of phase resolved wave models (Mike) 	
Literature	Vorlesungsumdruck	

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

Courses				
Title		Тур	Hrs/wk	СР
Biological Wastewater Treatment (I	_0517)	Lecture	2	2
Biological Wastewater Treatment (I		Recitation Section (larg	e) 1	1
Advanced Wastewater Treatment (L0357)	Lecture	2	2
Advanced Wastewater Treatment (L0358)	Recitation Section (larg	e) 1	1
Module Responsible	Dr. Joachim Behrendt			
Admission Requirements	None			
Recommended Previous	Knowledge of wastewater management	and the key processes involved in wastewater	treatment.	
Knowledge				
Educational Objectives	After taking part successfully, students h	ave reached the following learning results		
Professional Competence				
Knowledge	Students are able to outline key areas o	f the full range of treatment systems in waste	water management, a	s well as their mu
	dependence for sustainable water protect	tion. They can describe relevant economic, er	vironmental and socia	l factors.
Skills		plain the available wastewater treatment pro-	cesses and the scope	of their application
	municipal and for some industrial treatm	ent plants.		
Personal Competence				
	Social skills are not targeted in this mod	le		
Social competence	Social skills are not targeted in this mod	ui c .		
Autonomy	Students are in a position to work on a	a subject and to organize their work flow inc	dependently. They can	also present on
	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 Structur	al Engineering: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotech	nical Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Coastal	Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Water a	nd Traffic: Compulsory		
	Bioprocess Engineering: Specialisation A	- General Bioprocess Engineering: Elective Co	mpulsory	
	Environmental Engineering: Specialisatio	on Water Quality and Water Engineering: Electi	ve Compulsory	
	International Management and Engineer	ing: Specialisation II. Process Engineering and	Biotechnology: Elective	e Compulsory
	• •	ing: Specialisation II. Energy and Environmenta	•••	
		ronmental Process Engineering: Elective Comp		
	Process Engineering: Specialisation Proc			
	Water and Environmental Engineering: S			
	Water and Environmental Engineering: S	pecialisation Environment: Elective Compulsor	v	

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

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

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

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

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

Courses	
Title	Typ Hrs/wk CP
City Planning (L1066)	Project-/problem-based Learning 4 6
Module Responsible	Prof. Carsten Gertz
Admission Requirements	None
Recommended Previous	for "Principles of Urban Planning": none
Knowledge	for "Designing Urban Streetscapes": some knowledge of transport planning, e.g. through taking the undergraduate class "Trans
	Planning and Traffic Engineering"
	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
Αυτοποπιγ	Students are able to:
	 independently complete a written report including drawings following a broadly pre-defined process.
	 assess the consequences of their proposed solutions.
	 independently acquire knowledge and apply this to new issues or problem areas.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	
-	
Course achievement	
Examination	
Examination duration and scale	written assignment, designwork 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 Coastal Engineering: Elective Compulsory Civil Engineering: Specialisation Water and Traffic: Elective Compulsory
	Logistics, Infrastructure and Mobility: Specialisation Infrastructure and Mobility: Elective Compulsory
	Water and Environmental Engineering: Specialisation Environment: Elective Compulsory
	Water and Environmental Engineering: Specialisation Cities: Compulsory

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

Courses					
Title	Тур	1	Hrs/wk	СР	
Construction Logistics (L1163)	Lectu		1	2	
Construction Logistics (L1164)		tation Section (small)	1	2	
Project Development and Managen			1	1	
Project Development and Managen		ect-/problem-based Learning	1	1	
Module Responsible	-				
Admission Requirements					
Recommended Previous	none				
Knowledge					
Educational Objectives	After taking part successfully, students have reached the following lea	arning results			
Professional Competence					
Knowledge	Students can				
	• give definitions of the main terms of construction logistics and	project development and ma	anagement		
	name advantages and disadvantages of internal or external con	nstruction logistics			
	• explain characteristics of products, demand and production of	construction objects and the	eir consequer	nces for construction	
	specific supply chains				
	differentiate constructions logistics from other logistics systems	S			
CL 111					
Skills	Students can				
	carry out project life cycle assessments				
	apply methods and instruments of construction logistics				
	apply methods and instruments of project development and ma	anagement			
	 apply methods and instruments of conflict management 				
	 design supply and waste removal concepts for a construction project 				
Personal Competence					
Social Competence	Students can				
	 hold presentations in and for groups 				
	 apply methods of conflict solving skills in group work and cases 	studies			
Autonomy	Students can				
	solve problems by holistic, systemic and flow oriented thinking				
	• improve their creativity, negotiation skills, conflict and crises solution skills by applying methods of moderation in cas				
	studies				
	Independent Study Time 124, Study Time in Lecture 56				
Credit points					
Course achievement					
Examination	Written elaboration				
	Two written papers with presentations				
scale					
Assignment for the	Civil Engineering: Specialisation Structural Engineering: Elective Comp				
Following Curricula					
	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory				
	Civil Engineering: Specialisation Water and Traffic: Elective Compulsor				
	International Management and Engineering: Specialisation II. Civil Eng		ory		
	International Management and Engineering: Specialisation II. Logistics				
	Logistics, Infrastructure and Mobility: Specialisation Production and Lo				
	Logistics, Infrastructure and Mobility: Specialisation Infrastructure and	1 Mobility: Elective Compulso	ory		

Course L1163: Construction	Logistics			
Тур	Lecture			
Hrs/wk	1			
СР	2			
Workload in Hours	lependent Study Time 46, Study Time in Lecture 14			
Lecturer	Prof. Heike Flämig			
Language	DE			
Cycle	SoSe			
Content	The lecture gives deeper insight how important logistics are as a competetive factor for construction projects and which issues are to be adressed. The following toppics are covered: • competetive factor logistics • the concept of systems, planning and coordination of logistics • material, equipment and reverse logistics • IT in construction logistics • elements of the planning model of construction logistics and their connections • flow oriented logistics systems for construction projects • logistics concepts for ready to use construction projects (especially procurement and waste removel logistics) • best practice examples (construction logistics Potsdamer Platz, recent case study of the region) Contents of the lecture are deepened in special exercises.			
Literature	 Flämig, Heike: Produktionslogistik in Stadtregionen. In: Forschungsverbund Ökologische Mobilität (Hrsg.) Forschungsbericht Bd. 15.2. Wuppertal 2000. Krauss, Siri: Die Baulogistik in der schlüsselfertigen Ausführung, Bauwerk Verlag GmbH Berlin 2005. Lipsmeier, Klaus: Abfallkennzahlen für Neubauleistungen im Hochbau : Verlag Forum für Abfallwirtschaft und Altlasten, 2004. Schmidt, Norbert: Wettbewerbsfaktor Baulogistik. Neue Wertschöpfungspotenziale in der Baustoffversorgung. In: Klaus, Peter: Edition Logistik. Band 6. Deutscher Verkehrs-Verlag. Hamburg 2003. Seemann, Y.F. (2007): Logistikkoordination als Organisationseinheit bei der Bauausführung Wissenschaftsverlag Mainz in Aachen, Aachen. (Mitteilungen aus dem Fachgebiet Baubetrieb und Bauwirtschaft (Hrsg. Kuhne, V.): Heft 20) 			

Course L1164: Construction Logistics				
Тур	ation Section (small)			
Hrs/wk	1			
СР	2			
Workload in Hours	ndent Study Time 46, Study Time in Lecture 14			
Lecturer	leike Flämig			
Language	DE			
Cycle	SoSe			
Content	See interlocking course			
Literature	See interlocking course			

Course L1161: Project Devel	opment and Management
Тур	Lecture
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Heike Flämig, Dr. Anton Worobei
Language	DE
Cycle	SoSe
Content	Within the lecture, the main aspects of project development and management are tought:
	 Terms and definitions of project management Advantages and disadvantages of different ways of project handling organization, information, coordination and documentation cost and fincance management in projects time- and capacity management in projects specific methods and instruments for successful team work Contents of the lecture are deepened in special exercises.
Literature	Projektmanagement-Fachmann. Band 1 und Band 2. RKW-Verlag, Eschborn, 2004.

Course L1162: Project Devel	urse L1162: Project Development and Management				
Тур	ject-/problem-based Learning				
Hrs/wk	1				
СР	1				
Workload in Hours	endent Study Time 16, Study Time in Lecture 14				
Lecturer	Heike Flämig, Dr. Anton Worobei				
Language	DE				
Cycle	SoSe				
Content	See interlocking course				
Literature	See interlocking course				

Courses					
Title		Тур	Hrs/wk	СР	
Structural Dynamics (L1202)		Lecture	2	2	
Structural Dynamics (L1203)		Recitation Section (large)	2	2	
Fracture mechanics and fatigue in		Lecture	1	1	
Fracture mechanics and fatigue in	steel structures (L0565)	Recitation Section (large)	1	1	
Module Responsible	Prof. Bastian Oesterle				
Admission Requirements	None				
Recommended Previous	Knowledge of linear structural analysis	of statically determinate and indeterminate stru	ctures; Mechanics	I/II, Mathematics	
Knowledge	Differential equations I				
Educational Objectives	After taking part successfully students	have reached the following learning results			
Professional Competence					
	After successful completion of this more	dule, the student can explain the basic aspects of	dynamic effects (on structures and	
Kilowicage	respective methods.	and, the statent can explain the basic aspects of	aynamic cheets (Shi Structures and	
Skille	After successful completion of this m	odule, the students will be able to predict the r	ocnonco of motor	ial and structures	
SKIIIS		computational approaches and methods.	esponse of mater		
	aynamics loading asing the appropriate	computational approaches and methods.			
Devenuel Competence					
Personal Competence	Chudanta and				
Social Competence	Students can				
	 participate in subject-specific and 	l interdisciplinary discussions,			
	defend their own work results in front of others				
	promote the scientific development of colleagues				
	 Furthermore, they can give and accept professional constructive criticism 				
A 4 .			and the line of the second		
Autonomy		the subject area from given and other sources and		opiems. Furthermo	
	they are able to structure the solution process for problems in the area of Structural Analysis.				
Workload in Hours	Independent Study Time 96, Study Time	e in Lecture 84			
Credit points	6				
Course achievement	None				
Examination					
Examination duration and	150 min				
scale					
Assignment for the	Civil Engineering: Specialisation Structure	ral Engineering: Compulsory			
Following Curricula	Civil Engineering: Specialisation Geotech	hnical Engineering: Elective Compulsory			
	Civil Engineering: Specialisation Coastal	Engineering: Elective Compulsory			
	Civil Engineering: Specialisation Water a	and Traffic: Elective Compulsory			
	Civil Engineering: Specialisation Comput	tational Engineering: Elective Compulsory			

Course L1202: Structural Dy	namics	
Тур	ecture	
Hrs/wk	2	
CP	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Bastian Oesterle	
Language	DE	
Cycle	SoSe	
Content	 mechanical background of dynamics harmonic vibrations, damped and undamped free and forced vibrations frequency and time domain modelling aspects principle of d'Alembert systems with multiple degrees of freedom consistent and lumped mass matrices finite elements for dynamics problems impact problems eigenvalue problems and modal analysis direct time integration schemes, transient analyses 	
Literature	 Vorlesungsmanuskript Clough, R.W., Penzien, J.: Dynamics of Structures. 2. Aufl., McGraw-Hill, New York, 1993. 	

Course L1203: Structural Dy	ourse L1203: Structural Dynamics	
Тур	Recitation Section (large)	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Bastian Oesterle	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Тур	Lecture
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dr. Jürgen Priebe
Language	DE
Cycle	SoSe
Content	 basics of fatigue stress and fatigue resistance and determination of fatigue strength,
	 determination anduse of S-N-curves and classification of notch effects,
	set up of determination of fatigue strength under dynamic load using the accumulation formula by Palmgren-Miner,
	 set up of determination of fatigue strength in different examples,
	 basics of construction and design regarding the problem of material fatigue,
	basics of linear elastic fracture mechanics under static and dynamic load,
	determination of lifetime of steel construction based on linear elastic fracture mechanics in different examples.
Literature	Seeßelberg, C.; Kranbahnen - Bemessung und konstruktive Gestaltung; 3. Auflage; Bauwerk-Verlag; Berlin 2009
	• Kuhlmann, Dürr, Günther; Kranbahnen und Betriebsfestigkeit; in Stahlbau Kalender 2003; Verlag Ernst & Sohn; Berlin 2003
	Deutscher Stahlbau-Verband (Hrsg.); Stahlbau Handbuch Band 1 Teil B; 3. Auflage; Stahlbau-Verlagsgesellschaft; Köln 199
	Petersen, C.; Stahlbau; 3. überarb. und erw. Auflage; Vieweg-Verlag; Braunschweig 1993
	 DIN V ENV 1993-1-1: Eurocode 3; Bemessung und Konstruktion von Stahlbauwerken; Teil 1-1: Allgemeine Bemessungsre Bemessungsregeln für den Hochbau; 1993
	• DIN V ENV 1993-6: Eurocode 3; Bemessung und Konstruktion von Stahlbauwerken; Teil 6: Kranbahnen; 2001
	DIN-Fachbericht 126. Richtlinie zur Anwendung von DIN V ENV 1993-6; Nationales Anwendungsdokument (NAD); Berlin 20

Course L0565: Fracture med	ourse L0565: Fracture mechanics and fatigue in steel structures	
Тур	Recitation Section (large)	
Hrs/wk	1	
CP	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Dr. Jürgen Priebe	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Courses				
Title		Тур	Hrs/wk	СР
Steel Construction Project (L1206)		Project Seminar	4	6
Module Responsible	Prof. Marcus Rutner			
Admission Requirements	None			
Recommended Previous	Steel and Composite Structures			
Knowledge				
Educational Objectives	After taking part successfully, students hav	e reached the following learning results		
Professional Competence				
Knowledge	Students are able to prepare a part of the v	hole project and explain it to the others.		
Skills	Students can produce sketches and calcu	lations of their part of the project. They	are able to adjust their	work in reaction
	changing conditions resulting from other pa	rticipants of the project.		
Personal Competence				
Social Competence	Students can present their results to other members of the group.			
	They have the ability to work for a broad ag	reement with respect to intergroup depend	lencies.	
	They can distribute and process tasks indep	pendently.		
Autonomy	Students can handle their part of the project	t on their own resposibility-		
Workload in Hours	Independent Study Time 124, Study Time in	n Lecture 56		
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
Examination duration and	approx. 15-20 pages (without appendix)			
scale				
Assignment for the	Civil Engineering: Specialisation Geotechnic	al Engineering: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Coastal En	gineering: Elective Compulsory		
	Civil Engineering: Specialisation Structural	Engineering: Compulsory		
	Civil Engineering: Specialisation Computation	onal Engineering: Elective Compulsory		

Course L1206: Steel Constru	Course L1206: Steel Construction Project	
Тур	Project Seminar	
Hrs/wk	4	
СР	6	
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56	
Lecturer	Prof. Marcus Rutner	
Language	DE	
Cycle	SoSe	
Content	Design of a big construction project (i.e skyscraper, large bridge, roof of a stadiuim) in small groups	
Literature	Wird je nach Projekt individuell angegeben.	

Courses					
Title		Тур	Hrs/wk	СР	
Marine Geotechnics (L0548)		Lecture	1	2	
Marine Geotechnics (L0549)	Undrewlie Engine grieg (11146)	Recitation Section (large)	2	2	
Steel Structures in Foundation and		Lecture	Z	Z	
Module Responsible Admission Requirements					
	Complete modules: Geotechnics I-III, Math	omatics LIII			
Kecommended Previous Knowledge	complete modules: Geotechnics I-III, Math				
Kilowiedge	Courses: Soil laboratory course				
Educational Objectives	After taking part successfully, students ha	ve reached the following learning results			
Professional Competence					
Knowledge	The students get a deeper knowledge of steel and ground engineering as well as constructions knowledge concerning quay w			oncerning quay wa	
	Furthermore, the students get all the necessary knowledge to design singular construction elements for sheet pile walls and the				
	know how to choose the right construction	elements depending on the influencing conditions	š.		
	Furthermore, the students are able to div				
SKIIIS	Furthermore, the students are able to dimension sheet pile wall construction regarding all construction elements, to choose the				
	suitable construction elements with respect to the influencing conditions, to design all kinds of sheet pile walls (wave sheet pil walls and combined sheet pile walls) and to dimension all construction elements and connections.				
	waits and combined sheet pile waits) and t		10115.		
Personal Competence					
Social Competence					
Autonomy	Students are able to assess their own stre	ngths and weaknesses and organize their time and	learning manage	ement based on th	
Workload in Hours	Independent Study Time 110, Study Time	in Lecture 70			
Credit points	6				
Course achievement	None				
Examination	Written exam				
Examination duration and	90 min				
scale					
Assignment for the	Civil Engineering: Specialisation Geotechn	ical Engineering: Compulsory			
Following Curricula	Civil Engineering: Specialisation Structural	Engineering: Elective Compulsory			
	Civil Engineering: Specialisation Coastal E	ngineering: Compulsory			
	Civil Engineering: Specialisation Computat	ional Engineering: Elective Compulsory			
		5 5 7 7			

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

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

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

-				
Courses				
Title		Тур	Hrs/wk	СР
Port Logistics (L0686)		Lecture	2	3
Port Logistics (L1473)		Recitation Section (small)	2	3
Module Responsible				
Admission Requirements	None			
Recommended Previous	none			
Knowledge		and the failly of the sector sector		
Educational Objectives	After taking part successfully, students have reach	ed the following learning results		
Professional Competence				
Knowledge	In			
	After completing the module, students can			
	 reflect on the development of seaports (in te 	arms of the functions of the ports and the c	orresponding ter	minals as well as t
	relevant operator models) and place them in		orresponding ter	ininais, as well as t
	 explain and evaluate different types of 		haracteristics (argo, transhipme
	technologies, logistic functional areas);			
	 analyze common planning tasks (e.g. berth 	n planning, stowage planning, yard plannir	ng) at seaport te	rminals and develo
	suitable approaches (in terms of methods ar	nd tools) to solve these planning tasks;		
	 identify future developments and trends re 	egarding the planning and control of inno	vative seaport te	erminals and discu
	them in a problem-oriented manner.			
Skills	After completing the module, students will be able	to		
	 recognize functional areas in parts and sean 	ort torminals		
	 recognize functional areas in ports and seap define and evaluate suitable operating system 			
	 perform static calculations with regard to g 		canacity (narking	n spaces equipme
	requirements, quay wall length, port access)		cupacity (parking	j spaces, equipme
	 reliably estimate which boundary conditions 		ne static planning	of selected termin
	types and to what extent.	5		
Personal Competence				
Social Competence	After completing the module, students can			
	 transfer the acquired knowledge to further q 	uestions of port logistics;		
	discuss and successfully organize extensive	task packages in small groups;		
	 in small groups, document work results in with the second s	riting in an understandable form and prese	nt them to an ap	propriate extent.
Autonomy	After completing the module, the students are able	e to		
	 research and select specialist literature, ind 	cluding standards, guidelines and journal	nanors and to a	lovelon the center
	 research and select specialist interactive, ind independently; 	cidding standards, guidennes and journal	papers, and to c	levelop the conten
	 submit own parts in an extensive written ela 	aboration in small groups in due time and	to present them	iointly within a fixe
	time frame.	aboration in small groups in due time and	to present them	Jointry within a fixe
	Independent Study Time 124, Study Time in Lectur	re 56		
Credit points	6			
Course achievement	Compulsory Bonus Form	Description		
	No 15 % Written elaboration			
Examination	Written exam			
	120 minutes			
Examination duration and				
scale				
scale Assignment for the				
scale	International Management and Engineering: Specia	alisation II. Logistics: Elective Compulsory		
scale Assignment for the	International Management and Engineering: Specia Logistics, Infrastructure and Mobility: Specialisation	lisation II. Logistics: Elective Compulsory n Production and Logistics: Elective Compul	-	
scale Assignment for the	International Management and Engineering: Specia Logistics, Infrastructure and Mobility: Specialisatior Logistics, Infrastructure and Mobility: Specialisatior	alisation II. Logistics: Elective Compulsory n Production and Logistics: Elective Compul n Infrastructure and Mobility: Elective Comp	-	
scale Assignment for the	International Management and Engineering: Specia Logistics, Infrastructure and Mobility: Specialisation	alisation II. Logistics: Elective Compulsory n Production and Logistics: Elective Compul n Infrastructure and Mobility: Elective Comp ystems: Elective Compulsory	-	

Course L0686: Port Logistics			
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Carlos Jahn		
Language	DE		
Cycle	SoSe		
Content	Port Logistics deals with the planning, control, execution and monitoring of material flows and the associated information flows in the port system and its interfaces to numerous actors inside and outside the port area. The extraordinary role of maritime transport in international trade requires very efficient ports. These must meet numerous requirements in terms of economy, speed, safety and the environment. Against this background, the lecture Port Logistics deals		
	with the planning, control, execution and monitoring of material flows and the associated information flows in the port system an its interfaces to numerous actors inside and outside the port area. The aim of the lecture Port Logistics is to convey a understanding of structures and processes in ports. The focus will be on different types of terminals, their characteristical layout and the technical equipment used as well as the ongoing digitization and interaction of the players involved.		
	In addition, renowned guest speakers from science and practice will be regularly invited to discuss some lecture-relevant to from alternative perspectives.		
	 The following contents will be conveyed in the lectures: Instruction of structures and processes in the port Planning, control, implementation and monitoring of material and information flows in the port Fundamentals of different terminals, characteristical layouts and the technical equipment used Handling of current issues in port logistics 		
Literature	 Alderton, Patrick (2013). Port Management and Operations. Biebig, Peter and Althof, Wolfgang and Wagener, Norbert (2017). Seeverkehrswirtschaft: Kompendium. Brinkmann, Birgitt. Seehäfen: Planung und Entwurf. Berlin Heidelberg: Springer-Verlag, 2005. Büter, Clemens (2013). Außenhandel: Grundlagen internationaler Handelsbeziehungen. Gleissner, Harald and Femerling, J. Christian (2012). Logistik: Grundlagen, Übungen, Fallbeispiele. Jahn, Carlos; Saxe, Sebastian (Hg.). Digitalization of Seaports - Visions of the Future, Stuttgart: Fraunhofer Verlag, 2017. Kummer, Sebastian (2019). Einführung in die Verkehrswirtschaft Lun, Y.H.V. and Lai, KH. and Cheng, T.C.E. (2010). Shipping and Logistics Management. Woitschützke, Claus-Peter (2013). Verkehrsgeografie. 		

Course L1473: Port Logistics	
Тур	Recitation Section (small)
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Carlos Jahn
Language	DE
Cycle	SoSe
content	The content of the exercise is the independent preparation of a scientific paper plus an accompanying presentation on a current topic of port logistics. The paper deals with current topics of port logistics. For example, the future challenges in sustainability and productivity of ports, the digital transformation of terminals and ports or the introduction of new regulations by the International Maritime Organization regarding the verified gross weight of containers. Due to the international orientation of the event, the paper is to be prepared in English.
Literature	 Alderton, Patrick (2013). Port Management and Operations. Biebig, Peter and Althof, Wolfgang and Wagener, Norbert (2017). Seeverkehrswirtschaft: Kompendium. Brinkmann, Birgitt. Seehäfen: Planung und Entwurf. (2005) Berlin Heidelberg: Springer-Verlag. Büter, Clemens (2013). Außenhandel: Grundlagen internationaler Handelsbeziehungen. Gleissner, Harald and Femerling, J. Christian (2012). Logistik: Grundlagen, Übungen, Fallbeispiele. Jahn, Carlos; Saxe, Sebastian (Hg.) (2017) Digitalization of Seaports - Visions of the Future, Stuttgart: Fraunhofer Verlag. Kummer, Sebastian (2019). Einführung in die Verkehrswirtschaft Lun, Y.H.V. and Lai, KH. and Cheng, T.C.E. (2010). Shipping and Logistics Management. Woitschützke, Claus-Peter (2013). Verkehrsgeografie.

Courses				
Title		Тур	Hrs/wk	СР
Water and Environment (L2754) Water and Environment (L2753)		Project-/problem-based Learning Lecture	3 3	3 3
	Deef Nime Chalum	Lecture	2	3
Module Responsible Admission Requirements				
		dralagy		
Kecommended Previous Knowledge	Basic knowledge in water and environmental research, Hy	arology		
	After taking part successfully, students have reached the	iollowing loorning results		
Professional Competence	After taking part successiony, students have reached the	onowing learning results		
•	Common research tools and techniques together with	the fundamental knowledge relevan	t to multi-co	alo and multi ph
KIIOWIEdge	challenges present in water and environmental research	-		
	considered.	will be discussed in this module. Bo	our theory and	u application will
	considered.			
Skills	kills In addition to the fundamental knowledge, the students will be exposed to several analytical, experimental and number		and numerical to	
	and techniques relevant to water and environmental research at different scales. This will provide the students with an excelle			
	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 F	Research-Based Teaching approaches v	will be at the o	ore of this modul
Autonomy	The students will be involved in writing individual repo	rts and presentation. This will contri	bute to the s	students' ability
,	willingness to work independently and responsibly.			,
	Independent Study Time 96, Study Time in Lecture 84			
Credit points				
Course achievement				
	Subject theoretical and practical work			
Examination duration and	Report and Presentation			
scale				
-	Civil Engineering: Specialisation Coastal Engineering: Elect			
Following Curricula	Civil Engineering: Specialisation Water and Traffic: Elective			
	Environmental Engineering: Specialisation Environment ar			
	Water and Environmental Engineering: Specialisation Citie			
	Water and Environmental Engineering: Specialisation Water			
	Water and Environmental Engineering: Specialisation Envi	ronment: Compulsory		

Course L2754: Water and En	vironment
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

Courses				
Title		Тур	Hrs/wk	СР
Maritime Transport (L0063)		Lecture	2 2	3 3
Maritime Transport (L0064)		Recitation Section (small)	Z	3
Module Responsible				
Admission Requirements	None			
Recommended Previous				
Knowledge	After taking part successfully, students have reach	ed the following learning results		
	After taking part successfully, students have reach	ed the following learning results		
Professional Competence	The students are able to			
Knowledge	The students are able to			
	 present the actors involved in the maritime 	transport chain with regard to their typical	tasks;	
	 name common cargo types in shipping and 	classify cargo to the corresponding categor	ies;	
	 explain operating forms in maritime shipping 	g, transport options and management in tra	ansport networks	;
	 weigh the advantages and disadvantages of 	the various modes of hinterland transport	and apply them i	in practice;
	 estimate the potential of digitisation in mari 	time shipping.		
Skills	The students are able to			
	 determine the mode of transport, actors and 	d functions of the actors in the maritime su	oply chain;	
	 identify possible cost drivers in a transport of 			ion;
	 record, map and systematically analyse n 			
	problems and recommend solutions;		-	
	 perform risk assessments of human disrupti 	ons to the supply chain;		
	 analyse accidents in the field of maritime log 	gistics and evaluating their relevance in eve	eryday life;	
	 deal with current research topics in the field 	of maritime logistics in a differentiated wa	у;	
	 plan the deployment of a fleet based on sce 	narios;		
	 apply different process modelling methods i 	n a hitherto unknown field of activity and to	o work out the re	spective advantag
Personal Competence				
	The students are able to			
Social competence				
	 discuss and organise extensive work package 	ges in groups;		
	 document and present the elaborated result 			
Autonomy	The students are capable to			
Autonomy				
	 research and select technical literature, incl 	uding standards and guidelines;		
	 submit own shares in an extensive written extension 	laboration in small groups in due time.		
Workload in Hours	Independent Study Time 124, Study Time in Lectur	re 56		
Credit points	6			
Course achievement	Compulsory Bonus Form	Description		
	No 15 % Subject theoretical and	dTeilnahme an einem Planspiel und anschlie	eßende schriftlich	ne Ausarbeitung
	practical work			
Examination	Written exam			
Examination duration and				
scale				
Assignment for the	Civil Engineering: Specialisation Coastal Engineering	a: Elective Compulsory		
Following Curricula	International Management and Engineering: Specia			
i onowing curricula	Logistics, Infrastructure and Mobility: Specialisation	• • •	sorv	
	Logistics, Infrastructure and Mobility: Specialisation			
	Renewable Energies: Specialisation Wind Energy S		,	
	Theoretical Mechanical Engineering: Specialisation			

Course L0063: Maritime Trar	isport	
Тур	Lecture	
Hrs/wk	2	
CP	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Carlos Jahn	
Language	DE	
Cycle	SoSe	
	The general tasks of maritime logistics include the planning, design, implementation and control of material and information flows in the logistics chain ship - port - hinterland. The aim of the course is to provide students with knowledge of maritime transport and the actors involved in the maritime transport chain. Typical problem areas and tasks will be dealt with, taking into account the economic development. Thus, classical problems as well as current developments and trends in the field of maritime logistics are considered. In the lecture, the components of the maritime logistics chain and the actors involved will be examined and risk assessments of human disturbances on the supply chain will be developed. In addition, students learn to estimate the potential of digitisation in maritime shipping, especially with regard to the monitoring of ships. In addition, students are able to design operational planning for fleets of container or tramp vessels. Further content of the lecture is the different modes of transport in the hinterland, which students can evaluate after completion of the course regarding their advantages and disadvantages.	
Literature	 Clausen, Uwe and Geiger, Christiane. Verkehrs- und Transportlogistik. Berlin Heidelberg: Springer-Verlag, 2013. Schönknecht, Axel. Maritime Containerlogistik: Leistungsvergleich von Containerschiffen in intermodalen Transportketten. Berlin Heidelberg: Springer-Verlag, 2009. Rodrigue, Jean-Paul. Geography of Transport Systems. London New York: Routledge, 2020. Stopford, Martin. Maritime Economics Routledge, 2009. 	

Course L0064: Maritime Tran	isport	
Тур	Recitation Section (small)	
Hrs/wk		
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Carlos Jahn	
Language	DE	
Cycle	SoSe	
Content	The exercise lesson bases on the haptic management game MARITIME. MARITIME focuses on providing knowledge about structures and processes in a maritime transport network. Furthermore, the management game systematically provides process management methodology and also promotes personal skills of the participants.	
Literature	 Brinkmann, Birgitt. Seehäfen: Planung und Entwurf. Berlin Heidelberg: Springer-Verlag, 2005. Koch Susanne. Methoden des Prozessmanagements. In: Einführung in das Management von Geschäftsprozessen. Springer, Berlin, Heidelberg, 2011. Liebetruth, Thomas. Prozessmanagement in Einkauf und Logistik, Springer Gabler: Wiesbaden, 2020. Schönknecht, Axel. Maritime Containerlogistik: Leistungsvergleich von Containerschiffen in intermodalen Transportketten. Berlin Heidelberg: Springer-Verlag, 2009. Stopford, Martin. Maritime Economics Routledge, 2009 	

C				
Courses				
Title		Тур	Hrs/wk	СР
Smart Monitoring (L2762) Smart Monitoring (L2763)		Integrated Lecture Recitation Section (small)	2	2 4
Module Responsible	Prof. Kay Smarsly		-	·
Admission Requirements	None			
Recommended Previous	Basic knowledge or interest in object-oriented modeli	ng programming and sensor technologic	nies are helpful	Interest in mor
Knowledge	research and teaching areas, such as Internet of Thir			
J.	skills of scientific working, are required. Basic knowled			
	After taking part successfully, students have reached t	ne following learning results		
Professional Competence	The students will become familiar with the principle	and practices of smart monitoring	The students wil	l ha abla ta da
Kilowiedye	The students will become familiar with the principle decentralized smart systems to be applied for con			
	environment. In addition, the students will learn to des			
	analysis techniques, modern software design concepts			
	also part of this module, which will be conducted thro			
	students will design smart monitoring systems that inte	•	÷	
	Specific focus will be put on the application of machi			
	real-world (built or natural) systems, such as bridges o	5 1	5 5	
	every group will be documented in a paper. All student			
	system in the annual "Smart Monitoring" competition.	The written papers and oral examinatio	ns form the final	grades. The mo
	will be taught in English. Limited enrollment.			
Skills	s 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 i			
	implement the strategies in smart wireless sensor nodes, using embedded computing and programming. Finally, the students w be able to document the findings of their projects in short reports.			
	be able to document the infangs of their projects in sh	or reports.		
Personal Competence				
Social Competence	The students will be able to work in groups, share par	ts of the work for their projects, and de	evelop communic	ation skills, towa
	achieving the common project goals.			
Διιτοποπγ	The students will be able to gain a solid basis on app	proaching and solving problems in eng	ineering as well	as on documen
hatohomy	results, through their involvement in their monitoring of		incernig, us wen	us on usedinen
	Independent Study Time 124, Study Time in Lecture 56	5		
Credit points Course achievement				
	Written elaboration			
	10 pages of work with 15-minute oral presentation			
scale				
Assignment for the	Civil Engineering: Specialisation Water and Traffic: Elec	tive Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineer	ing: Elective Compulsory		
	Civil Engineering: Specialisation Coastal Engineering: E	lective Compulsory		
	Civil Engineering: Specialisation Structural Engineering	: Elective Compulsory		
	Computer Science: Specialisation II: Intelligence Engine	eering: Elective Compulsory		
	Environmental Engineering: Specialisation Energy and	Resources: Elective Compulsory		
	Environmental Engineering: Specialisation Environmen	t and Climate: Elective Compulsory		
	Environmental Engineering: Specialisation Water Quali	ty and Water Engineering: Elective Com	pulsory	
	Mechatronics: Technical Complementary Course: Elect	ve Compulsory		
	Mechatronics: Core Qualification: Elective Compulsory			
	Theoretical Mechanical Engineering: Specialisation Rob		ompulsory	
	Water and Environmental Engineering: Specialisation C			
	Water and Environmental Engineering: Specialisation E	nvironment: Elective Compulsory		
	Water and Environmental Engineering: Specialisation V			

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

ourse 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. 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 M1845: Thin-	walled structures			
	walled structures			
Courses				
Title		Тур	Hrs/wk	СР
Thin-walled structures (L1199)		Lecture	2	3
Thin-walled structures (L3045)		Recitation Section (large)	2	3
Module Responsible	Prof. Bastian Oesterle			
Admission Requirements	None			
Recommended Previous Knowledge	 Structural Analysis I Structural Analysis II Finite Element Methods 			
Educational Objectives	After taking part successfully, students have reache	d the following learning results		
Professional Competence				
Knowledge	After successful completion of this module, the st walled structures.	udents can express the basic aspects of	the load-carryin	g behaviour of thir
Skills	After successful completion of this module, the students will be able to predict load-carrying behaviour of thin-walled structure using appropriate analytical and coputational methods.			
Personal Competence				
Social Competence	Students can			
	 participate in subject-specific and interdiscip 	inary discussions,		
	 defend their own work results in front of other 	rs		
	 promote the scientific development of collear 	gues		
	 Furthermore, they can give and accept profe 	ssional constructive criticism		
Autonomy	Students are able to gain knowledge of the subject they are able to structure the solution process for p	÷ ,		
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	90 min			
scale				
Assignment for the	Civil Engineering: Specialisation Coastal Engineering	g: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engin	eering: Elective Compulsory		
	Civil Engineering: Specialisation Computational Eng	neering: Compulsory		
	Civil Engineering: Specialisation Structural Engineer	ing: Elective Compulsory		
	Theoretical Mechanical Engineering: Specialisation	Simulation Technology: Elective Compulso	гy	

Typ Hrs/wk	<u> </u>
	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
	Prof. Bastian Oesterle
Language	DE
Cycle	SoSe
Content	Plates loaded in-plane
	 Governing equations (equilibrium, kinematics, constitutive law)
	Differential equation
	Airy stress function
	Plane stress / plane strain
	Structural behaviour of plates loaded in-plane
	 finite elements for plates loaded in-plane, modelling apsects, interpretation and critical assessment of results
	Plates in bending
	Governing equations (equilibrium, kinematics, constitutive law)
	Differential equation
	Navier solution / Fourier series expansion
	Approximation procedures
	Circular and rectangular plates
	Structural behaviour of plates in bending
	 finite elements for plates in bending, modelling apsects, interpretation and critical assessment of results
	Shells
	Sileiis
	Phenomenona of the structural behaviour of shells
	Membrane and bending theory
	Equilibrium equations of shells of revolution
	Stress resultants and deformations of the spherical shell, the half spherical shell, and the cylindrical shell
	finite elements for shells
	Stability problems (overview)
	Plate buckling
	Shell buckling
Literature	Vorlesungsmanuskript
	Basar, Y.: Krätzig, W.B. (1985): Mechanik der Flächentragwerke. Vieweg-Verlag, Braunschweig, Wiesbaden
	 Girkmann, K. (1963): Flächentragwerke, Springer Verlag, Wien, 1963, unveränderter Nachdruck 1986
	 Zienkiewicz, O.C. (1977): The Finite Element Method in Enginieering Science. McGraw-Hill, London
	,

Course L3045: Thin-walled st	ourse L3045: Thin-walled structures		
Тур	Recitation Section (large)		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Bastian Oesterle		
Language	DE		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Module M0858: Coast	tal Hydraulic Engineering I			
Courses				
Title		Тур	Hrs/wk	СР
Basics of Coastal Engineering (L08		Lecture	3	4
Basics of Coastal Engineering (L14		Project-/problem-based Learning	, 1	2
Module Responsible	Prof. Peter Fröhle			
Admission Requirements	None			
Recommended Previous	Basics of hydraulic engineering, hydrology and hydromechanics			
Knowledge				
Educational Objectives	After taking part successfully, students ha	ave reached the following learning results		
Professional Competence				
Knowledge	The students are able to define and expla	in the basic concepts of coastal engineering and port	engineering. Th	ney are able to app
	the concepts to selected practical proble	ms of coastal engineering. Students can define and o	determine the b	asics for design a
	dimensioning of coastal engineering constructions.			
Skills	The students are canable to apply basic d	lesign approaches to selected and pre-defined design	tasks in coastal	engineering
Skiis		iesign approaches to selected and pre defined design		engineering.
Personal Competence				
Social Competence	The students are able to deploy their gai	ined knowledge in applied problems such as the des	ign of coastal p	rotection structure
	Additionaly, they will be able to work in te	eam with engineers of other disciplines, for instance d	esigning of coas	stal breakwaters.
Autonomy	The students will be able to independently	y extend their knowledge and applyit to new problem	S.	
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 ho	ours. The examination includes tasks with respect to	b the general u	inderstanding of th
scale	lecture contents and calculations tasks.			
Assignment for the	Civil Engineering: Specialisation Coastal E	ngineering: Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechr	nical Engineering: Compulsory		
	Civil Engineering: Specialisation Structura	l Engineering: Elective Compulsory		
	Environmental Engineering: Specialisation	n Environment and Climate: Elective Compulsory		
	Environmental Engineering: Specialisation	n Water Quality and Water Engineering: Elective Comp	oulsory	
	International Management and Engineering	ng: Specialisation II. Civil Engineering: Elective Compu	lsory	
	Water and Environmental Engineering: Sp	pecialisation Environment: Elective Compulsory		
	Water and Environmental Engineering: Sp	pecialisation Water: Elective Compulsory		

Course L0807: Basics of Coastal Engineering		
Lecture		
3		
4		
Independent Study Time 78, Study Time in Lecture 42		
Prof. Peter Fröhle		
EN		
SoSe		
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 		
Coastal Engineering Manual, CEM		
Vorlesungsumdruck		

Course L1413: Basics of Coas	Irse 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		

Courses				
Title		Тур	Hrs/wk	СР
Offshore Geotechnical Engineering	(L0067)	Lecture	1	1
Hydro Power Use (L0013)		Lecture	1	1
Wind Turbine Plants (L0011)		Lecture	2	3
Wind Energy Use - Focus Offshore	L0012)	Lecture	1	1
Module Responsible	Dr. Marvin Scherzinger			
Admission Requirements				
	Module: Technical Thermodynamics I,			
Knowledge	Module: Technical Thermodynamics II,			
	Module: Fundamentals of Fluid Mechanics			
Educational Objectives	After taking part successfully, students have reac	hed the following learning results		
Professional Competence				
Knowledge	By ending this module students can explain in detail knowledge of wind turbines with a particular focus of wind energy use offshore conditions and can critical comment these aspects in consideration of current developments. Furthermore, they are ab to describe fundamentally the use of water power to generate electricity. The students reproduce and explain the basic procedu in the implementation of renewable energy projects in countries outside Europe.			
	Through active discussions of various topics within the seminar of the module, students improve their understanding and application of the theoretical background and are thus able to transfer what they have learned in practice.			
Skills	s Students are able to apply the acquired theoretical foundations on exemplary water or wind power systems and evaluate ar assess technically the resulting relationships in the context of dimensioning and operation of these energy systems. They can compare critically the special procedure for the implementation of renewable energy projects in countries outside Europe with 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-speci	ficly and multidisciplinary within a se	eminar.	
Autonomy	Students can independently exploit sources in the context of the emphasis of the lecture material to clear the contents of t lecture and to acquire the particular knowledge about the subject area.			
Workload in Hours	Independent Study Time 110, Study Time in Lectu	ure 70		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	180 min			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Engine	ering: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Eng			
	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory			
	International Management and Engineering: Specialisation II. Energy and Environmental Engineering: Elective Compulsory			
	International Management and Engineering: Specialisation II. Renewable Energy: Elective Compulsory			
	Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory			
	Product Development, Materials and Production: Specialisation Production: Elective Compulsory			
	Product Development, Materials and Production: Specialisation Materials: Elective Compulsory			
	Renewable Energies: Core Qualification: Compulse	•		
	Theoretical Mechanical Engineering: Specialisation	- England Contained Election Community	orv	
	Process Engineering: Specialisation Environmenta	I Process Engineering: Elective Com		
	Process Engineering: Specialisation Environmenta Water and Environmental Engineering: Specialisal	I Process Engineering: Elective Comp tion Cities: Elective Compulsory	pulsory	
	Process Engineering: Specialisation Environmenta	Il Process Engineering: Elective Comp tion Cities: Elective Compulsory tion Environment: Elective Compulso	pulsory	

ourse L0067: Offshore Geot	technical Engineering		
Тур	ecture		
Hrs/wk			
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	cture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Dr. Rudolf Zellermann	
Language	DE	
Cycle	SoSe	
Content	 Historical development Wind: origins, geographic and temporal distribution, locations Power coefficient, rotor thrust Aerodynamics of the rotor Operating performance Power limitation, partial load, pitch and stall control Plant selection, yield prediction, economy Excursion 	
Literature	Gasch, R., Windkraftanlagen, 4. Auflage, Teubner-Verlag, 2005	

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

Courses				
Title		Тур	Hrs/wk	СР
Water Protection and Wastewater I	lanagement (L0226)	Lecture	3	3
Water Protection and Wastewater I	Aanagement (L2008)	Project Seminar	3	3
Module Responsible	Prof. Ralf Otterpohl			
Admission Requirements	None			
Recommended Previous	Basic knowledge in water manageme	nt:		
Knowledge	 Good knowledge in urban drainage; 	пс,		
	 Good knowledge of wastewater treat 	ment techniques:		
	 Good knowledge of wasternater deal Good knowledge of pollutants (e.g. Cl 			
Educational Objectives	After taking part successfully, students have	e reached the following learning results		
Professional Competence				
Knowledge		es of the regulatory framework related to the		
		substance cycles and water morphology in	-	•
		as ecosystem service and wastewater trea	tment with a special	focus on innovati
	solutions, remediation measures as well as	conceptual approaches.		
Skills	Students can accurately assess current pro	blems and situations in a country-specific or	local context. They o	an suggest concre
	actions to contribute to the planning of to	omorrow's urban water cycle. Furthermore,	they can suggest a	ppropriate technic
	administrative and legislative solutions to so	blve these problems.		
Personal Competence				
Social Competence	The students can work together in internation	onal groups.		
Autonomy	Students are able to organize their work flo	w to prepare presentations and discussions.	They can acquire ap	propriate knowled
,	by making enquiries independently.		, , , ,	
Workload in Hours	Independent Study Time 96, Study Time in I	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 E	indineering: Elective Compulsory		
5	Civil Engineering: Specialisation Structural E	5 5 1 5		
r onowing curricula	Civil Engineering: Specialisation Coastal Eng			
	Civil Engineering: Specialisation Water and			
	• • •	Vater Quality and Water Engineering: Elective	Compulsory	
		Specialisation II. Civil Engineering: Elective		
	Water and Environmental Engineering: Spec			
	Water and Environmental Engineering: Spec			
	Water and Environmental Engineering: Spec			

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

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

Courses				
Title		Тур	Hrs/wk	СР
Examination of Materials, Structura	al Condition and Damages (L0260)	Lecture	3	4
Examination of Materials, Structura	al Condition and Damages (L0261)	Recitation Section (small)	1	2
Module Responsible	Prof. Frank Schmidt-Döhl			
Admission Requirements	None			
Recommended Previous	Basic knowledge about building materials or main	erial science, for example by the mod	ule Building Ma	terials and Buildin
Knowledge	Chemistry.			
Educational Objectives	After taking part successfully, students have reache	d the following learning results		
Professional Competence				
Knowledge	The students are able to describe the rules for trading, use and marking of construction products in Germany. They know whic methods for the testing of building material properties are usable and know the limitations and characterics of the most important testing methods.			
Skills	The students are able to responsibly discover the ru They are able to chose suitable methods for the tes the examination of the structural conditions of build are able to describe an examination in form of a tes	ting and inspection of construction producings. They are able to conclude from sym	ts, the examina	•
Personal Competence				
Social Competence	The students can describe the different roles of ma framework of material testing. They can describe the			on bodies within th
Autonomy	The students are able to make the timing and the or	peration steps to learn the specialist know	edge of a very e	extensive field.
Workload in Hours	Independent Study Time 124, Study Time in Lecture	56		
Credit points				
Course achievement	None			
Examination	Written exam			
Examination duration and	120 min			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Engineer	ng: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engine	eering: Elective Compulsory		
	Civil Engineering: Specialisation Coastal Engineering	: Elective Compulsory		
	Civil Engineering: Specialisation Water and Traffic: E	lective Compulsory		
	International Management and Engineering: Special	sation II. Civil Engineering: Elective Comp	ulsory	
	Materials Science and Engineering: Specialisation Er	gineering Materials: Elective Compulsory		
	Materials Science: Specialisation Engineering Materi	als: Elective Compulsory		

Course L0260: Examination of	Course L0260: Examination of Materials, Structural Condition and Damages			
Тур	Lecture			
Hrs/wk	3			
СР	4			
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42			
Lecturer	Prof. Frank Schmidt-Döhl			
Language	DE			
Cycle	WiSe			
Content	Materials testing and marking process of construction products, testing methods for building materials and structures, testing			
	reports and expert opinions, describing the condition of a structure, from symptons to the cause of damages			
Literature	Frank Schmidt-Döhl: Materialprüfung im Bauwesen. Fraunhofer irb-Verlag, Stuttgart, 2013.			

Course L0261: Examination of Materials, Structural Condition and Damages		
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	2	
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14	
Lecturer	Prof. Frank Schmidt-Döhl	
Language	DE	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

		25				
Courses						
litle .			т	Тур	Hrs/wk	СР
Concrete Structures (L0579)				Seminar	1	1
Structural Concrete Members (L05	(7)		L	ecture	2	3
Structural Concrete Members (L05	/8)		R	ecitation Section (large)	2	2
Module Responsible	NN					
Admission Requirements	None					
Recommended Previous	Basics of structural	analysis, conception a	nd dimensioning of struc	tural concrete		
Knowledge						
	Modules: Reinforced	d Concrete Structures I	+II, Structural Analysis I-	+II, Mechanics I+II		
Educational Objectives	After taking part su	iccessfully students ha	ve reached the following	learning results		
Professional Competence	, iter taking part ba	iecessiany, stadents na	ie reached the following	i carring results		
	The students broaden their skills in structural engineering, especially in the field of buildings (houses, roofs, halls). They dispose (
Knowledge	the knowledge for the conception and design of concrete buildings and structural members that are often used.					
	the knowledge for t	the conception and des	ight of concrete buildings			
Skills	The students are al	ble to apply procedure	s of the conception and	dimensioning to to practic	al problems of st	ructural engineeri
	They are capable to draft concrete buildings and to design them for general action effects and to plan their deta			their detailing a		
	execution. Moreover, they can make design and construction sketches and draw up technical descriptions.					
Demonal Commetence						
Personal Competence						
	The students are able to obtain results of high quality in teamwork.					
Social Competence	The students are ab	Die to obtain results of .	nigh quality in teamwork			
				sioning tasks of structures	under the guidance	e of tutors.
Autonomy	The students are ab	ble to carry out comple:	x conception and dimens		under the guidand	e of tutors.
Autonomy	The students are ab		x conception and dimens		under the guidanc	e of tutors.
Autonomy	The students are ab Independent Study 6	ble to carry out comple: Time 110, Study Time	x conception and dimens		under the guidanc	e of tutors.
Autonomy Workload in Hours	The students are ab Independent Study 6 Compulsory Bonus	ble to carry out comple: Time 110, Study Time Form	x conception and dimens in Lecture 70 Description	sioning tasks of structures	under the guidand	e of tutors.
Autonomy Workload in Hours Credit points Course achievement	The students are ab Independent Study 6 Compulsory Bonus No None	ble to carry out comple: Time 110, Study Time	x conception and dimens in Lecture 70 Description		under the guidand	e of tutors.
Autonomy Workload in Hours Credit points Course achievement Examination	The students are ab Independent Study 6 Compulsory Bonus No None Written exam	ble to carry out comple: Time 110, Study Time Form	x conception and dimens in Lecture 70 Description	sioning tasks of structures	under the guidanc	e of tutors.
Autonomy Workload in Hours Credit points Course achievement Examination Examination duration and	The students are ab Independent Study 6 Compulsory Bonus No None Written exam	ble to carry out comple: Time 110, Study Time Form	x conception and dimens in Lecture 70 Description	sioning tasks of structures	under the guidanc	e of tutors.
Autonomy Workload in Hours Credit points Course achievement Examination	The students are ab Independent Study 6 Compulsory Bonus No None Written exam	ble to carry out comple: Time 110, Study Time Form	x conception and dimens in Lecture 70 Description	sioning tasks of structures	under the guidand	e of tutors.
Autonomy Workload in Hours Credit points Course achievement Examination Examination duration and scale	The students are ab Independent Study 6 Compulsory Bonus No None Written exam 120 minutes	ble to carry out comple: Time 110, Study Time Form Presentation	x conception and dimens in Lecture 70 Description	sioning tasks of structures	under the guidand	e of tutors.
Autonomy Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	The students are ab Independent Study 6 Compulsory Bonus No None Written exam 120 minutes Civil Engineering: Sp	ble to carry out comple: Time 110, Study Time Form Presentation Specialisation Structural	x conception and dimens in Lecture 70 Description Es werden 2 Re	sioning tasks of structures	under the guidand	e of tutors.
Autonomy Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	The students are ab Independent Study 6 Compulsory Bonus No None Written exam 120 minutes Civil Engineering: Sp Civil Engineering: Sp	ble to carry out comple: Time 110, Study Time Form Presentation Specialisation Structural Specialisation Geotechn	x conception and dimens in Lecture 70 Description Es werden 2 Re Engineering: Compulsor	sioning tasks of structures	under the guidand	e of tutors.
Autonomy Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	The students are ab Independent Study 6 Compulsory Bonus No None Written exam 120 minutes Civil Engineering: Sp Civil Engineering: Sp Civil Engineering: Sp	ble to carry out comple: Time 110, Study Time Form Presentation Specialisation Structural Specialisation Geotechn Specialisation Coastal En	x conception and dimens in Lecture 70 Description Es werden 2 Re Engineering: Compulsor ical Engineering: Elective	sioning tasks of structures eferate ausgegeben ry e Compulsory ipulsory	under the guidand	e of tutors.
Autonomy Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	The students are ab Independent Study 6 Compulsory Bonus No None Written exam 120 minutes Civil Engineering: Sp Civil Engineering: Sp Civil Engineering: Sp Civil Engineering: Sp Civil Engineering: Sp	ble to carry out complex Time 110, Study Time Form Presentation Specialisation Structural Specialisation Geotechn Specialisation Coastal Er Specialisation Water and	x conception and dimens in Lecture 70 Description Es werden 2 Re Engineering: Compulsor ical Engineering: Elective ngineering: Elective Com	sioning tasks of structures eferate ausgegeben ry e Compulsory ipulsory lsory	under the guidand	e of tutors.

Course L0579: Concrete Stru	ictures
Тур	Seminar
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	NN
Language	DE
Cycle	WiSe
Content	With help of a project teamwork the subjects of the course "Concrete Structures" is practiced, discussed and presented.
Literature	- Projektbezogene Unterlagen werden abgegeben.

Course L0578: Structural Concrete Members		
Тур	Recitation Section (large)	
Hrs/wk	2	
CP	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	NN	
Language	DE	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Courses				
Courses				
Title	(1106R) Project (prob	lom bacad Loarning	Hrs/wk 4	CP 6
Integrated Transportation Planning		lem-based Learning	4	0
Module Responsible				
Admission Requirements				
Recommended Previous	some knowledge of transport planning, e.g. through taking the undergraduate	e class "Transport P	lanning and I	raffic Engineerin
Knowledge				
	After taking part successfully, students have reached the following learning re	esuits		
Professional Competence				
Knowledge	Students are able to:			
	describe interdependencies between land-use/location choice and trans	sportation/mobility	behaviour	
	 explain and evaluate the social, ecological and economic effects of transport 	nsport and land-use	policy measu	res.
	 relate current issues in the area of integrated transport planning and for 	ormulate an opinion	on them.	
Skills	Students are able to:			
	quantify important parameters, which influence travel demand or are in	nfluenced by it		
	 comprehensively examine a pre-defined or self-selected topic from a t 		es nersnectiv	e and document t
	results in accordance with scientific conventions.		es perspectiv	
Personal 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 knowled	ge and use a	propriate means
	its execution.			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement				
Examination	Written elaboration			
Examination duration and	written assignment with presentation during the semester			
scale	5			
Assignment for the	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory			
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulso	ory		
J	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory	-		
	Civil Engineering: Specialisation Water and Traffic: Compulsory			
	Logistics, Infrastructure and Mobility: Specialisation Infrastructure and Mobility	y: Elective Compuls	ory	
	Water and Environmental Engineering: Specialisation Cities: Compulsory			

Course L1068: Integrated Tr	ansportation Planning
Тур	Project-/problem-based Learning
Hrs/wk	4
СР	6
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Lecturer	Prof. Carsten Gertz, Dr. Philine Gaffron, Jacqueline Bianca Maaß
Language	DE
Cycle	WiSe
	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)

Module M0963: Steel	and Composite Structures			
Courses				
Title		Тур	Hrs/wk	СР
Steel and Composite Structures (L1	204)	Lecture	2	2
Steel and Composite Structures (L1	205)	Recitation Section (large)	2	2
Steel Bridges (L1097)		Lecture	2	2
Module Responsible	Prof. Marcus Rutner			
Admission Requirements	None			
Recommended Previous	Basics of steel construction (i.e. Steel Structures I and	I, BUBC)		
Knowledge				
Educational Objectives	After taking part successfully, students have reached t	he following learning results		
Professional Competence				
Knowledge	After successful completition, students can			
	 describe the phenomenon of local buckling 			
	 explain warping torsion 			
	 illustrate the behaviour of composite structures 			
		uctures.		
	specify the principles in design of composite sttr			
	 sketch the contructions of steel and composite b 	indges		
Skills	After successful participation students are able to			
	check stiffened and unstiffened plated structure	5		
	 recognize and verify warping tosion in strucures 			
	 design composite structures 			
	 design bridges and o perform the detailing 			
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	180 min			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Engineering	: Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineer			
-	Civil Engineering: Specialisation Coastal Engineering: E	•		
	Civil Engineering: Specialisation Water and Traffic: Elec			
	Civil Engineering: Specialisation Computational Engine			
	International Management and Engineering: Specialisa		ulcon/	
	nicemational Management and Engineering: specialisa	tion in Civil Engineering: Elective Comp	JuisUly	

Course L1204: Steel and Con	Course L1204: Steel and Composite Structures		
Тур	Lecture		
Hrs/wk	2		
СР	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Prof. Marcus Rutner		
Language	DE		
Cycle	WiSe		
Content	 Local-buckling of plated structures Warping torsion Composite-girders, -columns, -slabs, -bridges Principles in composite constructions Bridge-design and -construction 		
Literature	Petersen, C.: Stahlbau, 4.Auflage 2013, Springer-Vieweg Verlag Minnert, J. Wagenknecht, G.: Verbundbau-Praxis - Berechnung und Konstruktion nach Eurocode 4, 2.Auflage 2013, Bauwerk Beuth Verlag		

Course L1205: Steel and Con	ourse L1205: Steel and Composite Structures		
Тур	Recitation Section (large)		
Hrs/wk	2		
СР	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Prof. Marcus Rutner		
Language	DE		
Cycle	WiSe		
Content	See interlocking course		
Literature	See interlocking course		

Course L1097: Steel Bridges	
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Yves Freundt
Language	
Cycle	
Content	Lecture Contents ,Steel Bridge Construction' DrIng. Jörg Ahlgrimm
	- From tendering and contracting to completion - the development of a steel bridge
	- Contents of a bridge static - structural details, examples of analysis in detail:
	-> effective width in regard to the longitudinal stiffeners
	-> Bearing point, bearing stiffener
	-> Crossbeam breakthrough, crossbeam reinforcement
	-> Analysis of the Rib-to-Floorbeam (RF) connection (web-tooth of the floorbeam between trapezoidal shaped Ribs)
	- Steel grades, -designation, testing methods and approval certificates
	- Nondestructive weld inspecting
	- Corrosion protection
	- Bridge bearing - types, format, function, dimensioning, installation
	- Expansion Joints
	- Oscillation of bridge hangers and cables - oscillation damper
	- Opening bridges- Detailed reviews to different assembling procedures and - implements
	- Selective damage events
	Requirements: Basic knowledge in the calculation, dimensioning, and construction of structural elements and joints of constructional steelwork
Literature	
	Herbert Schmidt, Ulrich Schulte, Rainer Zwätz, Lothar Bär: Ausführung von Stahlbauten
	Petersen, Christian: Stahlbau, Abschnitt Brückenbau
	Ahlgrimm, J., Lohrer, I.: Erneuerung der Eisenbahnüberführung in Fulda-Horas über die Fulda, Stahlbau 74 (2005), Heft 2, S. 114

Courses	
Title	Typ Hrs/wk CP
Module Responsible	Prof. Peter Fröhle
Admission Requirements	None
Recommended Previous	Subjects of the Port and Coastal Engineering specialisation.
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 port and coastal engineering. They can exemplify t state of technology and application and discuss critically in the context of actual problems and general conditions of science a society.
	The students can develop solving strategies and approaches for fundamental and practical problems in port and coast engineering. They may apply theory based procedures and integrate safety-related, ecological, ethical, and economic view poir of science and society.
Skills	Scientific work techniques that are used can be described and critically reviewed. The students are able to independently select methods for the project work and to justify this choice. They can explain how the methods relate to the field of work and how the context of application has to be adjusted. General findings and furth developments may essentially be outlined.
Personal Competence	
Social Competence	The students are able to condense the relevance and the structure of the project work, the work steps and the sub-problems the presentation and discussion in front of a bigger group. They can lead the discussion and give a feedback on the project to th colleagues.
Autonomy	The students are capable of independently planning and documenting the work steps and procedures while considering the giv deadlines. This includes the ability to accurately procure the newest scientific information. Furthermore, they can obtain feedba from experts with regard to the progress of the work, and to accomplish results on the state of the art in science and technology
Workload in Hours	Independent Study Time 180, Study Time in Lecture 0
Credit points	6
Course achievement	None
Examination	Study work
Examination duration and scale	The number of pages depends on the task.
Assignment for the Following Curricula	Civil Engineering: Specialisation Coastal Engineering: Compulsory

Module M0969: Selected Topics in Civil Engineering

Courses				
Title		Тур	Hrs/wk	СР
Design of Composite Bridges (L3092)		Integrated Lecture	2	3
Analysis of Offshore Structures (L1867)		Lecture	1	1
Energy Geotechnics (L3227)		Lecture	3	3
Solid Matter Process Technology fo	r Biomass (L0052)	Lecture	2	3
Forum I - Geotechnics and Construction Management (L1634)		Seminar	1	1
Forum II - Geotechnics and Constru	ction Management (L1635)	Seminar	1	1
Timber Structures (L1151)		Seminar	2	2
Innovative Timber Construction (L2	666)	Lecture	2	4
Glass Structures (L1152)		Lecture	2	2
Glass Structures (L1447)		Recitation Section (large)	1	1
Sustainable landfill design and ope	ration (L3270)	Integrated Lecture	3	3
Special Topics in Steel Design (L30	91)	Integrated Lecture	2	3
Special topics of civil engineering 1	CP (L2378)		1	1
Special topics of civil engineering 2	LP (L2379)		2	2
Special topics of civil engineering 3	3 LP (L2380)		3	3
Structural Design (L2789)		Seminar	2	2
Module Responsible	Prof. Frank Schmidt-Döhl			
Admission Requirements	None			
Recommended Previous	none			
Knowledge				
Educational Objectives	After taking part successfully, students have reache	ed the following learning results		
Professional Competence				
Knowledge				
	 Students are able to find their way through set 			
	 Students are able to explain basic models an 	d procedures in selected special areas of	civil and structura	al engineering.
	 Students are able to interrelate scientific and 	I technical knowledge.		
Skills	 Students are able to apply basis methods in a 	colocted proper of civil and structural onein	aaring	
	 Students are able to apply basic methods in s 	selected areas of civil and structural engin	leening.	
Personal Competence				
Social Competence				
,				
Autonomy	 Students can chose independently, in which 	fields they want to deepen their knowled	dge and skills th	rough the election o
	courses.		-	-
Workload in Hours	,			
Credit points	6			
Assignment for the	Civil Engineering: Specialisation Structural Engineer	ring: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engin	eering: Elective Compulsory		
	Civil Engineering: Specialisation Coastal Engineering	g: Elective Compulsory		
	Civil Engineering: Specialisation Water and Traffic: I			
	Civil Engineering: Specialisation Computational Eng			
	s Engineering. specialisation computational Eng	meeting: Elective compulsory		

Course L3092: Design of Composite Bridges	
Тур	Integrated Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and	90 min
scale	
Lecturer	Prof. Marcus Rutner
Language	DE
Cycle	SoSe
Content	
Literature	

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Тур	Lecture
	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Examination Form	Mündliche Prüfung
Examination duration and	30 min
scale	
	Dr. Said Fawad Mohammadi
Language Cycle	
-	Topic 1: Types of Offshore Structures, Fixed and floating structures for Oil & Gas and Offshore Wind industry
	Topic 2: Wave Forces, Morisons equation
	Topic 3: Irregular Seastates, Power spectrum and application of FFT
	Topic 4: Additional Environmental Forces, wind spectra, current forces
	Topic 5: Linear-Time-Invariant Systems, response of an LTI-system in frequency domain
	Topic 6: Tubular Welded Connections, stress concentration factors, weld geometry
	Topic 7: Introduction to Fracture Mechanics, criteria for fracture initiation and crack growth
	Topic 8: Time and Frequency Domain Fatigue Analyses, rainflow counting, application of LTI-systems for frequency domain fatigue
	Topic 9: Offshore Installation and Exam, installation of structures, pile driving, pipe laying techniques
Literature	Chakrabarti, Handbook of Offshore Engineering, 2005
	Sarpkaya, Wave Forces on Offshore Structures, 2010
	Faltinsen, Sea Loads on Ships and Offshore Structures, 1998
	Sorensen, Basic Coastal Engineering, 2006
	Dowling, Mechanical Behavior of Materials, 2007
	Haibach, Betriebsfestigkeit, 2006
	Marshall, Design of Welded Tubular Connections, 1992
	Newland, Random vibrations, spectral and wavelet analysis, 1993

Course L3227: Energy Geotechnics		
Тур	Lecture	
Hrs/wk	3	
СР	3	
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42	
Examination Form	Schriftliche Ausarbeitung (laut FPrO)	
Examination duration and	wird zu Beginn der Lehrveranstaltung festgelegt	
scale		
Lecturer	Pauline Kaminski	
Language	DE/EN	
Cycle	WiSe	
Content	Energy geotechnics is a young field in geotechnical engineering with the aim of developing sustainable geotechnical solutions for future-oriented issues relating to the production, transport, operation, decommissioning, and waste utilisation of various energy sources. Examples of possible fields of activity in energy geotechnics include geothermal energy and thermally activated foundation components, foundations for onshore and offshore wind turbines, the decommissioning of mining facilities and the handling of waste products from fossil fuels such as tailings and the geological storage of CO2. Relevant soil mechanical processes in these applications include the thermo-hydro-mechanically coupled behaviour of soils, multiphase flow in porous media and partially saturated soils. The lecture gives an overview of various aspects of energy geotechnics and provides in-depth knowledge of the associated soil mechanical processes. In addition, CO2-scarce geotechnical applications are discussed and emission estimates as well as the optimisation of geotechnical structures according to sustainability aspects are addressed.	
Literature		

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 L1634: Forum I - Geotechnics and Construction Management	
Тур	Seminar
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Examination Form	Mündliche Prüfung
Examination duration and	30 min
scale	
Lecturer	Prof. Jürgen Grabe
Language	DE
Cycle	WiSe
Content	Lectures about projects and issues with practical and scientific relevance.
Literature	

Course L1635: Forum II - Geotechnics and Construction Management	
Тур	Seminar
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Examination Form	Mündliche Prüfung
Examination duration and	30 min
scale	
Lecturer	Prof. Jürgen Grabe
Language	DE
Cycle	SoSe
Content	Lectures about projects and issues with practical and scientific relevance.
Literature	

Course L1151: Timber Structures	
Тур	Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Referat
Examination duration and	90 min
scale	
Lecturer	Prof. Torsten Faber
Language	DE
Cycle	WiSe
Content	
Literature	

Course L2666: Innovative Timber Construction		
Тур	Lecture	
Hrs/wk	2	
СР	4	
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28	
Examination Form	Schriftliche Ausarbeitung	
Examination duration and	45 Minuten	
scale		
Lecturer	Dr. Andreas Meisel	
Language	DE	
Cycle	WiSe	
Content		
Literature	- Blass, J.: "Ingenieurholzbau"	
	- Schickhofer, G.: "BSPhandbuch: Holz-Massivbauweise in Brettsperrholz"	
	- Informationsdienst Holz: div. Merkblätter und Broschüren	
	- Wallner-Novak M.: Brettsperrholz Bemessung, Band 1 und 2	
	- Gerner M.: "Fachwerk: Entwicklung, Instandsetzung, Neubau"	
	- Meisel, A.: "Historische Dachwerke: Beurteilung, realitätsnahe statische Analyse und Instandsetzung"	
	- Kempe K.: "Dokumentation Holzschädlinge"	
	- Huckfeldt T.: "Hausfäule- und Bauholzpilze"	

Course L1152: Glass Structures		
Тур	Lecture	
Hrs/wk		
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Examination Form	Mündliche Prüfung	
Examination duration and		
scale		
Lecturer	Marvin Matzik	
Language	DE	
Cycle	WiSe	
Content	Glass structures	
	 Introduction of the material glass (production, refinement, material characteristic) design of facades 	
	- facade types	
	- static calculation of glazing	
	- static calculation of facades	
	- load bearing behavior of glazing (plate or membrane stiffness)	
	- vertical / horizontal glazing with safety-related requirements	
	- glass structures	
	- fire safety of glass facades	
	- construction physics of facades and glazing	
Literature		

Course L1447: Glass Structures	
Тур	Recitation Section (large)
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Examination Form	Mündliche Prüfung
Examination duration and	
scale	
Lecturer	Marvin Matzik
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

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

Course L3091: Special Topics in Steel Design	
Тур	Integrated Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and	90 min
scale	
Lecturer	Prof. Marcus Rutner, Nikolay Lalkovski
Language	DE
Cycle	SoSe
Content	
Literature	

Course L2378: Special topics	Course L2378: Special topics of civil 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 Lehrveranstaltung festgelegt	
scale		
Lecturer	Dozenten des SD B	
Language	DE	
Cycle	WiSe/SoSe	
Content	The course occurs only if required. The content is defined at short notice.	
Literature	Die Literatur wird kurzfristig festgelegt.	

Course L2379: Special topics of civil engineering 2 LP	
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 Lehrveranstaltung festgelegt
scale	
Lecturer	Dozenten des SD B
Language	DE
Cycle	WiSe/SoSe
Content	The course occurs only if required. The content is defined at short notice.
Literature	Die Literatur wird kurzfristig festgelegt.

Course L2380: Special topics of civil engineering 3 LP	
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 Lehrveranstaltung festgelegt
scale	
Lecturer	Dozenten des SD B
Language	DE
Cycle	WiSe/SoSe
Content	The course occurs only if required. The content is defined at short notice.
Literature	Die Literatur wird kurzfristig festgelegt.

Course L2789: Structural Design	
Тур	Seminar
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and	20 min
scale	
Lecturer	Dr. Jan Mittelstädt
Language	DE/EN
Cycle	SoSe
Content	
Literature	[1] Structure Systems by Heino Engel, Hantje Cantz, 3rd edition (Feb 2007), ISBN-10: 3775718761
	Form and Force, Designing Efficient, Expressive Structures by Allan, E., Zalewski, W. et al, John Wiley and
	Sons; 1st edition (Sept 2009), ISBN-10: 047017465X
	[2] Peter Rice: An Engineer Imagines, ISBN-10 : 1849944237
	[3] Konrad Wachsmann and the Grapevine Structure by C. Sumi et al., Park Books (Oct 2018), ISBN-10:
	9783038601104
	[4] Manual of Multi-Story Timber Construction by Hermann Kaufmann, Stefan Krotsch, Stefan Winter, DETAIL,
	(June 2018), ISBN-10: 3955533948
	[5] The Art of Structural Design: A Swiss Legacy by B. Billington, Princeton University Art Museum; First Edition
	edition (Mar 2003), ISBN-10: 0300097867
	[6] Structured Lineages: Learning from Japanese Structural Design by G. Nordenson et al, The Museum of
	Modern Art (Jul 2019), ISBN-10: 1633450562
	[7] The Structure: Works of Mahendra Raj by V. Mehta, R. Mehndiretta, A. Huber, Park Books (Oct 2015),
	ISBN-10: 3038600253

Courses				
Title		Тур	Hrs/wk	СР
Chemistry of Drinking Water Treatment (L0311)		Lecture	2	1
Chemistry of Drinking Water Treatment (L0312)		Recitation Section (large)	1	2
Water Resource Management (L04	02)	Lecture	2	2
Water Resource Management (L04	03)	Recitation Section (small)	1	1
Module Responsible	Prof. Mathias Ernst			
Admission Requirements	None			
Recommended Previous	Knowledge of water management and th	e key processes involved in water treatment.		
Knowledge				
Educational Objectives	After taking part successfully, students h	ave reached the following learning results		
Professional Competence				
Knowledge	Students will be able to outline key are	as of conflict in water management, as well as the	eir mutual depend	dence for sustaina
	water supply. They will understand rele	evant economic, environmental and social factors.	Students will be	able to explain a
		vater companies. They will be able to explain the av		
	the scope of their application.	ater companies. They will be able to explain the a		intent processes
	the scope of their application.			
Skills	Students will be able to assess com	plex problems in drinking water production and	d establish solut	ions involving wa
		hey will be able to assess the evaluation methods		-
	•	ons for selected treatment processes and apply o		
	•	ons for selected treatment processes and apply g	lenerally accepted	
	standards to these processes.			
Personal Competence				
	Working in a diverse group of specialists	s, students will be able to develop and document o	omplex solutions	for the managem
		will be able to take an appropriate professional p		
	interests. They will be able to develop jo	int solutions in teams of diverse experts and presen	t these solutions t	to others.
Autonomy	Students will be in a position to work on	a subject independently and present on this subject		
Workload in Hours	Independent Study Time 96, Study Time	in Lecture 84		
Credit points				
Course achievement	None			
Examination	Written exam			
Examination duration and	60 min (chemistry) + presentation			
scale	oo min (enemistry) i presentation			
	Civil Engineering: Specialisation Structur	al Engineering: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotech			
ronowing curricula	Civil Engineering: Specialisation Water a			
	• • •			
	Civil Engineering: Specialisation Coastal			
		echnical Complementary Course: Elective Compulso	-	
	• •	ing: Specialisation II. Energy and Environmental Eng	-	Compulsory
	Process Engineering: Specialisation Envir	ronmental Process Engineering: Elective Compulsor	ý	
	Process Engineering: Specialisation Proce	ess Engineering: Elective Compulsory		
	Water and Environmental Engineering: S	pecialisation Water: Compulsory		
	Water and Environmental Engineering: S	pecialisation Environment: Elective Compulsory		

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

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

Course L0402: Water Resour	ce Management	
Тур	Lecture	
Hrs/wk		
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 Resour	ourse L0403: Water Resource Management	
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Mathias Ernst	
Language	DE	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Courses	
Title	Typ Hrs/wk CP
Adaptation to climate change in hy	draulic engineering (L2291) Project-/problem-based Learning 4 6
Module Responsible	Prof. Peter Fröhle
Admission Requirements	None
Recommended Previous	
Knowledge	 Hydrology, Hydraulic Engineering Hydromechanic, Hydraulics
	Fundamentals of Coastal Engineering, Coastal- and Flood Protection
	Hydrological Systems
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	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	
en me	 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, plann
	methods
	Consideration of complex tasks
Personal Competence	
Social Competence	. Walia in bakananan mana
	Working in heterogenous groups Working with different scientific (non scientific disciplines
	Working with different scientific / non-scientific disciplines Self reflection
Autonomy	Application oriented use of knowledge and skills
	Application oriented use of knowledge and skins Autonomous work on complex tasks
	Independent Study Time 124, Study Time in Lecture 56
Credit points Course achievement	
Examination	
	Preparation of a written report and a presentation of a complex task.
scale	
	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory
Following Curricula	
ytuiu	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	o climate change in hydraulic engineering
Тур	Project-/problem-based Learning
Hrs/wk	4
СР	6
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Lecturer	Prof. Peter Fröhle
Language	DE
Cycle	WiSe
Content	 Climate protection and climate adaptation Findings on climate change and its regional characteristics: fundamentals of climate change, climate modelling / climate models Impacts of climate change on the components of the regional hydrological cycle(climate science view) Fundamentals of the analysis of climate data Concequences of the impacts of climate change (ingenieering science view) Measures for climate change adaptation Assessment, prioritization and communication of measures Fundamentals of analysis of hydrometeorological and hydrological data
Literature	 Wird bereitgestellt über die HOOU - eLearning Plattform abhängig von den jeweils schwerpunktmäßig behandelten Fragestellungen wird das Schrifttum (aktuelle Paper) in der Veranstaltung bzw. über StudIP zur Verfügung gestellt.

Courses				
Title		Тур	Hrs/wk	СР
Sustainable Nature-based Coastal	Protection in a Changing Climate (SeaPiaC) (L2926)	Project-/problem-based Learning	4	6
Module Responsible	Prof. Peter Fröhle			
Admission Requirements	None			
Recommended Previous	Hydraulic Engineering			
Knowledge	Hydromechanics, Hydraulics			
	 Fundamentals of Coastal Engineering, Coastal- a 	nd Flood Protection		
	After taking part successfully, students have reached th	e following learning results		
Professional Competence				
Knowledge	Climate and Climate Change			
	General Impacts of Climate Change on Wind Reg	me and Water Cycle		
	Consequences of Climate Change for Coastal Pro	cesses		
	Coastal Protection in Taiwan and Germany			
	 Fundamentals of Climate Adaptation 			
	Nature-based Solutions (NBS) for Coastal Protect	on		
Skills				
	Critical thinking: analysis of processes and relation			
	Creative thinking: development of adaptation str Dractical thinking: inclusion of restrictions and	•	ode numeric	al madala planni
	 Practical thinking: inclusion of restrictions, app methods 	ication of calculation approaches, metr	ious, numerica	a models, plannin
	Consideration of complex tasks			
Personal Competence				
Social Competence	Working in heterogenous groups			
	Working in international groups			
	 Working with different scientific / non-scientific d 	sciplines		
	Self reflection			
Autonomy	 Application oriented use of knowledge and skills 			
	Autonomous work on complex tasks			
Workload in Hours				
Credit points Course achievement				
	None Written elaboration			
	Preparation of a written report on a complex task with	a presentation and subsequent discussion	on The work o	n the complex ta
scale	happens in the course of the lecture.	a presentation and subsequent discussion	JII. THE WORK C	in the complex ta
Assignment for the	Civil Engineering: Specialisation Coastal Engineering: El	ective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering:			
2	Civil Engineering: Specialisation Structural Engineering:			
	Civil Engineering: Specialisation Water and Traffic: Elect			
	Environmental Engineering: Specialisation Environment	and Climate: Elective Compulsory		
	Water and Environmental Engineering: Specialisation C	ties: Elective Compulsory		
	Water and Environmental Engineering: Specialisation En	vironment: Elective Compulsory		
	Water and Environmental Engineering: Specialisation W	ater: 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.

Courses				
Title		Тур	Hrs/wk	СР
Scientific Working in Computationa	Engineering (L2764)	Project-/problem-based Learning	4	6
Module Responsible	Prof. Kay Smarsly			
Admission Requirements	None			
Recommended Previous	Basic knowledge in scientific writing. String interest in topics	s related to computing in civil engine	ering.	
Knowledge				
Educational Objectives	After taking part successfully, students have reached the fol	lowing learning results		
Professional Competence				
Personal Competence	course instructors and in collaboration with each other, the students will also learn to understand the complex process of scientific thinking, being able to accurately plan, implement and analyze scientific projects, such as prospective master theses. A project will be conducted throughout the semester, which will contribute to the grade. Since scientific writing is of particular importance is this course, a scientific paper will be developed based, which is a prerequisite for the final examination. The paper will be writte based on the project conducted within this course. Project meetings in small groups, presentations, and critical discussions or scientific publications are further key activities. The students will be capable (i) of solving a scientific problem following a scientific methodology, (ii) of documenting their wore effectively in the form of a paper, and (iii) of sharing their work in a presentation.			
Autonomy	The students will be able to extend their knowledge and app	bly it to solve scientific problems by w	vorking indepe	ndently in a proje
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points				
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: B	Elective Compulsory		
	Civil Engineering: Specialisation Coastal Engineering: Electiv	e Compulsory		
	Civil Engineering: Specialisation Structural Engineering: Elec	tive Compulsory		
	Civil Engineering: Specialisation Computational Engineering	Elective Compulsory		
	Computer Science: Specialisation II: Intelligence Engineering	1: Elective Compulsory		

Course L2764: Scientific Wor	rking in Computational 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. Kay Smarsly
Language	EN
Cycle	WiSe/SoSe
Content	In the course, a scientific problem of practical relevance will first be defined, taking into account the interests of the students participating in the course. The scientific problem will then systematically be solved within the framework of a comprehensive project. The principles of scientific working will be taught based on the scientific problem defined previously. As an integral part of scientific working, fundamentals of scientific writing will be presented and applied to a scientific paper to be written during the course. Topics related to scientific writing include structuring in scientific writing (structuring the abstract, the introduction, the main part, the summary and conclusions, and the acknowledgments and references) and recommendations on effective scientific writing (principles of composition, use of English in scientific writing, useful tips, creating figures, writing in mathematics, referencing, and formal email correspondence). A final paper and a final presentation will be assembled by the students.
Literature	Smarsly, K. & Dragos, K., 2019. Scientific Writing in Engineering. Tredition, Hamburg, Germany.

Courses					
Title		Тур	Hrs/wk	СР	
Modern discretization methods in s	tructural mechanics (L3043)	Lecture	2	3	
Modern discretization methods in s	tructural mechanics (L3044)	Recitation Section (small)	2	3	
Module Responsible	Prof. Bastian Oesterle				
Admission Requirements	None				
Recommended Previous Knowledge	Finite Element MethodsFlächentragwerke				
Educational Objectives	After taking part successfully, students have rea	ched the following learning results			
Professional Competence					
Knowledge	After successful completion of this module, students can express the basic aspects of modern discretization methods in structura mechanics.				
Skills	After successful completion of this module, the students will be able to use and further improve modern discretization methods for problems in structural mechanics.				
Personal Competence					
Social Competence	Students can				
	 participate in subject-specific and interdis 	 participate in subject-specific and interdisciplinary discussions, 			
	 defend their own work results in front of o 				
	 promote the scientific development of col 	leagues			
	• Furthermore, they can give and accept pr	 Furthermore, they can give and accept professional constructive criticism 			
Δυτοροφγ	Students are able to gain knowledge of the subj	ect area from given and other sources and ar	only it to new pro	blems Furthermo	
, laconomy	they are able to structure the solution process for				
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	90 min				
scale					
Assignment for the	Civil Engineering: Specialisation Coastal Enginee	ring: Elective Compulsory			
Following Curricula	Civil Engineering: Specialisation Geotechnical En	igineering: Elective Compulsory			
	Civil Engineering: Specialisation Structural Engin	eering: Elective Compulsory			
	Civil Engineering: Specialisation Computational B	Engineering: Elective Compulsory			
	Theoretical Mechanical Engineering: Specialisati	on Simulation Technology: Elective Compulso	ry		

Course L3043: Modern discre	etization methods in structural mechanics
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Bastian Oesterle
Language	EN
Cycle	WiSe
Content	 The course covers variational formulations, various locking phenomena and alternative formulations for finite elements and modern discretization schemes in the context of structural mechanics, like isogeometric analysis. variational formulation of finite elements, mixed variational principles geometrical and material locking effects in structural and solid mechanics hybrid-mixed and enhanced assumed strain finite element formulations, reduced integration and stabilization, DSG method, u-p formulations patch test, stability, convergence linear and non-linear analyses introduction to isogeometric analysis isogeometric beam, plate and shell formulations locking effects and their avoidance in modern, smooth discretization schemes, like isogeometric analysis
Literature	 lecture notes and selected scientific papers O.C. Zienkiewicz, R.L. Taylor, and J.Z. Zhu: Finite Element Method: Its Basis and Fundamentals. Elsevier, 2013. J. Austin Cottrell, Thomas J. R Hughes, Yuri Bazilevs: Isogeometric Analysis: Toward Integration of CAD and FEA. Wiley, 2009.

Course L3044: Modern discre	urse L3044: Modern discretization methods in structural mechanics		
Тур	Recitation Section (small)		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Bastian Oesterle		
Language	EN		
Cycle	WiSe		
Content	See interlocking course		
Literature	See interlocking course		

	ing and Excavation Law					
Courses						
Title		Тур	Hrs/wk	СР		
	w in (excavation) practice (L3182) uction (excavation) practice (L3181)	Lecture Lecture	2	3 3		
Module Responsible				-		
Admission Requirements						
Recommended Previous	Complete modules: Geotechnics I-III					
Knowledge						
Educational Objectives	After taking part successfully, students have rea	ched the following learning results				
Professional Competence						
Knowledge	Students will gain knowledge of					
	 the history of civil engineering law, 					
	 basics of foundation and civil engineering 					
	 legal aspects of technical regulations in c 	ivil engineering (with case studies),				
	 the civil engineering contract, 					
	 the liability of the designer and contracto 	r in civil engineering,				
	 the subsoil risk and the system risk, 					
	 the total debt in (civil) engineering law, 					
	 the (construction) conflict, dispute avoidance models and the construction process, 					
	 the systematics of construction contract law, the BGB construction contract law, responsibilities on the construction site, remuneration and contract management, 					
	 liability for defects, 					
	public procurement law					
	 Disturbed construction processes: How m 	uch money am Lentitled to?				
	Correct calculation of supplements.					
	· correct calculation of supplements.					
CL:III-	Chudanta lasm ta anglu lasgi ang sta ing signi		ad way. Chudaata laama	h -		
SKIIIS	Students learn to apply legal aspects in plannin					
	construction management aspects in practice (planning and construction) on the con	struction site in a targe	ted manner and		
	to manage the construction project optimally.					
Personal Competence						
Social Competence	Students can work in groups and support each c	ther in finding solutions.				
Autonomy	Students are able to assess their own strengths	and weaknesses and organize their tir	ne and learning manage	ment based on th		
Workload in Hours	Independent Study Time 124, Study Time in Leo	ture 56				
Credit points						
Course achievement	None					
Examination	Oral exam					
Examination duration and						
scale						
•	Civil Engineering: Specialisation Coastal Enginee	• • •				
Following Curricula						
	Civil Engineering: Specialisation Structural Engin	• • •				
	Civil Engineering: Specialisation Water and Traff					
	Civil Engineering: Specialisation Computational	Engineering: Elective Compulsory				

Course L3182: Construction	law BGB and VOB - law in (excavation) practice
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Günther Schalk
Language	DE
Cycle	WiSe
Content	
Literature	Literatur:
	- Folienskript (in der Vorlesung erhältlich)
	- Fuchs/Maurer/Schalk: Handbuch Tiefbaurecht

Course L3181: Construction	urse L3181: Construction disputes from construction (excavation) practice		
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Ingo Junker		
Language	DE		
Cycle	WiSe		
Content			
Literature			

Courses					
Title		Тур	Hrs/wk	СР	
Coastal- and Flood Protection (L0808)		Lecture	2	3	
Coastal- and Flood Protection (L14) Maintenance and Defence of Flood	-	Project-/problem-based Learning Lecture	1 2	1 2	
Module Responsible		Lecture	2	2	
Admission Requirements					
Recommended Previous					
Knowledge					
Educational Objectives	After taking part successfully, students have reached th	e following learning results			
Professional Competence					
•	The students have the capability to define and explain	in detail the important aspects of erosi	on protection	and flood protecti	
	and are able to apply the aspects to practical coastal protection problems. They are able to design and dimension 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 of erosion and flood protection				
	measures and apply these approaches to practical design tasks.				
Personal Competence					
Social Competence	The students are able to deploy their gained knowledge	ge in applied problems such as the fun	ctional and co	onstructive design	
	coastal and flood protection structures. Additionaly, the	y will be able to work in team with engine	eers of other d	lisciplines.	
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 130 min. The exam	mination includes tasks with respect to	the general ι	understanding of t	
scale	lecture contents and calculations tasks.				
Assignment for the	Civil Engineering: Specialisation Coastal Engineering: Co	ompulsory			
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering	ng: Elective Compulsory			
	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory				
	Environmental Engineering: Specialisation Environment	and Climate: Elective Compulsory			
	Environmental Engineering: Specialisation Water Quality and Water Engineering: Elective Compulsory				
	Water and Environmental Engineering: Specialisation En	vironment: Elective Compulsory			
	Water and Environmental Engineering: Specialisation Wa	ater: Elective Compulsory			

Course L0808: Coastal- and 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 I	urse 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	Course L1411: Maintenance and Defence of Flood Protection Structures	
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Dr. Olaf Müller	
Language	EN	
Cycle	WiSe	
Content	 Dike protection Maintennance of flood protection measures 	
Literature	Vorlesungsumdruck	

Courses				
Title		Тур	Hrs/wk	СР
Waste and Environmental Chemist	· · ·	Practical Course	2	2
Biological Waste Treatment (L0318		Project-/problem-based Learning	3	4
Module Responsible	Prof. Kerstin Kuchta			
Admission Requirements	None			
	chemical and biological basics			
Knowledge				
Educational Objectives	After taking part successfully, students have re	eached the following learning results		
Professional Competence				
Knowledge	design and layout of anaerobic and aerobic wa	ng the planning of biological waste treatment plan ste treatment plants in detail, describe different to d 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 quali 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.			
Personal Competence				
	Students can participate in subject-specific an	d interdisciplinary discussions, develop cooperate	ed solutions a	and defend their
	work results in front of others and promote t accept professional constructive criticism.	the scientific development in front of colleagues	. Furthermore	e, they can give
Autonomy	are capable, in consultation with supervisors as	om literature, business or test reports and transfo s well as in the interim presentation, to assess the fine targets for new application-or research-orien	ir learning lev	vel and define fur
Workload in Hours	Independent Study Time 110, Study Time in Le	ecture 70		
Credit points	1 3 1 3			
Course achievement	Compulsory Bonus Form	Description		
course acmevement	Yes None Subject theoretical	and		
	practical work			
Examination	Presentation			
Examination duration and	Elaboration and Presentation (15-25 minutes in	n groups)		
scale				
Assignment for the	Civil Engineering: Specialisation Coastal Engine	eering: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical E	Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Structural Eng	ineering: Elective Compulsory		
	Civil Engineering: Specialisation Water and Tra	ffic: Elective Compulsory		
	Bioprocess Engineering: Specialisation A - Gene	eral Bioprocess Engineering: Elective Compulsory		
	Chemical and Bioprocess Engineering: Specialis	sation General Process Engineering: Elective Comp	oulsory	
	Chemical and Bioprocess Engineering: Speciali	sation Bioprocess Engineering: Elective Compulsor	у	
	Chemical and Bioprocess Engineering: Specialis	sation Chemical Process Engineering: Elective Con	npulsory	
	Chemical and Bioprocess Engineering: Specialis	sation Chemical and Bio process Engineering: Elec	tive Compuls	ory
	Environmental Engineering: Core Qualification:	Compulsory		
		pecialisation II. Renewable Energy: Elective Compu	lsory	
	Process Engineering: Specialisation Environme			
	Water and Environmental Engineering: Special	isation Cities: Elective Compulsory		
	Water and Environmental Engineering: Special			

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

Course L0318: Biological Wa	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			

Courses				
Title		Тур	Hrs/wk	СР
Finite element modeling of structur	es (L3046)	Lecture	2	3
Finite element modeling of structur	es (L3047)	Recitation Section (small)	2	3
Module Responsible	Prof. Bastian Oesterle			
Admission Requirements	None			
Recommended Previous Knowledge	Finite Element MethodsThin-walled structures			
Educational Objectives	After taking part successfully, students have re	eached the following learning results		
Professional Competence				
Knowledge	After successful completion of this module, stu	dents can express the basic aspects of modelli	ng of structures v	with finite elements
Skills	After successful completion of this module, the students will be able to model structures with finite elements and to analy structures using appropriate computational methods.			
Personal Competence				
Social Competence	Students can			
	 participate in subject-specific and interd 	isciplinary discussions,		
	defend their own work results in front of	others		
	 promote the scientific development of c 	olleagues		
	• Furthermore, they can give and accept	professional constructive criticism		
Autonomy	Students are able to gain knowledge of the su they are able to structure the solution process	oject area from given and other sources and ap for problems in the area of finite element mode		
Workload in Hours	Independent Study Time 124, Study Time in Le	ecture 56		
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
Examination duration and	written elaboration of a project work (10-15 pa	ges)		
scale				
Assignment for the	Civil Engineering: Specialisation Computationa	l Engineering: Compulsory		
Following Curricula	Civil Engineering: Specialisation Coastal Engine	eering: Elective Compulsory		
	Civil Engineering: Specialisation Geotechnical	Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Structural Eng	ineering: Elective Compulsory		
	Theoretical Mechanical Engineering: Specialisa	tion Simulation Technology: Elective Compulso	ry	

ourse L3046: Finite element modeling of structures		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Bastian Oesterle	
Language	EN	
Cycle	WiSe	
	 Basic phenomena and aspects of the finite element modelling of structures are discussed. Besides theoretical decription of the phenomena and methods, a strong focus is on the practical use a commercial finite element software within computer-based exercises. The covered topics are: finite element modeling of trusses/beams/frames, plates subject to in-plane/out-of-plane loading and shells convergence properties of displacements and stresses singularities locking effects critical assessment, interpretation and check of results mixed-dimensional coupling of finite elements geometrically linear and non-linear, and material linear and non-linear analyses stability: bifurcation and snap-through problems dynamic problems, modal analyses 	
Literature	Vorlesungsmanuskript, Vorlesungsfolien	

Course L3047: Finite elemen	urse L3047: Finite element modeling of structures		
Тур	Recitation Section (small)		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Bastian Oesterle		
Language	EN		
Cycle	WiSe		
Content	See interlocking course		
Literature	See interlocking course		

Courses				
Title		Тур	Hrs/wk	СР
Modeling of Subsurface Processes	(L2731)	Recitation Section (sm	all) 3	3
Subsurface Solute Transport (L272	8)	Lecture	2	2
Subsurface Solute Transport (L272	9)	Recitation Section (lar	ge) 1	1
Module Responsible	Prof. Nima Shokri			
Admission Requirements	None			
Recommended Previous	Basic Mathematics, Hydrology			
Knowledge				
Educational Objectives	After taking part successfully, students h	ave reached the following learning results		
Professional Competence				
•	Upon completion of this module. the st	udents will understand the mechanisms co	ntrolling solute transp	ort in soil and natu
		th the equations that govern the fate and tra	5	
	, numerical and experimental tools and tee			-
Skills	In addition to the physical insights, the st	udents will be exposed to analytical, expering	mental and numerical t	ools and techniques
	this module. This provides them with an	excellent opportunity to improve their skills of	on multiple fronts which	n will be useful in th
	future career.			
Personal Competence				
Social Competence	Teamwork & problem solving			
Autonomy	The students will be involved in writing individual reports and presentation. This will contribute to the students' ability ar			
	willingness to work independently and re-	sponsibly.		
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			
scale				
Assignment for the	Civil Engineering: Specialisation Structura	al Engineering: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotech	nical Engineering: Elective Compulsory		
-	Civil Engineering: Specialisation Coastal B	Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Water ar	d Traffic: Elective Compulsory		
	Civil Engineering: Specialisation Compute	tional Engineering: Elective Compulsory		
	Chemical and Bioprocess Engineering: Te	chnical Complementary Course: Elective Cor	npulsory	
	Environmental Engineering: Core Qualific	ation: Compulsory	-	
	Process Engineering: Specialisation Envir	onmental Process Engineering: Elective Com	pulsory	
	Process Engineering: Specialisation Proce	ss Engineering: Elective Compulsory		
	Water and Environmental Engineering: Sp	pecialisation Water: Compulsory		
	Water and Environmental Engineering: S			

Course L2731: Modeling of S	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	Dr. Milad Aminzadeh		
Language	EN		
Cycle	WiSe		
Content	Basic usage and background of chosen computer software to calculate flow and transport in the saturated and unsaturated zone and to analyze field data like pumping test data		
Literature			

Course L2728: Subsurface So	plute Transport
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Nima Shokri
Language	EN
Cycle	WiSe
Content	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	rse L2729: Subsurface Solute Transport			
Тур	Recitation Section (large)			
Hrs/wk	1			
СР	1			
Workload in Hours	pendent Study Time 16, Study Time in Lecture 14			
Lecturer	es Nevermann			
Language	EN			
Cycle	WiSe			
Content	See interlocking course			
Literature	See interlocking course			

Specialization Geotechnical Engineering

Module M0699: Geote	chnics III					
Courses						
			11			
Title Numerical Methods in Geotechnics	(10275)	Typ Lecture	Hrs/wk 3	СР 3		
Advanced Foundation Engineering		Lecture	2	2		
Advanced Foundation Engineering		Recitation Section (large)	1	1		
Module Responsible						
Admission Requirements						
-	Geotechnics I and II, Mathematics I-III					
Knowledge						
	After taking part successfully, students have reached the	e following learning results				
Professional Competence						
-	After successfully completing the module, students will b	be able to				
	 describe individual procedures for the geotechnica 	al monitoring of civil engineering me	easures,			
	reproduce exploration and investigation methods					
	select suitable types of field and laboratory tests f					
	 state the differences between various stress and 	deformation states and the physica	l significance of in	variants of the stress		
	and distortion tensor,		and a local second second			
	 outline the standard and special soil mechanics te 		rain benavior of so	ΙΙ,		
	 describe continuum models and the resulting boundary value problems from t 		in such a way that	t they can be calved		
	 as well as define boundary value problems from t unambiguously. 		g in such a way the	it they can be solved		
Skills	Students will be able to					
	 dimension vertical drains for soil improvement of 	soft soils,				
	 calculate depth compaction using various appropr 	iate methods,				
	 apply principles of horizontal bearing capacity of p 	piles,				
	• verify the internal and external stability of fluid-supported diaphragm walls,					
	 evaluate the boundary conditions for the designation 	in of a deep excavation and des	ign the individual	components of the		
	excavation,					
	perform, evaluate and interpret tests for the description		cording to applicab	le standards,		
	computationally implement numerical algorithms			2011 - 10 - 10 - 1		
	 select and apply the types of analyses depending determine appropriate model parameters for difference 	-				
	 determine appropriate model parameters for different possibilities and limitations of material models for the generative 					
	of soils.					
Personal Competence						
Social Competence	Students can work in groups and support each other in fi	inding solutions.				
Autonomy	Students are able to assess their own strengths and weaknesses and, based on this, organize their time and learning management and think in terms of processes.					
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84					
Credit points	6					
Course achievement	None					
Examination	Written exam					
Examination duration and	120 min					
scale						
Assignment for the	Civil Engineering: Specialisation Structural Engineering:	Compulsory				
J	Civil Engineering: Specialisation Geotechnical Engineerin					
-	Civil Engineering: Specialisation Coastal Engineering: Co					
	Civil Engineering: Specialisation Water and Traffic: Electi	ve Compulsory				
	Civil Engineering: Specialisation Computational Engineer	ing: Compulsory				
	International Management and Engineering: Specialisation	on II. Civil Engineering: Elective Con	npulsory			

Course L0375: Numerical Me	thods in Geotechnics
Тур	Lecture
Hrs/wk	3
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Dr. Hans Mathäus Stanford
Language	DE
Cycle	WiSe
Content	Topics:
	 Introduction to numerical soil mechanics Introduction to numerical mathematics Finite Element Method (analysis procedures, algorithms) Finite Element Method (application in geotechnical engineering)
Literature	 Wriggers P. (2001): Nichtlineare Finite-Elemente-Methoden. Springer Wriggers P. (2008): Nonlinear Finite Element Methods. Springer Deutsche Gesellschaft für Geotechnik e.V. (Hrsg., 2014): Empfehlungen des Arbeitskreises "Numerik in der Geotechnik". Ernst & Sohn

Course L0497: Advanced Fou	undation Engineering		
Тур	Lecture		
Hrs/wk			
СР	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Prof. Jürgen Grabe		
Language	DE		
Cycle	WiSe		
Content	 Vertical drains Piles Ground improvement (Deep Compaction, Soil mixing) Vibration driving Jet grouting Slurry wall Deep excavation 		
Literature	 EAK (2002): Empfehlungen für Küstenschutzbauwerke EAU (2004): Empfehlungen des Arbeitsausschusses Uferbauwerke EAB (1988): Empfehlungen des Arbeitskreises Baugruben Grundbau-Taschenbuch, Teil 1-3, (1997), Ernst & Sohn Verlag 		

Course L0498: Advanced Fou	ourse L0498: Advanced Foundation Engineering		
Тур	Recitation Section (large)		
Hrs/wk	1		
СР	1		
Workload in Hours	endent Study Time 16, Study Time in Lecture 14		
Lecturer	ürgen Grabe		
Language	DE		
Cycle	WiSe		
Content	e interlocking course		
Literature	See interlocking course		

Courses						
Title		Tura	Hrs/wk	СР		
Applied Tunnel Constructions (L24)		Typ Lecture	2	3		
Introduction to tunnel construction		Lecture	1	2		
Introduction to tunnel construction	(L1811)	Recitation Section (large)	1	1		
Module Responsible	Prof. Jürgen Grabe					
Admission Requirements	None					
Recommended Previous	Modules from Bachelor studies Civil	and environmental engineering:				
Knowledge						
	Geotechnics I-II					
Educational Objectives	After taking part successfully, stude	nts have reached the following learning results				
Professional Competence						
Knowledge	Knowledge of different tunnel construction types as well as special methods and techniques of subsoil construction.					
Skills	Basic knowledge of tunnel design as well as practical skills in structural tunnel analysis.					
Personal Competence						
Social Competence	Capacity for teamwork concerning project management and design of tunnels.					
Autonomy	Promotion of independent and creative work flow in the framework of a design exercise.					
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56					
Credit points	6					
Course achievement	Compulsory Bonus Form	Description				
	No 5% Excercises					
Examination	Written exam					
Examination duration and	120 minutes					
scale						
Assignment for the	Civil Engineering: Specialisation Stru	ctural Engineering: Elective Compulsory				
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering: Compulsory					
	Civil Engineering: Specialisation Coastal Engineering: Compulsory					
	Civil Engineering: Specialisation Water and Traffic: Elective Compulsory					
	Civil Engineering: Specialisation Con	nputational Engineering: Elective Compulsory				

Course L2407: Applied Tunne	Course L2407: Applied Tunnel Constructions		
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	endent Study Time 62, Study Time in Lecture 28		
Lecturer	ürgen Grabe, Tim Babendererde		
Language	DE		
Cycle	WiSe		
Content			
Literature			

Course L0707: Introduction t	o tunnel construction			
Тур	Lecture			
Hrs/wk	1			
CP				
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14			
Lecturer	Dr. Julian Bubel			
Language	DE			
Cycle	WiSe			
Content	 Definitions Historical development in tunneling Geology for tunneling Hard rock tunneling (construction composite and machines) Tunnelung in temporarly stable soil with conventional construction methods Tunneling in soft soils (form of supports, shield types, compressed air application) Pipe jacking Tunnel Lining, tunnel supporting structures Calculation approaches for supporting structures in shield-driven tunnels Surveying for tunneling Safety requirements Construction Contract Literature and sources 			
Literature	• Vorlesung/Übung s. www.tu-harburg.de/gbt			

Course L1811: Introduction t	Course L1811: Introduction to tunnel construction		
Тур	Recitation Section (large)		
Hrs/wk	1		
CP	1		
Workload in Hours	dent Study Time 16, Study Time in Lecture 14		
Lecturer	an Bubel		
Language	DE		
Cycle	WiSe		
Content	See interlocking course		
Literature	See interlocking course		

Prof. Kay Smarsly None Basics of project-oriented programming After taking part successfully, students have reached the follow	Typ Project-/problem-based Learning	Hrs/wk 6	CP 6
None Basics of project-oriented programming			
None Basics of project-oriented programming			
Basics of project-oriented programming			
After taking part successfully, students have reached the follow			
After taking part successfully, students have reached the follow			
incontaining part successiony, students have reached the follow	ing learning results		
Basics of robotics			
Applications in civil engineering			
linematics			
Jse of specific hardware			
Development of software routines			
Puthon programming language			
ython programming language			
mage processing			
Basics of localization (LIDAR, SLAM)			
Feamwork			
communication skills			
ndependent work			
ndependent decisions			
Civil Engineering: Specialisation Structural Engineering: Elective	e Compulsory		
Civil Engineering: Specialisation Water and Traffic: Elective Com	npulsory		
Civil Engineering: Specialisation Coastal Engineering: Elective C	ompulsory		
Civil Engineering: Specialisation Geotechnical Engineering: Elect	tive Compulsory		
	ective Compulsory		
	Aasics of robotics applications in civil engineering Ginematics Use of specific hardware Development of software routines bython programming language mage processing Basics of localization (LIDAR, SLAM) feamwork Communication skills independent work independent decisions independent decisions independent Study Time 96, Study Time in Lecture 84 Solutione Vritten elaboration a. 10 Seiten Civil Engineering: Specialisation Structural Engineering: Elective Civil Engineering: Specialisation Coastal Engineering: Elective Civil Civil Engineering: Specialisation Geotechnical Engineering: Elective Civil Engineering: Specialisation Computational Engineering: Elective Civil Engineering: Specialisation II: Intelligence Engineering: Elective Civil Engineering: Specialis	tasics of robotics applications in civil engineering finematics Use of specific hardware Development of software routines Sython programming language mage processing tasics of localization (LIDAR, SLAM) feamwork formmunication skills ndependent work ndependent work ndependent study Time 96, Study Time in Lecture 84 finemation for the study Time 96, Study Time in Lecture 84 finemation finemation final fina	tasics of robotics spplications in civil engineering tinematics Jose of specific hardware Development of software routines Sython programming language mage processing lasics of localization (LIDAR, SLAM) leamwork communication skills independent work independent work independent Study Time 96, Study Time in Lecture 84 i lone Vritten elaboration a. 10 Seiten Civil Engineering: Specialisation Structural Engineering: Elective Compulsory Vivil Engineering: Specialisation Goate Engineering: Elective Compulsory Vivil Engineering: Specialisation Computational Engineering: Elective Compulsory Vivil Engineering: Specialisation Computational Engineering: Elective Compulsory Civil Engineering: Specialisation Computational Engineering: Elective Compuls

τνρ	roject-/problem-based Learning				
Hrs/wk					
CP					
	Independent Study Time 96, Study Time in Lecture 84				
	of. Kay Smarsly, Jan Stührenberg				
Language					
Cycle					
Content	 Introduction: Robotics in civil engineering Presentation of potential topics Programming of algorithms in Python Application of software systems: LINUX distribution, ROS, CloudCompare, Application of hardware systems: Petoi Bittle Dog, Raspberry Pi, Arduino, sensing Topics considered for robotics using the Petoi Bittle Dog: Movement Use of sensors (camera, infrared,) Data structures/data acquisition Programming Topics technically relevant to building inspection: Geodetic evaluations Image processing Localization 				
Literature	Bock/Linner: Construction Robotics				
	Verl et al.: Soft Robotics				
	Pasquale: New Laws of robotics				

Module M0593: Building Materials and Building Preservation

Courses						
Title			Ту	p	Hrs/wk	СР
Repair of Structures (L0255)			-	ture	1	1
Mineral Building Materials (L0253)			Leo	ture	2	2
Technology of mineral Building Mat	erials (L0256)		Pro	ject-/problem-based Learn	ing 1	2
Transport Processes in Building Mat	erials and Damage Proc	esses (L0254)	Leo	ture	1	1
Module Responsible	Prof. Frank Schmidt-D	öhl				
Admission Requirements	None					
Recommended Previous	Basic knowledge abo	ut building materials, b	ouilding physics and b	uilding chemistry, for e	example by the n	nodules Principles
Knowledge	Building Materials and	d Building Physics and Bu	uilding Materials and B	uilding Chemistry.		
Educational Objectives	After taking part succ	essfully, students have r	eached the following l	earning results		
Professional Competence						
Knowledge	The students are able to describe the components of mineral building materials and their function in detail and to use them for the manufacture of special mineral building materials. They are able to show the characteristics of mineral building materials. They are able to describe the manufacture, properties and fields of application of special mortars and special concretes and the correlations of their material parameters. They are able to show the principles of anchor technology and design.					
Skills	The students are able to perform an optimization of granulometry of a mineral building material. They are able to design a special mineral mortar and to manufacture this mortar. The students are able to manufacture post installed rebar connections. They are able to recognize damages, to assess possible causes, to use the fundamentals of construction preservation and to select repa and strengthening measures.					
Personal Competence						
Social Competence	The students are able to develop in small grous the mixture of a special mortar. They present their results to the lecturer and the other students. In a critical discussion they defend and adjust their results. The students are able to manufacture their special building material on the basis of this feedback.					
Autonomy	The students are able to responsibly use the resources of materials and lab equipment for their project and to investigate and to get missing components.					
Workload in Hours	Independent Study Ti	me 110, Study Time in L	ecture 70			
Credit points	6					
Course achievement	CompulsoryBonusYes20 %	Form Subject theoretical practical work	Description and			
Examination	Written exam					
Examination duration and scale	120 min					
	Civil Engineering, Spe	cialisation Geotechnical	Engineering: Compuls	orv		
Following Curricula	• • ·	cialisation Coastal Engin	• • •	-		
	S Engineering. Spe	classición coustar Engin	comp. Elective comp			
5	Civil Engineering: Spe	cialisation Structural Eng	aineerina: Elective Cor	npulsory		

Course L0255: Repair of Structures		
Тур	Lecture	
Hrs/wk	1	
СР	1	
Workload in Hours	dependent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Frank Schmidt-Döhl	
Language	DE	
Cycle	SoSe	
Content	Maintenance of structures, repair and strengthening, subsequent waterproofing of structures	
Literature	BetonMarketing Deutschland (Hrsg.): Stahlbetonoberflächen - schützen, erhalten, instandsetzen	

Course L0253: Mineral Building Materials				
Тур	Lecture			
Hrs/wk	2			
СР	2			
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28			
Lecturer	Prof. Frank Schmidt-Döhl			
Language	DE			
Cycle	SoSe			
Content	Components of mineral building materials and their function, binding materials, concrete and mortar, special mortars, special concretes			
Literature	Taylor, H.F.W.: Cement Chemistry			
	Springenschmid, R.: Betontechnologie für die Praxis			

Course L0256: Technology of mineral Building Materials			
Тур	Project-/problem-based Learning		
Hrs/wk	1		
СР	2		
Workload in Hours	ndependent Study Time 46, Study Time in Lecture 14		
Lecturer	Prof. Frank Schmidt-Döhl		
Language	DE		
Cycle	SoSe		
Content	Design and production of a special mineral building material		
Literature	Taylor, H.F.W.: Cement Chemistry		
	Springenschmid, R.: Betontechnologie für die Praxis		

Course L0254: Transport Processes in Building Materials and Damage Processes		
Тур	Lecture	
Hrs/wk	1	
СР	1	
Workload in Hours	ndependent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Frank Schmidt-Döhl	
Language	DE	
Cycle	SoSe	
Content	Transport Processes in Building Materials and Damage Processes	
Literature	Blaich, J.: Bauschäden, Analyse und Vermeidung	

Courses						
Title		Тур	Hrs/wk	СР		
Design of Prestressed Structures and Concreet Bridges (L0603)		Lecture	3	4		
Design of Prestressed Structures a	nd Concreet Bridges (L0604)	Recitation Section (large)	2	2		
Module Responsible	NN					
Admission Requirements	None					
Recommended Previous	Detailed knowledge on the design of concrete structures.					
Knowledge						
	Modules: Reinforced Concrete Structures I+II, Structural Analysis I+II, Mechanics I+II, Concrete Structures					
Educational Objectives	After taking part successfully, students have reached the following learning results					
Professional Competence						
Knowledge	The students know the main bridge types, their applications and the various loads. They can explain the basic design method					
	They can explain the design of a prestressed bridge.					
CI-ill-						
SKIIIS	The students are able to design reinforced or prestressed concrete bridges.					
Personal Competence						
Social Competence	e The students can design in teamwork a real concrete bridge.					
Autonomy						
Autonomy The students are able to design a prestressed concrete bridge and discuss the problems and results wit						
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 minutes					
scale						
Assignment for the	Civil Engineering: Specialisation Structural	Engineering: Compulsory				
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory					
	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory					
	Civil Engineering: Specialisation Computational Engineering: Elective Compulsory					
	International Management and Engineering					

Course L0603: Design of Pre	stressed Structures and Concreet Bridges
Тур	Lecture
Hrs/wk	3
СР	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	NN
Language	DE
Cycle	SoSe
Content	prestressed structures
	 basis of prestressed structures, field of application differences between reinforced and prestressed concrete structures history of prestressing construction materials: concrete, tendons, ducts, anchorage systems construction: prestressing methods prestressing forces and member forces (friction, elongation) tendon layout time dependant prestressing losses design of prestressed structures design of anchorage region non-bonded prestressing prestressed flat slabs
	Concrete bridges history of bridges design of bridges loads on bridges loads on bridges member forces for slab, T-beam, hollow box, frame and arch bridges precast bridges - precast segmental bridges bearings abutments, columns construction methods damages - checking of bridges
Literature	 Vorlesungsumdruckim STUDiP Rombach, G. (2003): Spannbetonbau. Ernst & Sohn, Berlin Wicke, M. (2002): Anwendung des Spannbetons. Betonkalender 2002, Teil II, S. 113-180, Verlag Ernst & Sohn, Berlin Leonhardt, F. (1980): Vorlesungen über Massivbau. Teil 5: Spannbeton. Berlin Mehlhorn, G. (2007): Handbuch Brücken, Springer Verlag Schäfer, H.; Kaufeld, K. (1997): Massivbrücken. Betonkalender Teil II, S. 443ff, Ernst & Sohn, Berlin Menn, Ch. (1986): Stahlbetonbrücken. Springer Verlag, Wien

Course L0604: Design of Pre	urse L0604: Design of Prestressed Structures and Concreet Bridges		
Тур	Recitation Section (large)		
Hrs/wk	2		
СР	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	NN		
Language	DE		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Courses				
Title		Тур	Hrs/wk	СР
Digital Twinning in Civil Engineerin	g (L3136)	Lecture	2	2
Digital Twinning in Civil Engineerin	g (L3137)	Seminar	2	4
Module Responsible	Alexander Chmelnizkij			
Admission Requirements	None			
Recommended Previous				
Knowledge				
Educational Objectives	After taking part successfully, students h	ave reached the following learning results		
Professional Competence				
Knowledge				
Skills				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 124, Study Time	e in Lecture 56		
Credit points	6			
Course achievement	None			
Examination	Presentation			
Examination duration and	20 min presentation and 5 pages handou	t		
scale				
Assignment for the	Civil Engineering: Specialisation Compute	ational Engineering: Compulsory		
Following Curricula	Civil Engineering: Specialisation Coastal	Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Geotech	nical Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Structura	al Engineering: Elective Compulsory		

Course L3136: Digital Twinning in Civil Engineering		
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Alexander Chmelnizkij, Prof. Bastian Oesterle, Prof. Kay Smarsly	
Language	DE	
Cycle	SoSe	
Content		
Literature		

Course L3137: Digital Twinning in Civil Engineering		
Тур	Seminar	
Hrs/wk	2	
СР	4	
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28	
Lecturer	Alexander Chmelnizkij, Prof. Bastian Oesterle, Prof. Kay Smarsly	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Module M0827: Mode	ling in Water Management			
	,			
Courses				
Title		Тур	Hrs/wk	СР
Groundwater Modeling using Modfl		Lecture	1	1
Groundwater Modeling using Modfl Modeling of Water Supply Network		Recitation Section (small) Project-/problem-based Learning	2 2	2 3
		rioject-problem-based Leanning	Z	5
Module Responsible Admission Requirements				
Recommended Previous				
Knowledge	Groundwater			
ieuge	 groundwater hydraulics and transport of 	substances		
	Pipe Systems			
		res, in particular drinking water systemsand	urban drainag	e systems includin
	special structures	and the second second		
	Hydraulics of drinking water supply syste Basis knowledge on water management	ms and sewer systems		
	 Basic knowledge on water management 			
Educational Objectives	After taking part successfully, students have rea	ached the following learning results		
Professional Competence				
Knowledge	The students are able to describe the modelling	of groundwater flow and transport as well as up	ban water infr	astructures. They ca
	carry out systems analyses and can detect tech	nnical and conceptual weak points within the sy	stems in case	studies. Besides the
	are able to analyse interdependencies of hydrau	lic and toxic phenomena in soil and water.		
Skills	The students are able to construct and apply s	cientific groundwater models indipendently. Th	ey can work o	n different scenarios
	and can compare or assess different solutions for	or existing problems by application of selected s	oftware produ	cts. The students are
	able to use different software solutions (e.g. EP/	ANET, EPA-SWMM).		
Personal Competence				
	Wird nicht vermittelt.			
Autonomy	Wird nicht vermittelt.			
Workload in Hours	Independent Study Time 110, Study Time in Leo	ture 70		
Credit points	6			
Course achievement	None			
Examination	Oral exam			
Examination duration and	30 min			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Engin	neering: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering	ngineering: Elective Compulsory		
	Civil Engineering: Specialisation Coastal Engine	ering: Elective Compulsory		
	Civil Engineering: Specialisation Water and Traf	fic: Elective Compulsory		
	Civil Engineering: Specialisation Computational	Engineering: Elective Compulsory		
	Water and Environmental Engineering: Specialis	ation Environment: Elective Compulsory		
	Water and Environmental Engineering: Specialis			
	Water and Environmental Engineering: Specialis	ation Water: Elective Compulsory		

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

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

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

	lechanics and -Dynamics			
Courses				
Title		Тур	Hrs/wk	СР
Soil Mechanics - Selected Topics (L	0374)	Lecture	2	2
Soil Dynamics (L0452)		Lecture	2	2
Experimental Researches in Geote	chnics (L0706)	Practical Course	2	2
Module Responsible	Prof. Jürgen Grabe			
Admission Requirements	None			
Recommended Previous	Modules: Mathematics I-III, Mechanics I-II, Geote	chnics I		
Knowledge	Courses: Soil laboratory course, (Applied structu	ral dynamics)		
Educational Objectives	After taking part successfully, students have rea	ched the following learning results		
Professional Competence				
	Students will be able to,			
	describe wave propagation in the ground			
	to measure vibrations and to interpret the			
	justify when elastodynamic methods are s		ts must be taken into a	account,
	 to reproduce the collapse theorems of pla 			
	 describe the viscous behavior of cohesive structure the second sec	e soils and computationally account r	or creep deformation	and rate-depende
	shear strengthsas well as to determine the effect of partia	al saturation on the seenage flow and th	a choar strongth	
	• as well as to determine the effect of partic	a saturation on the seepage now and th	le shear strength.	
Skills	After the successful completion of the module th	e students should be able to:		
	 to derive and apply the basic equation of 	a simple mass oscillator		
	 to understand the wave propagation in the 		letect the relevant nar	ameters
	 to know the essential laboratory and field 			
	 to design machine foundations to dynamic 			ie chem,
	 to measure shocks to perform vibration for 			
	 to evaluate shocks in terms of their effect 			
	 to evaluate possibilities of isolation, 			
	 to understand mechanisms that cause ear 	thquakes and evaluate earthquakes in t	terms of their magnitu	de and intensity,
	 to know methods to determine axial pile of 			
	 to know the mechanisms that lead to a dependence 			e these deformatio
	mathematically,			
	 to distinguish the area of application of th 	e method of elastodynamics and plasto	dynamics,	
	 to detect the undrained shear strength as 	a function of a number of state variable	25,	
	 to capture the visous behaviour of cohesi 	ve soils and to consider the effects of c	reep and rate-depend	ent shear strength
	calculations,			
	 to consider the impact of the partly satura 	ted of a seepage and shear strength.		
Devenuel Competence				
Personal Competence	Students will be able to work in teams to achie	ve results on measurement and experi	mental principles and	present their rocu
Social competence	together at the end of the semester.	ve results on measurement and experil	mentar principles alla	present their resu
	together at the end of the semester.			
Autonomy	Students are able to assess their own strengths	and weaknesses and organize their time	e and learning manage	ment based on this
Workload in Hours	Independent Study Time 96, Study Time in Lectu	ıre 84		
Credit points	6			
Course achievement	Compulsory Bonus Form	Description		
	,	ind		
	practical work			
Examination	Written exam			
Examination duration and	135 min			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Engin			
Following Curricula	Civil Engineering: Specialisation Geotechnical En			
	Civil Engineering: Specialisation Coastal Enginee			
	Civil Engineering: Specialisation Computational E	ngineering: Elective Compulsory		

Course L0374: Soil Mechanics	s - Selected Topics
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Hans Mathäus Stanford
Language	DE
Cycle	SoSe
Content	selected topis:
Literature	 Stress-strain behaviour (experiments, observations, models) Hydraulic behaviour (experiments, observations, models) Physical modelling (similarity theory, 1g model tests, ng model tests) Limit and safety analysis (collapse theorems of plasticity theory, upper and lower bound analysis, limit equilibrium analysis, numerical analysis) Heat transport (heat conduction, convective heat transport, freezing/thawing) Kolymbas D. (2019): Geotechnik - Bodenmechanik, Grundbau und Tunnelbau. Springer Verlag, 5. Auflage Muir Wood D. (2004). Geotechnical modelling. CRC Press Nova, R. (2010). Soil mechanics. Wiley Verruijt, A. (2012). Soil mechanics. u r l: https://geo.verruijt.net Verruijt A. (2018). An introduction to soil mechanics. Vol. 30, Springer Series Theory and Applications of Transport in Porous Media

Course L0452: Soil Dynamics		
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Anne Hagemann	
Language		
Cycle	SoSe	
Content	mass-spring-damper systems,	
	• wave propagation in soils,	
	dynamic soil parameters,	
	• Determination of dynamic soil parameters,	
	• machine foundations,	
	• in-situ measurement of ground motion, ground motion prediction, evaluation of ground motion,	
	• ground motion shielding,	
	introduction into earthquake engineering,	
	• dynamic pile tests,	
	cyclic accumulation,	
	• plastodynamics	
Literature	 Das B.M.: Fundamentals of Soil Dynamics, Elsevier Empfehlungen des Arbeitskreises Baugrunddynamik. Hrsg. Deutsche Gesellschaft für Geotechnik (DGGT) Haupt W.: Bodendynamik. Vieweg und Teubner Meskouris K. und Hinzen KG.: Bauwerke und Erdbeben. Vieweg Verlag Studer J.A., Koller M.G. und Laue J.: Bodendynamik, Springer Verlag 	

Course L0706: Experimental	Researches in Geotechnics
Тур	Practical Course
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Hans Mathäus Stanford, Göta Bürkner
Language	DE
Cycle	SoSe
Content	The students are supposed to:
	 become acquainted with geotechnical model tests, field tests and laboratory tests as well as corresponding measurement techniques. These compromise amongst others inclinometer measurements and geophone measurements as well as high-grade laboratory tests on the stress-strain relationship of soil specimens, e. g. triaxial tests, simple shear tests and resonant column tests. gain insight into current soil mechanical research. plan, coordinate, perform and evaluate soil mechanical tests in a team. discuss, reflect, review and present the obtained results in a group. An important learning target is the introduction to scientific work for students who plan a scientific career, and for those who will work in practice with the responsibility to order corresponding tests and evaluate the results. The practical laboratory work is based on annualy changing problems, which are however related to the experience and results of the preceding year's course group.
Literature	- Grabe, J. (2004): Bodenmechanik und Grundbau, Band 3 der Veröffentlichungsreihe des Instituts für Geotechnik und Baubetrieb, Technische Universität Hamburg-Harburg.
	- Kolymbas, D. (2007): Geotechnik - Bodenmechanik, Grundbau und Tunnelbau. 2., korrigierte und ergänzte Auflage, Springer Verlag.
	 Normen zu geotechnischen Versuchsgeräten und Versuchsverfahren: DIN 18135:2012-04: Baugrund, Untersuchung von Bodenproben - Eindimensionaler Kompressionsversuch, Deutsches Institut für Normung, e. V.
	- DIN 18137-2:2011-04: Baugrund, Untersuchung von Bodenproben - Bestimmung der Scherfestigkeit - Teil 2: Triaxialversuch, Deutsches Institut für Normung e. V.

Courses				
Title	Т	Тур	Hrs/wk	СР
Noise Protection (L1109)		ecture	2	2
Urban Infrastructures (L0874)	Р	roject-/problem-based Learning	2	4
Module Responsible	Dr. Dorothea Rechtenbach			
Admission Requirements	None			
Recommended Previous				
Knowledge	Knowledge on Urban planning			
	Knowledge on measures for climate protection			
	General knowledge of scientific writing/working			
Educational Objectives	After taking part successfully, students have reached the following	learning results		
Professional Competence				
Knowledge	Students can describe urban development corridors as well as cur	rent and future urban environr	mental probler	ns. They are able
	explain the causes of environmental problems (like noise).			
	Students can specify applications for various technical innovations and explain why these contribute to the improvement			
	life. They can, for example, derive and discuss measures for effective noise abatement.			
Skills Students are able to develop specific colutions for correcting existing or future environment related i			problems of urb	
JKIIIS	Skills Students are able to develop specific solutions for correcting existing or future environment-related problem development. They can define a range of conceptual and technical solutions for environmental problems for different of paths. To solve specific urban environmental problems they can select technical innovations and integrate them inte			
	context.			
Personal Competence				
Social Competence	The students can work together in international groups.			
Autonomy	y Students are able to organize their work flow to prepare themselves for presentations and contributions to the discussion			ie discussions. Th
	can acquire appropriate knowledge by making enquiries independe	ently.		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
Examination duration and	Written Report plus oral Presentation			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Engineering: Elective Co	ompulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering: Elective	e Compulsory		
	Civil Engineering: Specialisation Coastal Engineering: Elective Com	ipulsory		
	Civil Engineering: Specialisation Water and Traffic: Elective Compu	llsory		
	Environmental Engineering: Core Qualification: Elective Compulsor	у		
	Joint European Master in Environmental Studies - Cities and Sustain	•		
	Logistics, Infrastructure and Mobility: Specialisation Infrastructure	and Mobility: Elective Compuls	ory	
	Water and Environmental Engineering: Specialisation Environment Water and Environmental Engineering: Specialisation Cities: Comp			

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.

Courses				
Title		Тур	Hrs/wk	СР
Harbour Engineering (L0809)		Lecture	2	2
Harbour Engineering (L1414)		Project-/problem-based Learning	1	2
Port Planning and Port Construction	(L0378)	Lecture	2	2
Module Responsible	Prof. Peter Fröhle			
Admission Requirements	None			
Recommended Previous	Basics of coastal engineering			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the f	ollowing learning results		
Professional Competence				
Knowledge	The students are able to define in details and to choose design approaches for the functional design of a port and apply them			
	design tasks. They can design the fundamental elements of a port.			
<i>CL 11</i>				
SKIIIS	The students are able to select and apply appropriate approaches for the functional design of ports.			
Personal Competence				
Social Competence	The students are able to deploy their gained knowledge in applied problems such as the functional design of ports. Additiona			
	they will be able to work in team with engineers of other d	sciplines.		
Autonomy	The students will be able to independently extend their kn	owledge 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 examir	ation includes tasks with respect to	the general u	understanding of t
scale	lecture contents and calculations tasks.			
Assignment for the	Civil Engineering: Specialisation Structural Engineering: Ele	ective Compulsory		
-	Civil Engineering: Specialisation Geotechnical Engineering:			
-	Civil Engineering: Specialisation Coastal Engineering: Com	pulsory		
	Civil Engineering: Specialisation Water and Traffic: Elective	Compulsory		
	International Management and Engineering: Specialisation	II Civil Engineering: Elective Compuls	onv	

burse L0809: Harbour Engineering	
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
Cycle	SoSe
Content	 Fundamentals of harbor engineering Maritime transportation and waterways engineering Ships Elements of harbors Harbor approaches and water-side harbor areas Terminal design and handling of cargo Quay-walls and piers Equipment of harbors Sluices and other special constructions Connection to inland transportation / inland waterway transportation Protection of harbors Breakwaters and Jetties Wave protection of harbors Fishery and other small harbors
Literature	Brinkmann, B.: Seehäfen, Springer 2005

Course L1414: Harbour Engin	ourse L1414: Harbour 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	DE		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

ourse L0378: Port Planning	
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Frank Feindt
Language	DE
Cycle	SoSe
Content	 Planning and implementation of major projects Market analysis and traffic relations Planning process and plan Port planning in urban neighborhood Development of the logistics center "Port of Hamburg" in the metropolis Quays and waterfront structure Special planning Law Harbor - securing of a flexible use of the port Dimensioning of quays Flood protection structures and development Port of Hamburg - Infrastructure and development Preparation of areas Scour formation in front of shore structures
Literature	Vorlesungsumdruck, s. www.tu-harburg.de/gbt

Courses				
Title		Түр	Hrs/wk	СР
Hydraulic Models (L0813)		Project-/problem-based Learning	1	1
Modelling of Waves (L0812)		Project-/problem-based Learning	1	1
Modelling of Flow in Rivers and Est	Jaries (L0810)	Lecture	3	4
Module Responsible	Prof. Peter Fröhle			
Admission Requirements	None			
Recommended Previous	Coastal Hydraulic Engineering I			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the follo	owing learning results		
Professional Competence				
Knowledge	Knowledge Students are able to define in detail the basic processes that are related to the modelling of flows in hydraulic			ydraulic engineerir
	Besides, they can describe the basic aspects of numerical modelling and actual numerical models for the simulation of flows an			
	waves.			
Skille	Students are able to apply hydrodynamic-numerical models t	practical hydraulic engineering ta	eke	
JKIIIS	Students are able to apply hydrodynamic-humencar models t	b practical hydraulic engineering ta	585.	
Personal Competence				
Social Competence	e The students are able to deploy their gained knowledge in simple applied problems. Additionaly, they will be able to work in t		able to work in tea	
	with others.			
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 3 hours. The examination	on includes tasks with respect to	the general u	understanding of t
scale	lecture contents and calculations tasks.			
Assignment for the	Civil Engineering: Specialisation Structural Engineering: Elect	ve Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering: El	ective Compulsory		
	Civil Engineering: Specialisation Coastal Engineering: Elective	Compulsory		
	Civil Engineering: Specialisation Computational Engineering:			

Course L0813: Hydraulic Mod	dels
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	DE/EN
Cycle	SoSe
Content	 Fundamentals of hydraulic models Model laws Pi theorem of Buckingham Practical examples of hydraulic models
Literature	Strobl, Zunic: Wasserbau, Kap. 11 Hydraulische Modelle, Springer

Course L0812: Modelling of	Waves
Тур	Project-/problem-based Learning
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Peter Fröhle
Language	DE/EN
Cycle	SoSe
Content	 Waves, interactions with shallow water and constructions Wave theories Sea state and surges Development of waves Wave spectra Modelling of Waves / phase averaged and phase resolved models Application of a phase averaged model for wave prediction (SWAN) Application of phase resolved wave models (Mike)
Literature	Vorlesungsumdruck

Course L0810: Modelling of I	
	Lecture
Hrs/wk	
CP	4
	Independent Study Time 78, Study Time in Lecture 42
	Prof. Edgar Nehlsen, Prof. Peter Fröhle
Language	
Cycle	SoSe Introduction to numerical flow modelling
	 Processes affecting tht flow Examples and applications of numerical models Procedure of numerical modelling Model concept Basic equations of hydrodynamics Saint-Venant equations Euler Equations Navier-Stokes equations Reynolds-averaged Navier-Stokes equations
	 Shallow water equations Solving schemes Numerical discretization Solution algorithms Convergence
Literature	Vorlesungsskript
	Bund der Ingenieure für Wasserwirtschaft, Abfallwirtschaft und Kulturbau (1997): Hydraulische Berechnung von naturnaher 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 de 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 fü Wasserwirtschaft und Kulturbau. Bonn: Wirtschafts- und VerlGes. Gas und Wasser (Schriftenreihe des Deutschen Verbandes für Wasserwirtschaft und Kulturbau, 127).

Module M0874: Wast	ewater Systems			
Courses				
Title		Тур	Hrs/wk	СР
Biological Wastewater Treatment (I		Lecture	2	2
Biological Wastewater Treatment (Recitation Section (large		1
Advanced Wastewater Treatment (Advanced Wastewater Treatment (
) 1	1
Module Responsible				
Admission Requirements	None			
	Knowledge of wastewater management	and the key processes involved in wastewater t	reatment.	
Knowledge				
	After taking part successfully, students I	nave reached the following learning results		
Professional Competence				
Knowledge		f the full range of treatment systems in waste v	-	
	dependence for sustainable water prote-	ction. They can describe relevant economic, env	ironmental and socia	factors.
Skills	Students are able to pre-design and explain the available wastewater treatment processes and the scope of their application			
SKIIS	municipal and for some industrial treatment plants.		or their application	
	indificipal and for some madstral clean	iene pianes.		
Personal Competence				
Social Competence	Social skills are not targeted in this mod	ule.		
Autonomy		a subject and to organize their work flow inde	ependently. They can	also present on t
	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 Structur	al Engineering: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotech	nnical Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Coastal	Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Water a	nd Traffic: Compulsory		
	Bioprocess Engineering: Specialisation A	- General Bioprocess Engineering: Elective Con	pulsory	
	Environmental Engineering: Specialisation	on Water Quality and Water Engineering: Electiv	e Compulsory	
	International Management and Engineer	ing: Specialisation II. Process Engineering and B	iotechnology: Elective	e Compulsory
	International Management and Engineer	ing: Specialisation II. Energy and Environmental	Engineering: Elective	Compulsory
	Process Engineering: Specialisation Envi	ronmental Process Engineering: Elective Compu	lsory	
	Process Engineering: Specialisation Proc	ess Engineering: Elective Compulsory		
	Water and Environmental Engineering: S	Specialisation Water: Compulsory		
	Water and Environmental Engineering: S	Specialisation Environment: Elective Compulsory		
	Water and Environmental Engineering: S	Specialisation 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
i de la companya de l	

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

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

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

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

Courses	
Title	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 "Trar
	Planning and Traffic Engineering"
Educational Objectives	After taking part successfully, students have reached the following learning results
	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowleage	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	
-	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.
Washington	Jadapandant Study Time 124 Study Time in Lasture 56
	Independent Study Time 124, Study Time in Lecture 56
Credit points	
Course achievement	None
	Written elaboration
	written assignment, designwork during the semester
scale	
-	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory
	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory
	Civil Engineering: Specialisation Water and Traffic: Elective Compulsory
	Logistics, Infrastructure and Mobility: Specialisation Infrastructure and Mobility: Elective Compulsory
	Water and Environmental Engineering: Specialisation Environment: Elective Compulsory

solving them. They will also be able to comprehend the process of urban planning. The course also covers the various function 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 buildi masterplan and a street redesign. Literature Albers, Gerd; Wekel, Julian (2021) Stadtplanung: Eine illustrierte Einführung. 4. überarbeitete Auflage. Primus Verlag. Darmstadt.	ourse L1066: City Planning	
CP 6 Workload in Hours Independent Study Time 124, Study Time in Lecture 56 Lecturer Prof. Carsten Gertz Language DE Cycle SoSe Content "Principles of Urban Planning" deals with the determinants of urban development and their interactions. Topics include: • legal framework, • instruments and methods of planning, • functional requirements, • stakeholders and actors • basic design requirements • different planning levels and • historical contexts. The objective of the course is for students to acquire a basic understanding of urban development problems and approaches I solving them. They will also be able to comprehend the process of urban planning. The course also covers the various functior 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 build masterplan and a street redesign. Literature Albers, Gerd; Wekel, Julian (2021) Stadtplanung: Eine illustrierte Einführung. 4. überarbeitete Auflage. Primus Verlag. Darmstadt.	Тур	Project-/problem-based Learning
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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 f solving them. They will also be able to comprehend the process of urban planning. The course also covers the various functior 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 buildi masterplan and a street redesign. Literature Albers, Gerd; Wekel, Julian (2021) Stadtplanung: Eine illustrierte Einführung. 4. überarbeitete Auflage. Primus Verlag. Darmstadt.	СР	6
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		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. Wasmut		Frick, Dieter (2011) Theorie des Städtebaus: Zur baulich-räumlichen Organisation von Stadt. 3. veränderte Auflage. Wasmuth-
Verlag. Tübingen		Verlag. Tübingen
Jonas, Carsten (2009) Die Stadt und ihr Grundriss. Wasmuth-Verlag. Tübingen		jonas, Carsten (2009) Die Staat und ihr Grundriss. Wasmuth-verlag. Tubingen
Kostof, Spiro; Castillo, Greg (1998) Die Anatomie der Stadt. Geschichte städtischer Strukturen. Campus-Verlag. Frankfurt/Ne York.		Kostof, Spiro; Castillo, Greg (1998) Die Anatomie der Stadt. Geschichte städtischer Strukturen. Campus-Verlag. Frankfurt/New York.

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Courses				
Title	Тур	3	Hrs/wk	СР
Construction Logistics (L1163)		ture	1	2
Construction Logistics (L1164)		itation Section (small)	1	2
Project Development and Managen Project Development and Managen		ture ject-/problem-based Learning	1	1
		ect-problem-based Learning	T	1
Module Responsible Admission Requirements	None			
Recommended Previous	none			
Knowledge	none			
	After taking part successfully, students have reached the following le	arning results		
	Alter taking part successiony, students have reached the following le			
Professional Competence	Students can			
Knowledge				
	give definitions of the main terms of construction logistics and	project development and ma	anagement	
	 name advantages and disadvantages of internal or external co 	onstruction logistics		
	 explain characteristics of products, demand and production of 	construction objects and the	eir consequer	nces for construction
	specific supply chains			
	 differentiate constructions logistics from other logistics system 	15		
Skills	Students can			
	 carry out project life cycle assessments 			
	 apply methods and instruments of construction logistics 			
	 apply methods and instruments of project development and m 	lanagement		
	 apply methods and instruments of conflict management 			
	 design supply and waste removal concepts for a construction p 	project		
Personal Competence				
Social Competence	Students can			
	hold presentations in and for groups			
	 apply methods of conflict solving skills in group work and case 	studies		
Autonomy	Students can			
	 solve problems by holistic, systemic and flow oriented thinking 			
	 improve their creativity, negotiation skills, conflict and crises studies 	s solution skills by applying	methods of	moderation in ca
	studies			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
Examination duration and	Two written papers with presentations			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Engineering: Elective Com	ipulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering: Elective C	Compulsory		
	Civil Engineering: Specialisation Coastal Engineering: Elective Compu	lsory		
	Civil Engineering: Specialisation Water and Traffic: Elective Compulso	ory		
	International Management and Engineering: Specialisation II. Civil Eng	gineering: Elective Compulso	ory	
	International Management and Engineering: Specialisation II. Logistic	s: Elective Compulsory		
	Logistics, Infrastructure and Mobility: Specialisation Production and Lo	ogistics: Elective Compulsory	/	
	Logistics, Infrastructure and Mobility: Specialisation Infrastructure and	d Mobility: Elective Compulso	ory	

Course L1163: Construction	Logistics
Тур	Lecture
Hrs/wk	1
СР	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Heike Flämig
Language	DE
Cycle	SoSe
Content	 The lecture gives deeper insight how important logistics are as a competetive factor for construction projects and which issues are to be adressed. The following toppics are covered: competetive factor logistics the concept of systems, planning and coordination of logistics material, equipment and reverse logistics IT in construction logistics elements of the planning model of construction projects flow oriented logistics systems for construction projects logistics concepts for ready to use construction projects (especially procurement and waste removel logistics) best practice examples (construction logistics Potsdamer Platz, recent case study of the region)
Literature	Contents of the lecture are deepened in special exercises. Flämig, Heike: Produktionslogistik in Stadtregionen. In: Forschungsverbund Ökologische Mobilität (Hrsg.) Forschungsbericht Bd 15.2. Wuppertal 2000. Krauss, Siri: Die Baulogistik in der schlüsselfertigen Ausführung, Bauwerk Verlag GmbH Berlin 2005.
	Lipsmeier, Klaus: Abfallkennzahlen für Neubauleistungen im Hochbau : Verlag Forum für Abfallwirtschaft und Altlasten, 2004. Schmidt, Norbert: Wettbewerbsfaktor Baulogistik. Neue Wertschöpfungspotenziale in der Baustoffversorgung. In: Klaus, Peter: Edition Logistik. Band 6. Deutscher Verkehrs-Verlag. Hamburg 2003. Seemann, Y.F. (2007): Logistikkoordination als Organisationseinheit bei der Bauausführung Wissenschaftsverlag Mainz in Aachen, Aachen. (Mitteilungen aus dem Fachgebiet Baubetrieb und Bauwirtschaft (Hrsg. Kuhne, V.): Heft 20)

Course L1164: Construction Logistics	
Тур	Recitation Section (small)
Hrs/wk	1
СР	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Heike Flämig
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L1161: Project Develo	opment and Management
Тур	Lecture
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Heike Flämig, Dr. Anton Worobei
Language	DE
Cycle	SoSe
Content	Within the lecture, the main aspects of project development and management are tought:
	Terms and definitions of project management
	 Advantages and disadvantages of different ways of project handling
	 organization, information, coordination and documentation
	cost and fincance management in projects
	 time- and capacity management in projects
	 specific methods and instruments for successful team work
	Contents of the lecture are deepened in special exercises.
Literature	Projektmanagement-Fachmann. Band 1 und Band 2. RKW-Verlag, Eschborn, 2004.

Course L1162: Project Devel	rse L1162: Project Development and Management		
Тур	Project-/problem-based Learning		
Hrs/wk	1		
СР	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Prof. Heike Flämig, Dr. Anton Worobei		
Language	DE		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Courses				
Title		Тур	Hrs/wk	СР
Structural Dynamics (L1202)		Lecture	2	2
Structural Dynamics (L1203)		Recitation Section (large)	2	2
Fracture mechanics and fatigue in s		Lecture	1	1
Fracture mechanics and fatigue in s	teel structures (L0565)	Recitation Section (large)	1	1
Module Responsible	Prof. Bastian Oesterle			
Admission Requirements	None			
Recommended Previous	Knowledge of linear structural analysis of	statically determinate and indeterminate structu	ires; Mechanics	I/II, Mathematics
Knowledge	Differential equations I			
Educational Objectives	After taking part successfully, students have	reached the following learning results		
Professional Competence				
-	After successful completion of this module.	the student can explain the basic aspects of dy	namic effects o	n structures and
	respective methods.		,	
Skills	After successful completion of this modul	e, the students will be able to predict the resp	ponse of materi	al and structures
	dynamics loading using the appropriate com	putational approaches and methods.		
Personal Competence				
Social Competence	Students can			
	 participate in subject-specific and interview 	rdisciplinany discussions		
	defend their own work results in front	or others		
	 promote the scientific development of 	5		
		•		
	 Furthermore, they can give and accept 	•		
Autonomy	• Furthermore, they can give and accept	ot professional constructive criticism	pply it to new pro	oblems. Furthermo
Autonomy	• Furthermore, they can give and accept Students are able to gain knowledge of the	ot professional constructive criticism subject area from given and other sources and ap		oblems. Furthermo
Autonomy	• Furthermore, they can give and accept Students are able to gain knowledge of the	ot professional constructive criticism		oblems. Furthermo
	• Furthermore, they can give and accept Students are able to gain knowledge of the	ot professional constructive criticism subject area from given and other sources and ag ss for problems in the area of Structural Analysis.		oblems. Furthermo
Workload in Hours Credit points	• Furthermore, they can give and accept Students are able to gain knowledge of the they are able to structure the solution procet Independent Study Time 96, Study Time in L 6	ot professional constructive criticism subject area from given and other sources and ag ss for problems in the area of Structural Analysis.		oblems. Furthermo
Workload in Hours Credit points Course achievement	 Furthermore, they can give and accept Students are able to gain knowledge of the they are able to structure the solution procet Independent Study Time 96, Study Time in L 6 None 	ot professional constructive criticism subject area from given and other sources and ag ss for problems in the area of Structural Analysis.		oblems. Furthermo
Workload in Hours Credit points Course achievement Examination	Furthermore, they can give and accept Students are able to gain knowledge of the they are able to structure the solution process Independent Study Time 96, Study Time in L 6 None Written exam	ot professional constructive criticism subject area from given and other sources and ag ss for problems in the area of Structural Analysis.		oblems. Furthermo
Workload in Hours Credit points Course achievement	Furthermore, they can give and accept Students are able to gain knowledge of the they are able to structure the solution process Independent Study Time 96, Study Time in L 6 None Written exam	ot professional constructive criticism subject area from given and other sources and ag ss for problems in the area of Structural Analysis.		oblems. Furthermo
Workload in Hours Credit points Course achievement Examination	Furthermore, they can give and accept Students are able to gain knowledge of the they are able to structure the solution process Independent Study Time 96, Study Time in L 6 None Written exam	ot professional constructive criticism subject area from given and other sources and ag ss for problems in the area of Structural Analysis.		oblems. Furthermo
Workload in Hours Credit points Course achievement Examination Examination duration and scale	Furthermore, they can give and accept Students are able to gain knowledge of the they are able to structure the solution process Independent Study Time 96, Study Time in L 6 None Written exam	ot professional constructive criticism subject area from given and other sources and ag ss for problems in the area of Structural Analysis. ecture 84		oblems. Furthermo
Workload in Hours Credit points Course achievement Examination Examination duration and scale	Furthermore, they can give and accept Students are able to gain knowledge of the they are able to structure the solution proce- Independent Study Time 96, Study Time in L 6 None Written exam 150 min	nt professional constructive criticism subject area from given and other sources and ag ss for problems in the area of Structural Analysis. ecture 84		oblems. Furthermo
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	Furthermore, they can give and accept Students are able to gain knowledge of the they are able to structure the solution procet Independent Study Time 96, Study Time in L 6 None Written exam 150 min Civil Engineering: Specialisation Structural E	ngineering: Compulsory al Engineering: Elective Compulsory		oblems. Furtherm
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	Furthermore, they can give and accept Students are able to gain knowledge of the they are able to structure the solution procet Independent Study Time 96, Study Time in L 6 None Written exam 150 min Civil Engineering: Specialisation Structural E Civil Engineering: Specialisation Geotechnica	nt professional constructive criticism subject area from given and other sources and ag ss for problems in the area of Structural Analysis. ecture 84 ngineering: Compulsory al Engineering: Elective Compulsory ineering: Elective Compulsory		oblems. Furtherm
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	Furthermore, they can give and accept Students are able to gain knowledge of the they are able to structure the solution procet Independent Study Time 96, Study Time in L 6 None Written exam 150 min Civil Engineering: Specialisation Structural E Civil Engineering: Specialisation Geotechnica Civil Engineering: Specialisation Coastal Engineering: Sp	at professional constructive criticism subject area from given and other sources and ag ss for problems in the area of Structural Analysis. ecture 84 ngineering: Compulsory al Engineering: Elective Compulsory ineering: Elective Compulsory 'raffic: Elective Compulsory		bblems. Furtherm

Course L1202: Structural Dy	namics		
Тур	Lecture		
Hrs/wk			
СР			
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Prof. Bastian Oesterle		
Language	DE		
Cycle	SoSe		
Content	 mechanical background of dynamics harmonic vibrations, damped and undamped free and forced vibrations frequency and time domain modelling aspects principle of d'Alembert systems with multiple degrees of freedom consistent and lumped mass matrices finite elements for dynamics problems impact problems eigenvalue problems and modal analysis direct time integration schemes, transient analyses 		
Literature	 Vorlesungsmanuskript Clough, R.W., Penzien, J.: Dynamics of Structures. 2. Aufl., McGraw-Hill, New York, 1993. 		

Course L1203: Structural Dynamics	
Тур	Recitation Section (large)
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Bastian Oesterle
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Тур	Lecture
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dr. Jürgen Priebe
Language	DE
Cycle	SoSe
Content	 basics of fatigue stress and fatigue resistance and determination of fatigue strength,
	determination and use of S-N-curves and classification of notch effects,
	set up of determination of fatigue strength under dynamic load using the accumulation formula by Palmgren-Miner,
	set up of determination of fatigue strength in different examples,
	 basics of construction and design regarding the problem of material fatigue,
	basics of linear elastic fracture mechanics under static and dynamic load,
	determination of lifetime of steel construction based on linear elastic fracture mechanics in different examples.
Literature	Seeßelberg, C.; Kranbahnen - Bemessung und konstruktive Gestaltung; 3. Auflage; Bauwerk-Verlag; Berlin 2009
	• Kuhlmann, Dürr, Günther; Kranbahnen und Betriebsfestigkeit; in Stahlbau Kalender 2003; Verlag Ernst & Sohn; Berlin 2003
	Deutscher Stahlbau-Verband (Hrsg.); Stahlbau Handbuch Band 1 Teil B; 3. Auflage; Stahlbau-Verlagsgesellschaft; Köln 199
	Petersen, C.; Stahlbau; 3. überarb. und erw. Auflage; Vieweg-Verlag; Braunschweig 1993
	 DIN V ENV 1993-1-1: Eurocode 3; Bemessung und Konstruktion von Stahlbauwerken; Teil 1-1: Allgemeine Bemessungsree Bemessungsregeln f ür den Hochbau; 1993
	• DIN V ENV 1993-6: Eurocode 3; Bemessung und Konstruktion von Stahlbauwerken; Teil 6: Kranbahnen; 2001
	DIN-Fachbericht 126. Richtlinie zur Anwendung von DIN V ENV 1993-6; Nationales Anwendungsdokument (NAD); Berlin 20
	1

Course L0565: Fracture mechanics and fatigue in steel structures		
Тур	Recitation Section (large)	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Dr. Jürgen Priebe	
Language	DE	
Cycle	SoSe	
Content	ent See interlocking course	
Literature	See interlocking course	

Courses				
Гitle		Тур	Hrs/wk	СР
Steel Construction Project (L1206)		Project Seminar	4	6
Module Responsible	Prof. Marcus Rutner			
Admission Requirements	None			
Recommended Previous	Steel and Composite Structures			
Knowledge				
Educational Objectives	After taking part successfully, students	have reached the following learning results		
Professional Competence				
Knowledge	Students are able to prepare a part of the	ne whole project and explain it to the others.		
Skills	Students can produce sketches and calculations of their part of the project. They are able to adjust their work in reaction			
	changing conditions resulting from othe	r participants of the project.		
Personal Competence				
Social Competence	Students can present their results to oth	ner members of the group.		
	They have the ability to work for a broad	d agreement with respect to intergroup depen	dencies.	
	They can distribute and process tasks in	dependently.		
Autonomy	Students can handle their part of the pro	oject on their own resposibility-		
Workload in Hours	Independent Study Time 124, Study Tim	ne in Lecture 56		
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
Examination duration and	approx. 15-20 pages (without appendix)			
scale				
Assignment for the	Civil Engineering: Specialisation Geotec	hnical Engineering: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Coastal	Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Structu	ral Engineering: Compulsory		
	Civil Engineering: Specialisation Comput	tational Engineering: Elective Compulsory		

Course L1206: Steel Construction Project			
Тур	ect Seminar		
Hrs/wk	4		
СР	6		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56		
Lecturer	of. Marcus Rutner		
Language	DE		
Cycle	SoSe		
Content	Design of a big construction project (i.e skyscraper, large bridge, roof of a stadiuim) in small groups		
Literature	Wird je nach Projekt individuell angegeben.		

Courses				
Title		Тур	Hrs/wk	СР
Marine Geotechnics (L0548)		Lecture	1	2
Marine Geotechnics (L0549)	Undreulie Engine grieg (11146)	Recitation Section (large)	2	2
Steel Structures in Foundation and		Lecture	Z	Z
Module Responsible Admission Requirements				
	Complete modules: Geotechnics I-III, Math	omatics LIII		
Kecommended Previous Knowledge	complete modules: Geotechnics I-III, Math			
Kilowiedge	Courses: Soil laboratory course			
Educational Objectives	After taking part successfully, students ha	ve reached the following learning results		
Professional Competence				
Knowledge	The students get a deeper knowledge of s	steel and ground engineering as well as construction	ons knowledge co	oncerning quay wa
	Furthermore, the students get all the necessary knowledge to design singular construction elements for sheet pile w know how to choose the right construction elements depending on the influencing conditions.			et pile walls and th
	Furthermore, the students are able to div			
Skills Furthermore, the students are able to dimension sheet pile wall construction regarding all construction eler suitable construction elements with respect to the influencing conditions, to design all kinds of sheet pile w walls and combined sheet pile walls) and to dimension all construction elements and connections.		, , , , , , , , , , , , , , , , , , , ,		
		alls (wave sheet		
	waits and combined sheet pile waits) and t		10115.	
Personal Competence				
Social Competence				
Autonomy	Students are able to assess their own stre	ngths and weaknesses and organize their time and	learning manage	ement based on th
Workload in Hours	Independent Study Time 110, Study Time	in Lecture 70		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	Civil Engineering: Specialisation Geotechn	ical Engineering: Compulsory		
Following Curricula	Civil Engineering: Specialisation Structural	Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Coastal E	ngineering: Compulsory		
	Civil Engineering: Specialisation Computat	ional Engineering: Elective Compulsory		
		5 5 7 7		

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

Module Manual M.Sc. "Civil Engineering"

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

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

Courses				
		T	llue (sele	60
Title Smart Monitoring (L2762)		Typ Integrated Lecture	Hrs/wk 2	CP 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 modelir	g, programming, and sensor technological	ogies are helpful	. Interest in mod
Knowledge	research and teaching areas, such as Internet of Thing	is, Industry 4.0 and cyber-physical sy	stems, as well as	s the will to deep
	skills of scientific working, are required. Basic knowledg	e in scientific writing and good English	skills.	
Educational Objectives	After taking part successfully, students have reached th	e following learning results		
Professional Competence	Arter taking part successiony, students have reached th			
•	The students will become familiar with the principles	and practices of smart monitoring	The students wil	I be able to des
Knowneuge	decentralized smart systems to be applied for conti			
	environment. In addition, the students will learn to desi			
	analysis techniques, modern software design concepts,			
	also part of this module, which will be conducted throu	ighout the semester and will contribu	te to the grade.	In small groups,
	students will design smart monitoring systems that inte	grate a number of "intelligent" sensor	s to be implemen	ted by the stude
	Specific focus will be put on the application of machine learning techniques. The smart monitoring systems will be mounted o			
	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. T	he written papers and oral examination	ons form the final	grades. The mo
	will be taught in English. Limited enrollment.			
Skills	The students will gain insights into operating state-of-t	ne-art smart sensor systems, used for	monitoring a wi	de range of phys
	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 w			
	be able to document the findings of their projects in sho	rt reports.		
Personal Competence				
	The students will be able to work in groups, share part	s of the work for their projects, and de	evelop communic	ation skills. towa
,,	achieving the common project goals.			·····
Autonomy	The students will be able to gain a solid basis on appr	• • • •	ineering, as well	as on documen
	results, through their involvement in their monitoring gr	oup 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: Elect	ive Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineeri			
	Civil Engineering: Specialisation Coastal Engineering: El	1 ,		
	Civil Engineering: Specialisation Structural Engineering:			
	Computer Science: Specialisation II: Intelligence Engine			
	Environmental Engineering: Specialisation Energy and F Environmental Engineering: Specialisation Environment			
	Environmental Engineering: Specialisation Environment Environmental Engineering: Specialisation Water Quality		nulsory	
	Mechatronics: Technical Complementary Course: Electiv		ipaisory	
	Mechatronics: Core Qualification: Elective Compulsory	e company		
	Theoretical Mechanical Engineering: Specialisation Robo	otics and Computer Science: Elective C	Compulsory	
	Water and Environmental Engineering: Specialisation Ci			
	Water and Environmental Engineering: Specialisation Er	vironment: Elective Compulsory		

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

Course L2763: Smart Monito	ring
	Recitation Section (small)
Hrs/wk	
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. 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.

Medule M1045, Thin				
Module M1845: Thin-	walled structures			
Courses				
Title		Тур	Hrs/wk	СР
Thin-walled structures (L1199)		Lecture	2	3
Thin-walled structures (L3045)		Recitation Section (large)	2	3
Module Responsible	Prof. Bastian Oesterle			
Admission Requirements	None			
Recommended Previous Knowledge	 Structural Analysis I Structural Analysis II Finite Element Methods 			
Educational Objectives	After taking part successfully, students have	e reached the following learning results		
Professional Competence				
Knowledge	After successful completion of this module, the students can express the basic aspects of the load-carrying behaviour of thir walled structures.			
Skills	After successful completion of this module, the students will be able to predict load-carrying behaviour of thin-walled structure using appropriate analytical and coputational methods.			
Personal Competence				
Social Competence	Students can			
	 participate in subject-specific and int 	erdisciplinary discussions,		
	defend their own work results in from	t of others		
	promote the scientific development of	of colleagues		
	Furthermore, they can give and acce	pt professional constructive criticism		
Autonomy		subject area from given and other sources and a ess for problems in the area of modelling and anal		
Workload in Hours	Independent Study Time 124, Study Time in	n Lecture 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	Civil Engineering: Specialisation Coastal Eng	gineering: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnic	al Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Computation	onal Engineering: Compulsory		
	Civil Engineering: Specialisation Structural E	Engineering: Elective Compulsory		
	Theoretical Mechanical Engineering: Specia	lisation Simulation Technology: Elective Compulso	ory	

Тур	Lecture
Hrs/wk	
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
	Prof. Bastian Oesterle
Language	DE
Cycle	SoSe
Content	Plates loaded in-plane
	Governing equations (equilibrium, kinematics, constitutive law)
	Differential equation
	Airy stress function
	Plane stress / plane strain
	Structural behaviour of plates loaded in-plane Structural behaviour of plates loaded in-plane
	• finite elements for plates loaded in-plane, modelling apsects, interpretation and critical assessment of results
	Plates in bending
	 Governing equations (equilibrium, kinematics, constitutive law)
	Differential equation
	Navier solution / Fourier series expansion
	Approximation procedures
	Circular and rectangular plates
	Structural behaviour of plates in bending
	 finite elements for plates in bending, modelling apsects, interpretation and critical assessment of results
	Shells
	Shens
	Phenomenona of the structural behaviour of shells
	Membrane and bending theory
	Equilibrium equations of shells of revolution
	Stress resultants and deformations of the spherical shell, the half spherical shell, and the cylindrical shell
	finite elements for shells
	Stability problems (overview)
	Plate buckling
	Shell buckling
	• Shen bucking
Literature	
	Vorlesungsmanuskript
	Basar, Y.: Krätzig, W.B. (1985): Mechanik der Flächentragwerke. Vieweg-Verlag, Braunschweig, Wiesbaden
	• Girkmann, K. (1963): Flächentragwerke, Springer Verlag, Wien, 1963, unveränderter Nachdruck 1986
	• Zienkiewicz, O.C. (1977): The Finite Element Method in Enginieering Science. McGraw-Hill, London

Course L3045: Thin-walled st	ourse L3045: Thin-walled structures	
Тур	Recitation Section (large)	
Hrs/wk	2	
CP	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Bastian Oesterle	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Filoadie Filosof Coas	tal Hydraulic Engineering I			
Courses				
Title		Тур	Hrs/wk	СР
Basics of Coastal Engineering (L08		Lecture	3	4
Basics of Coastal Engineering (L14		Project-/problem-based Learn	ng 1	2
Module Responsible				
Admission Requirements				
	Basics of hydraulic engineering, hydrolog	gy and hydromechanics		
Knowledge				
Educational Objectives	After taking part successfully, students h	nave reached the following learning results		
Professional Competence				
Knowledge	e The students are able to define and explain the basic concepts of coastal engineering and port engineering. They are able to appl			
		ems of coastal engineering. Students can define and	d determine the b	pasics for design a
	dimensioning of coastal engineering con	structions.		
Skills	The students are capable to apply basic design approaches to selected and pre-defined design tasks in coastal engineering.			
Personal Competence				
•	The students are able to deploy their ga	ained knowledge in applied problems such as the d	esign of coastal g	protection structure
,	Additionaly, they will be able to work in t	team with engineers of other disciplines, for instance	designing of coa	stal breakwaters.
Autonomy	The students will be able to independent	tly extend their knowledge and applyit to new proble	ms.	
Workload in Hours	Independent Study Time 124, Study Tim	ne in Lecture 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	The duration of the examination is 2 h	nours. The examination includes tasks with respect	to the general u	understanding of t
scale	lecture contents and calculations tasks.			
Assignment for the	Civil Engineering: Specialisation Coastal	Engineering: Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotech	nnical Engineering: Compulsory		
	Civil Engineering: Specialisation Structur	ral Engineering: Elective Compulsory		
	Environmental Engineering: Specialisation	on Environment and Climate: Elective Compulsory		
	Environmental Engineering: Specialisation	on Water Quality and Water Engineering: Elective Con	mpulsory	
	International Management and Engineer	ing: Specialisation II. Civil Engineering: Elective Com	pulsory	
	Water and Environmental Engineering: S	Specialisation Environment: Elective Compulsory		
	Water and Environmental Engineering: S	Specialisation Water: Elective Compulsory		

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

Course L1413: Basics of Coas	rse 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	

Courses				
Title		Тур	Hrs/wk	СР
Offshore Geotechnical Engineering	(L0067)	Lecture	1	1
Hydro Power Use (L0013)		Lecture	1	1
Wind Turbine Plants (L0011)		Lecture	2	3
Wind Energy Use - Focus Offshore	(L0012)	Lecture	1	1
Module Responsible	Dr. Marvin Scherzinger			
Admission Requirements	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 reach	ed 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 to offshore conditions and can critical comment these aspects in consideration of current developments. Furthermore, they are to describe fundamentally the use of water power to generate electricity. The students reproduce and explain the basic proce in the implementation of renewable energy projects in countries outside Europe. Through active discussions of various topics within the seminar of the module, students improve their understanding an application of the theoretical background and are thus able to transfer what they have learned in practice.			the basic proced
				derstanding and
Skills	s Students are able to apply the acquired theoretical foundations on exemplary water or wind power systems and evaluate a assess technically the resulting relationships in the context of dimensioning and operation of these energy systems. They car compare critically the special procedure for the implementation of renewable energy projects in countries outside Europe with 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-specifi	icly and multidisciplinary within a se	eminar.	
Autonomy	Students can independently exploit sources in the context of the emphasis of the lecture material to clear the contents of lecture and to acquire the particular knowledge about the subject area.			
Workload in Hours	Independent Study Time 110, Study Time in Lectur	re 70		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	180 min			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Enginee	ering: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engi	neering: Elective Compulsory		
	Civil Engineering: Specialisation Coastal Engineerin	ng: Elective Compulsory		
	International Management and Engineering: Specialisation II. Energy and Environmental Engineering: Elective Compulsory			
	International Management and Engineering: Specialisation II. Renewable Energy: Elective Compulsory			
	Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory			
	Product Development, Materials and Production: Sp	pecialisation Product Development:	LICCUVC Compulsory	
	Product Development, Materials and Production: Sp Product Development, Materials and Production: Sp			
		pecialisation Production: Elective Co	ompulsory	
	Product Development, Materials and Production: Sp	pecialisation Production: Elective Co pecialisation Materials: Elective Cor	ompulsory	
	Product Development, Materials and Production: Sp Product Development, Materials and Production: Sp Renewable Energies: Core Qualification: Compulso	pecialisation Production: Elective Co pecialisation Materials: Elective Con ry	ompulsory npulsory	
	Product Development, Materials and Production: Sp Product Development, Materials and Production: Sp	pecialisation Production: Elective Co pecialisation Materials: Elective Con ry Energy Systems: Elective Compuls	ompulsory npulsory ory	
	Product Development, Materials and Production: Sp Product Development, Materials and Production: Sp Renewable Energies: Core Qualification: Compulso Theoretical Mechanical Engineering: Specialisation Process Engineering: Specialisation Environmental	pecialisation Production: Elective Co pecialisation Materials: Elective Con ry Energy Systems: Elective Compuls Process Engineering: Elective Com	ompulsory npulsory ory	
	Product Development, Materials and Production: Sp Product Development, Materials and Production: Sp Renewable Energies: Core Qualification: Compulso Theoretical Mechanical Engineering: Specialisation	pecialisation Production: Elective Co pecialisation Materials: Elective Con ry Energy Systems: Elective Compuls Process Engineering: Elective Com on Cities: Elective Compulsory	ompulsory npulsory ory pulsory	

Course L0067: Offshore Geot	echnical Engineering		
Тур	ecture		
Hrs/wk			
СР			
Workload in Hours	ndependent 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	cture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Dr. Rudolf Zellermann	
Language	DE	
Cycle	SoSe	
Content	 Historical development Wind: origins, geographic and temporal distribution, locations Power coefficient, rotor thrust Aerodynamics of the rotor Operating performance Power limitation, partial load, pitch and stall control Plant selection, yield prediction, economy Excursion 	
Literature	Gasch, R., Windkraftanlagen, 4. Auflage, Teubner-Verlag, 2005	

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

Module M0581: Wate	FIOLECTION			
Courses				
Title		Тур	Hrs/wk	СР
Water Protection and Wastewater M	lanagement (L0226)	Lecture	3	3
Water Protection and Wastewater N	lanagement (L2008)	Project Seminar	3	3
Module Responsible	Prof. Ralf Otterpohl			
Admission Requirements	None			
Recommended Previous	Basic knowledge in water manageme	nt:		
Knowledge	 Good knowledge in urban drainage; 	nt,		
	 Good knowledge of wastewater treatr 	ment techniques:		
	 Good knowledge of pollutants (e.g. CO 			
Educational Objectives	After taking part successfully, students have	e reached the following learning results		
Professional Competence				
Knowledge	The students can describe the basic principl	es of the regulatory framework related to the	e international and Eu	ropean water sect
		substance cycles and water morphology in	-	
		as ecosystem service and wastewater trea	itment with a special	l focus on innovati
	solutions, remediation measures as well as o	conceptual approaches.		
Skills	Students can accurately assess current prol	blems and situations in a country-specific or	local context. They o	can suggest concre
		omorrow's urban water cycle. Furthermore,		
	administrative and legislative solutions to so	blve these problems.		
Personal Competence				
Social Competence	The students can work together in international groups.			
Autonomy	Students are able to organize their work flo	ow to prepare presentations and discussions.	They can acquire ap	propriate knowled
	by making enquiries independently.			
Workload in Hours	Independent Study Time 96, Study Time in L	Lecture 84		
Credit points	6			
Course achievement	None			
Examination	Presentation			
Examination duration and	Term paper plus presentation			
scale				
A sei un un trat faur tha				
•	Civil Engineering: Specialisation Structural E	• • • •		
Following Curricula	Civil Engineering: Specialisation Geotechnica Civil Engineering: Specialisation Coastal Eng	5 5 1 5		
	Civil Engineering: Specialisation Coastal Eng Civil Engineering: Specialisation Water and T			
	• • •	Vater Quality and Water Engineering: Elective	Compulsory	
	• • •	Specialisation II. Civil Engineering: Elective		
	Water and Environmental Engineering: Spec		sompulsory	
	Water and Environmental Engineering: Spec			
		License company		

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

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

Courses				
Title		Тур	Hrs/wk	СР
Examination of Materials, Structura	-	Lecture	3	4
Examination of Materials, Structura	I Condition and Damages (L0261)	Recitation Section (small)	1	2
Module Responsible	Prof. Frank Schmidt-Döhl			
Admission Requirements	None			
Recommended Previous	Basic knowledge about building materials or	material science, for example by the mod	dule Building Ma	terials and Buildi
Knowledge	Chemistry.			
Educational Objectives	After taking part successfully, students have read	hed the following learning results		
Professional Competence				
Knowledge	The students are able to describe the rules for t methods for the testing of building material prop testing methods.	• • •		
Skills	The students are able to responsibly discover the rules for trading and using of building products in Germany. They are able to chose suitable methods for the testing and inspection of construction products, the examination of damages and the examination of the structural conditions of buildings. They are able to conclude from symptons to the cause of damages. The are able to describe an examination in form of a test report or expert opinion.			
Personal Competence				
Social Competence	The students can describe the different roles of framework of material testing. They can describe		-	on bodies within t
Autonomy	The students are able to make the timing and the	e operation steps to learn the specialist know	ledge of a very e	xtensive field.
Workload in Hours	Independent Study Time 124, Study Time in Lect	ure 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	120 min			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Engine	eering: Elective Compulsory		
Following Curricula				
-	Civil Engineering: Specialisation Coastal Engineer			
	Civil Engineering: Specialisation Water and Traffi			
	International Management and Engineering: Spec	ialisation II. Civil Engineering: Elective Comp	oulsory	
	Materials Science and Engineering: Specialisation	Engineering Materials: Elective Compulsory		
	Materials Science: Specialisation Engineering Mat	erials: Elective Compulsory		

Course L0260: Examination of	Course L0260: Examination of Materials, Structural Condition and Damages				
Тур	Lecture				
Hrs/wk	3				
СР	4				
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42				
Lecturer	Prof. Frank Schmidt-Döhl				
Language	DE				
Cycle	WiSe				
Content	Materials testing and marking process of construction products, testing methods for building materials and structures, testing				
	reports and expert opinions, describing the condition of a structure, from symptons to the cause of damages				
Literature	Frank Schmidt-Döhl: Materialprüfung im Bauwesen. Fraunhofer irb-Verlag, Stuttgart, 2013.				

Course L0261: Examination of	Course L0261: Examination of Materials, Structural Condition and Damages		
Тур	Recitation Section (small)		
Hrs/wk	1		
СР	2		
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14		
Lecturer	Prof. Frank Schmidt-Döhl		
Language	DE		
Cycle	WiSe		
Content	See interlocking course		
Literature	See interlocking course		

Madula M0712. Cana		_				
Module M0713: Conci	rete Structure	5				
Courses						
Title				Тур	Hrs/wk	СР
Concrete Structures (L0579)				Seminar	1	1
Structural Concrete Members (L05	77)			Lecture	2	3
Structural Concrete Members (L05	78)			Recitation Section (large)	2	2
Module Responsible	NN					
Admission Requirements	None					
Recommended Previous	Basics of structural	analysis, conception ar	nd dimensioning of stru	ictural concrete		
Knowledge						
	Modules: Reinforced	d Concrete Structures I-	+II, Structural Analysis	I+II, Mechanics I+II		
Educational Objectives	After taking part sur	ccessfully, students ha،	ve reached the followir	g learning results		
Professional Competence				5 5		
Knowledae	The students broad	en their skills in structu	ural engineering, espec	ially in the field of buildings	(houses, roofs, h	alls). They dispose
				is and structural members t		
	5					
Skills	The students are at	ole to apply procedures	s of the conception and	d dimensioning to to praction	cal problems of st	ructural engineerin
	They are capable to draft concrete buildings and to design them for general action effects and to plan their detail				their detailing an	
	execution. Moreove	r, they can make desig	n and construction ske	tches and draw up technica	l descriptions.	
Personal Competence						
	The students are ab	ole to obtain results of h	nigh quality in teamwo	rk.		
,			5 1			
Autonomy	The students are ab	le to carry out complex	conception and dime	nsioning tasks of structures	under the guidance	ce of tutors.
Workload in Hours	Independent Study	Time 110, Study Time i	in Lecture 70			
Credit points						
Course achievement	Compulsory Bonus	Form	Description			
	No None	Presentation	Es werden 2 F	Referate ausgegeben		
Examination	Written exam					
Examination duration and	120 minutes					
scale						
Assignment for the	Civil Engineering: S	pecialisation Structural	Engineering: Compuls	ory		
Following Curricula	Civil Engineering: S	pecialisation Geotechni	ical Engineering: Electi	ve Compulsory		
	Civil Engineering: S	pecialisation Coastal Er	ngineering: Elective Co	mpulsory		
	Civil Engineering: S	pecialisation Water and	Traffic: Elective Comp	oulsory		
	Civil Engineering: S	pecialisation Computati	ional Engineering: Elec	tive Compulsory		
	International Manag	jement and Engineering	g: Specialisation II. Civi	I Engineering: Elective Com	pulsory	

Course L0579: Concrete Stru	Course L0579: Concrete Structures			
Тур	Seminar			
Hrs/wk	1			
СР	1			
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14			
Lecturer	NN			
Language	DE			
Cycle	WiSe			
Content	With help of a project teamwork the subjects of the course "Concrete Structures" is practiced, discussed and presented.			
Literature	- Projektbezogene Unterlagen werden abgegeben.			

Course L0578: Structural Concrete Members		
Тур	Recitation Section (large)	
Hrs/wk	2	
CP	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	NN	
Language	DE	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Courses				
Title		Тур	Hrs/wk	СР
Chemistry of Drinking Water Treatment (L0311)		Lecture	2	1
Chemistry of Drinking Water Treatr		Recitation Section (large)	1	2
Water Resource Management (L04)2)	Lecture	2	2
Water Resource Management (L04	03)	Recitation Section (small)	1	1
Module Responsible	Prof. Mathias Ernst			
Admission Requirements	None			
Recommended Previous	Knowledge of water management and th	e key processes involved in water treatment.		
Knowledge				
Educational Objectives	After taking part successfully, students h	ave reached the following learning results		
Professional Competence				
Knowledge	Students will be able to outline key area	as of conflict in water management, as well as th	eir mutual depen	dence for sustaina
	water supply. They will understand rele	vant economic, environmental and social factors	Students will be	able to explain a
		vater companies. They will be able to explain the a		•
	the scope of their application.	ater companies. They will be able to explain the a		finenc processes
Skills	Students will be able to assess com	plex problems in drinking water production an	d establish solut	ions involving w
		hey will be able to assess the evaluation methods		
	5	ons for selected treatment processes and apply g		
		sing for selected treatment processes and apply (generally accepted	
	standards to these processes.			
Personal Competence				
Social Competence	Working in a diverse group of specialists	s, students will be able to develop and document	complex solutions	for the managen
<i>p</i>	• • • •	will be able to take an appropriate professional p		•
		nt solutions in teams of diverse experts and preser		
	interests. They will be able to develop joi	The solutions in teams of diverse experts and preser	it these solutions i	to others.
Autonomy	Students will be in a position to work on a	a subject independently and present on this subjec	t.	
Workload in Hours	Independent Study Time 96, Study Time	in Locture 94		
Credit points		III Lecture 64		
Course achievement	None			
Examination	Written exam			
	60 min (chemistry) + presentation			
scale	oo min (chemistry) + presentation			
Assignment for the	Civil Engineering: Specialisation Structure	al Engineering: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotech			
i onowing curricula	Civil Engineering: Specialisation Geotech			
	Civil Engineering: Specialisation Water al			
			201	
		echnical Complementary Course: Elective Compulso	•	Commute
		ng: Specialisation II. Energy and Environmental Eng		compulsory
		conmental Process Engineering: Elective Compulsor	У	
	Process Engineering: Specialisation Proce			
	Water and Environmental Engineering: S	pecialisation Water: Compulsory		
	Water and Environmental Engineering: S	pecialisation Environment: Elective Compulsory		

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

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

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

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

	grated Transportation Planning	
Courses		
Title	Typ Hrs/wk	СР
Integrated Transportation Planning	g (L1068) Project-/problem-based Learning 4	6
Module Responsible	e Prof. Carsten Gertz	
Admission Requirements	s None	
Recommended Previous		Traffic Engineerin
Knowledge		
Educational Objectives		
Professional Competence		
Knowledge	e 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 mean	sures.
	 relate current issues in the area of integrated transport planning and formulate an opinion on them. 	
Skills	s Students are able to:	
	 quantify important parameters, which influence travel demand or are influenced by it. 	
	comprehensively examine a pre-defined or self-selected topic from a transportation studies perspect	ive and document
	results in accordance with scientific conventions.	
Personal Competence	e	
Social Competence	e 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	y Students are able to:	
	assess potential consequences of their future professional activities	
	• independently plan working on a pre-defined project topic, acquire the necessary knowledge and use	appropriate means
	its execution.	
	Independent Study Time 124, Study Time in Lecture 56	
Credit points	s 6	
Course achievement	t None	
Examination	n Written elaboration	
Examination duration and	d written assignment with presentation during the semester	
scale	e	
Assignment for the	e Civil Engineering: Specialisation Structural Engineering: Elective Compulsory	
Following Curricula		
	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 Tr	ansportation Planning
Тур	Project-/problem-based Learning
Hrs/wk	4
СР	6
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Lecturer	Prof. Carsten Gertz, Dr. Philine Gaffron, Jacqueline Bianca Maaß
Language	DE
Cycle	WiSe
	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)

Module M0963: Steel	and Composite Structures			
Courses				
litle		Тур	Hrs/wk	СР
Steel and Composite Structures (L1	204)	Lecture	2	2
Steel and Composite Structures (L1		Recitation Section (large)	2	2
Steel Bridges (L1097)		Lecture	2	2
Module Responsible	Prof. Marcus Rutner			
Admission Requirements	None			
Recommended Previous	Basics of steel construction (i.e. Steel Structures I an	nd II, BUBC)		
Knowledge				
Educational Objectives	After taking part successfully, students have reached	d the following learning results		
Professional Competence				
Knowledge	After successful completition, students can			
	 describe the phenomenon of local buckling 			
	explain warping torsion			
	 illustrate the behaviour of composite structure 	es		
	 specify the principles in design of composite s 			
	 sketch the contructions of steel and composit. 			
	• sketen the contractions of steel and composit	e bhuges		
Skills	After successful participation students are able to			
	 check stiffened and unstiffened plated structure 	ires		
	 recognize and verify warping tosion in strucur 	es		
	 design composite structures 			
	 design bridges and o perform the detailing 			
Personal Competence				
Social Competence				
Autonomy				
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	180 min			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Engineeri	ng: Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engine	eering: Elective Compulsory		
-	Civil Engineering: Specialisation Coastal Engineering			
	Civil Engineering: Specialisation Water and Traffic: E			
	Civil Engineering: Specialisation Computational Engin			
	International Management and Engineering: Speciali		ulcon	
	international Management and Engineering: Special	sation in civil Engineering. Elective Comp	uisui y	

Course L1204: Steel and Con	nposite Structures
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Marcus Rutner
Language	DE
Cycle	WiSe
Content	 Local-buckling of plated structures Warping torsion Composite-girders, -columns, -slabs, -bridges Principles in composite constructions Bridge-design and -construction
Literature	Petersen, C.: Stahlbau, 4.Auflage 2013, Springer-Vieweg Verlag Minnert, J. Wagenknecht, G.: Verbundbau-Praxis - Berechnung und Konstruktion nach Eurocode 4, 2.Auflage 2013, Bauwerk Beuth Verlag

Course L1205: Steel and Con	ourse L1205: Steel and Composite Structures	
Тур	Recitation Section (large)	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Marcus Rutner	
Language	DE	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L1097: Steel Bridges	
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Yves Freundt
Language	
Cycle	
Content	Lecture Contents ,Steel Bridge Construction' DrIng. Jörg Ahlgrimm
	bi-ng. Jorg Angrinin
	- From tendering and contracting to completion - the development of a steel bridge
	- Contents of a bridge static - structural details, examples of analysis in detail:
	-> effective width in regard to the longitudinal stiffeners
	-> Bearing point, bearing stiffener
	-> Crossbeam breakthrough, crossbeam reinforcement
	-> Analysis of the Rib-to-Floorbeam (RF) connection (web-tooth of the floorbeam between trapezoidal shaped Ribs)
	- Steel grades, -designation, testing methods and approval certificates
	- Nondestructive weld inspecting
	- Corrosion protection
	- Bridge bearing - types, format, function, dimensioning, installation
	- Expansion Joints
	- Oscillation of bridge hangers and cables - oscillation damper
	- Opening bridges- Detailed reviews to different assembling procedures and - implements
	- Selective damage events
	Requirements: Basic knowledge in the calculation, dimensioning, and construction of structural elements and joints of constructional steelwork
Literature	
	Herbert Schmidt, Ulrich Schulte, Rainer Zwätz, Lothar Bär: Ausführung von Stahlbauten
	Petersen, Christian: Stahlbau, Abschnitt Brückenbau
	 Ahlgrimm, J., Lohrer, I.: Erneuerung der Eisenbahnüberführung in Fulda-Horas über die Fulda, Stahlbau 74 (2005), Heft 2, S. 114

Courses	
Title	Typ Hrs/wk CP
Module Responsible	Dozenten des SD B
Admission Requirements	None
Recommended Previous	Subjects of the Foundation Engineering specialisation.
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 geotechnical and foundation engineering. They ca exemplify the state of technology and application and discuss critically in the context of actual problems and general conditions science and society.
	The students can develop solving strategies and approaches for fundamental and practical problems in geotechnical ar foundation engineering. They may apply theory based procedures and integrate safety-related, ecological, ethical, and econom view points of science and society.
Skills	Scientific work techniques that are used can be described and critically reviewed. The students are able to independently select methods for the project work and to justify this choice. They can explain how the methods relate to the field of work and how the context of application has to be adjusted. General findings and furth 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 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 feedback from experts with regard to the progress of the work, and to accomplish results on the state of the art in science and technology.
Workload in Hours	Independent Study Time 180, Study Time in Lecture 0
Credit points	6
Course achievement	None
Examination	Study work
Examination duration and scale	see FSPO
Assignment for the	Civil Engineering: Specialisation Geotechnical Engineering: Compulsory
Following Curricula	

Module M0969: Selected Topics in Civil Engineering

Courses				
Title		Тур	Hrs/wk	СР
Design of Composite Bridges (L3092)		Integrated Lecture	2	3
Analysis of Offshore Structures (L1867)		Lecture	1	1
Energy Geotechnics (L3227)		Lecture	3	3
Solid Matter Process Technology for	r Biomass (L0052)	Lecture	2	3
Forum I - Geotechnics and Constru	ction Management (L1634)	Seminar	1	1
Forum II - Geotechnics and Constru	uction Management (L1635)	Seminar	1	1
Timber Structures (L1151)		Seminar	2	2
Innovative Timber Construction (L2	2666)	Lecture	2	4
Glass Structures (L1152)		Lecture	2	2
Glass Structures (L1447)		Recitation Section (large)	1	1
Sustainable landfill design and ope	ration (L3270)	Integrated Lecture	3	3
Special Topics in Steel Design (L30	91)	Integrated Lecture	2	3
Special topics of civil engineering	LCP (L2378)		1	1
Special topics of civil engineering 2	2 LP (L2379)		2	2
Special topics of civil engineering 3	3 LP (L2380)		3	3
Structural Design (L2789)		Seminar	2	2
Module Responsible	Prof. Frank Schmidt-Döhl			
Admission Requirements	None			
Recommended Previous	none			
Knowledge				
Educational Objectives	After taking part successfully, students have reached	d the following learning results		
Professional Competence				
Knowledge				
_	 Students are able to find their way through se 	lected special areas within civil and struc	tural engineering	l.
	 Students are able to explain basic models and 	d procedures in selected special areas of	civil and structura	al engineering.
	Students are able to interrelate scientific and	technical knowledge.		
Skills	• Students are able to apply basic methods in selected areas of civil and structural engineering.			
Personal Competence				
Social Competence				
Autonomy				
Autonomy	 Students can chose independently, in which to courses. 	fields they want to deepen their knowled	dge and skills thr	rough the election o
Workload in Hours	Depends on choice of courses			
Credit points	6			
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: E			
	Civil Engineering: Specialisation Computational Engin			
	com Engineering. Specialisation Computational Eligit	neering. Liecuve compuisory		

Course L3092: Design of Composite Bridges	
Тур	Integrated Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and	90 min
scale	
Lecturer	Prof. Marcus Rutner
Language	DE
Cycle	SoSe
Content	
Literature	

Module Manual M.Sc. "Civil Engineering"

Course L1867: Analysis of Of	
Тур	Lecture
Hrs/wk CP	1
Examination Form	
Examination duration and	
scale	
Lecturer	Dr. Said Fawad Mohammadi
Language	DE/EN
Cycle	SoSe
Content	Topic 1: Types of Offshore Structures, Fixed and floating structures for Oil & Gas and Offshore Wind industry
	Topic 2: Wave Forces, Morisons equation
	Topic 3: Irregular Seastates, Power spectrum and application of FFT
	Topic 4: Additional Environmental Forces, wind spectra, current forces
	Topic 5: Linear-Time-Invariant Systems, response of an LTI-system in frequency domain
	Topic 6: Tubular Welded Connections, stress concentration factors, weld geometry
	Topic 7: Introduction to Fracture Mechanics, criteria for fracture initiation and crack growth
	Topic 8: Time and Frequency Domain Fatigue Analyses, rainflow counting, application of LTI-systems for frequency domain fatigue
	Topic 9: Offshore Installation and Exam, installation of structures, pile driving, pipe laying techniques
Literature	Chakrabarti, Handbook of Offshore Engineering, 2005
	Sarpkaya, Wave Forces on Offshore Structures, 2010
	Faltinsen, Sea Loads on Ships and Offshore Structures, 1998
	Sorensen, Basic Coastal Engineering, 2006
	Dowling, Mechanical Behavior of Materials, 2007
	Haibach, Betriebsfestigkeit, 2006
	Marshall, Design of Welded Tubular Connections, 1992
	Newland, Random vibrations, spectral and wavelet analysis, 1993

Course L3227: Energy Geotechnics		
Тур	Lecture	
Hrs/wk	3	
СР	3	
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42	
Examination Form	Schriftliche Ausarbeitung (laut FPrO)	
Examination duration and	wird zu Beginn der Lehrveranstaltung festgelegt	
scale		
Lecturer	Pauline Kaminski	
Language	DE/EN	
Cycle	WiSe	
Content	Energy geotechnics is a young field in geotechnical engineering with the aim of developing sustainable geotechnical solutions for future-oriented issues relating to the production, transport, operation, decommissioning, and waste utilisation of various energy sources. Examples of possible fields of activity in energy geotechnics include geothermal energy and thermally activated foundation components, foundations for onshore and offshore wind turbines, the decommissioning of mining facilities and the handling of waste products from fossil fuels such as tailings and the geological storage of CO2. Relevant soil mechanical processes in these applications include the thermo-hydro-mechanically coupled behaviour of soils, multiphase flow in porous media and partially saturated soils. The lecture gives an overview of various aspects of energy geotechnics and provides in-depth knowledge of the associated soil mechanical processes. In addition, CO2-scarce geotechnical applications are discussed and emission estimates as well as the optimisation of geotechnical structures according to sustainability aspects are addressed.	
Literature		

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 L1634: Forum I - Geotechnics and Construction Management	
Тур	Seminar
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Examination Form	Mündliche Prüfung
Examination duration and	30 min
scale	
Lecturer	Prof. Jürgen Grabe
Language	DE
Cycle	WiSe
Content	Lectures about projects and issues with practical and scientific relevance.
Literature	

Course L1635: Forum II - Geotechnics and Construction Management	
Тур	Seminar
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Examination Form	Mündliche Prüfung
Examination duration and	30 min
scale	
Lecturer	Prof. Jürgen Grabe
Language	DE
Cycle	SoSe
Content	Lectures about projects and issues with practical and scientific relevance.
Literature	

Course L1151: Timber Structures	
Тур	Seminar
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Referat
Examination duration and	90 min
scale	
Lecturer	Prof. Torsten Faber
Language	DE
Cycle	WiSe
Content	
Literature	

Course L2666: Innovative Timber Construction		
Тур	Lecture	
Hrs/wk	2	
СР	4	
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28	
Examination Form	Schriftliche Ausarbeitung	
Examination duration and	45 Minuten	
scale		
Lecturer	Dr. Andreas Meisel	
Language	DE	
Cycle	WiSe	
Content		
Literature	- Blass, J.: "Ingenieurholzbau"	
	- Schickhofer, G.: "BSPhandbuch: Holz-Massivbauweise in Brettsperrholz"	
	- Informationsdienst Holz: div. Merkblätter und Broschüren	
	- Wallner-Novak M.: Brettsperrholz Bemessung, Band 1 und 2	
	- Gerner M.: "Fachwerk: Entwicklung, Instandsetzung, Neubau"	
	- Meisel, A.: "Historische Dachwerke: Beurteilung, realitätsnahe statische Analyse und Instandsetzung"	
	- Kempe K.: "Dokumentation Holzschädlinge"	
	- Huckfeldt T.: "Hausfäule- und Bauholzpilze"	

Course L1152: Glass Structures		
Тур	Lecture	
Hrs/wk	2	
CP	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Examination Form	Mündliche Prüfung	
Examination duration and		
scale		
Lecturer	Marvin Matzik	
Language	DE	
Cycle	WiSe	
Content	Glass structures	
	- Introduction of the material glass (production, refinement, material characteristic)	
	- design of facades	
	- facade types	
	- static calculation of glazing	
	- static calculation of facades	
	- load bearing behavior of glazing (plate or membrane stiffness)	
	- vertical / horizontal glazing with safety-related requirements	
	- glass structures	
	- fire safety of glass facades	
	- construction physics of facades and glazing	
Literature		

Course L1447: Glass Structures	
Тур	Recitation Section (large)
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Examination Form	Mündliche Prüfung
Examination duration and	
scale	
Lecturer	Marvin Matzik
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

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

Course L3091: Special Topics	Course L3091: Special Topics in Steel Design		
Тур	Integrated Lecture		
Hrs/wk	2		
CP	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Examination Form	Klausur		
Examination duration and	90 min		
scale			
Lecturer	Prof. Marcus Rutner, Nikolay Lalkovski		
Language	DE		
Cycle	SoSe		
Content			
Literature			

Course L2378: Special topics	ourse L2378: Special topics of civil engineering 1CP		
Тур			
Hrs/wk	1		
CP	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 Lehrveranstaltung festgelegt		
scale			
Lecturer	Dozenten des SD B		
Language	DE		
Cycle	WiSe/SoSe		
Content	The course occurs only if required. The content is defined at short notice.		
Literature	Die Literatur wird kurzfristig festgelegt.		

Course L2379: Special topics	of civil engineering 2 LP
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 Lehrveranstaltung festgelegt
scale	
Lecturer	Dozenten des SD B
Language	DE
Cycle	WiSe/SoSe
Content	The course occurs only if required. The content is defined at short notice.
Literature	Die Literatur wird kurzfristig festgelegt.

Course L2380: Special topics	Course L2380: Special topics of civil engineering 3 LP		
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 Lehrveranstaltung festgelegt		
scale			
Lecturer	Dozenten des SD B		
Language	DE		
Cycle	WiSe/SoSe		
Content	The course occurs only if required. The content is defined at short notice.		
Literature	Die Literatur wird kurzfristig festgelegt.		

Course L2789: Structural Des	sign
Тур	Seminar
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and	20 min
scale	
Lecturer	Dr. Jan Mittelstädt
Language	DE/EN
Cycle	SoSe
Content	
Literature	[1] Structure Systems by Heino Engel, Hantje Cantz, 3rd edition (Feb 2007), ISBN-10: 3775718761
	Form and Force, Designing Efficient, Expressive Structures by Allan, E., Zalewski, W. et al, John Wiley and
	Sons; 1st edition (Sept 2009), ISBN-10: 047017465X
	[2] Peter Rice: An Engineer Imagines, ISBN-10 : 1849944237
	[3] Konrad Wachsmann and the Grapevine Structure by C. Sumi et al., Park Books (Oct 2018), ISBN-10:
	9783038601104
	[4] Manual of Multi-Story Timber Construction by Hermann Kaufmann, Stefan Krotsch, Stefan Winter, DETAIL,
	(June 2018), ISBN-10: 3955533948
	[5] The Art of Structural Design: A Swiss Legacy by B. Billington, Princeton University Art Museum; First Edition edition (Mar 2003), ISBN-10: 0300097867
	[6] Structured Lineages: Learning from Japanese Structural Design by G. Nordenson et al, The Museum of
	Modern Art (Jul 2019), ISBN-10: 1633450562
	[7] The Structure: Works of Mahendra Raj by V. Mehta, R. Mehndiretta, A. Huber, Park Books (Oct 2015),
	ISBN-10: 3038600253

Courses	
Title	Typ Hrs/wk CP
Adaptation to climate change in hy	vdraulic engineering (L2291) Project-/problem-based Learning 4 6
Module Responsible	Prof. Peter Fröhle
Admission Requirements	None
Recommended Previous	
Knowledge	 Hydrology, Hydraulic Engineering Hydromechanic, Hydraulics
	Fundamentals of Coastal Engineering, Coastal- and Flood Protection
	Hydrological Systems
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	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	
en me	 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, plann
	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	
Examination	
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 Geotechnical Engineering: Elective Compulsory
	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory
	Civil Engineering: Specialisation Water and Traffic: Elective Compulsory
	Water and Environmental Engineering: Specialisation Cities: Elective Compulsory
	Water and Environmental Engineering: Specialisation Environment: Elective Compulsory
	Water and Environmental Engineering: Specialisation Water: Elective Compulsory

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

Courses				
Title		Тур	Hrs/wk	СР
Scientific Working in Computationa	Engineering (L2764)	Project-/problem-based Learning	4	6
Module Responsible	Prof. Kay Smarsly			
Admission Requirements	None			
Recommended Previous	Basic knowledge in scientific writing. String interest in t	opics related to computing in civil engine	ering.	
Knowledge				
Educational Objectives	After taking part successfully, students have reached the	ne following learning results		
Professional Competence				
Personal Competence	course instructors and in collaboration with each other, thinking, being able to accurately plan, implement an will be conducted throughout the semester, which will this course, a scientific paper will be developed based based on the project conducted within this course. P scientific publications are further key activities. The students will be capable (i) of solving a scientific effectively in the form of a paper, and (iii) of sharing th The students will be able to work in a multidisciplinary	d analyze scientific projects, such as pro contribute to the grade. Since scientific we which is a prerequisite for the final exam roject meetings in small groups, present problem following a scientific methodolo eir work in a presentation.	spective mash riting is of part nination. The p ations, and co gy, (ii) of doc	ter theses. A proje ticular importance paper will be writte ritical discussions umenting their wo
	The students will be able to extend their knowledge an	·		-
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: Elec	tive Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineer	ng: Elective Compulsory		
	Civil Engineering: Specialisation Coastal Engineering: E	ective Compulsory		
	Civil Engineering: Specialisation Structural Engineering	Elective Compulsory		
	Civil Engineering: Specialisation Computational Engineer	ering: Elective Compulsory		
	Computer Science: Specialisation II: Intelligence Engine	ering: Elective Compulsory		

Course L2764: Scientific Wor	rking in Computational 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. Kay Smarsly
Language	EN
Cycle	WiSe/SoSe
Content	In the course, a scientific problem of practical relevance will first be defined, taking into account the interests of the students participating in the course. The scientific problem will then systematically be solved within the framework of a comprehensive project. The principles of scientific working will be taught based on the scientific problem defined previously. As an integral part of scientific working, fundamentals of scientific writing will be presented and applied to a scientific paper to be written during the course. Topics related to scientific writing include structuring in scientific writing (structuring the abstract, the introduction, the main part, the summary and conclusions, and the acknowledgments and references) and recommendations on effective scientific writing (principles of composition, use of English in scientific writing, useful tips, creating figures, writing in mathematics, referencing, and formal email correspondence). A final paper and a final presentation will be assembled by the students.
Literature	Smarsly, K. & Dragos, K., 2019. Scientific Writing in Engineering. Tredition, Hamburg, Germany.

Courses				
Title		Тур	Hrs/wk	СР
Sustainable Nature-based Coastal P	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 Eventeering Constal Engineering Constal on	d Fland Darkasking		
	 Fundamentals of Coastal Engineering, Coastal- ar 			
Educational Objectives	After taking part successfully, students have reached th	e following learning results		
Professional Competence				
Knowledge	Climate and Climate Change			
	Climate and Climate Change Constant Impacts of Climate Change on Wind Regi	me and Water Cycle		
	General Impacts of Climate Change on Wind Regi			
	Consequences of Climate Change for Coastal Proc	cesses		
	Coastal Protection in Taiwan and Germany			
	Fundamentals of Climate Adaptation			
	 Nature-based Solutions (NBS) for Coastal Protecti 	on		
Skills				
	 Critical thinking: analysis of processes and relation 	ns, assessment of needs for action		
	 Creative thinking: development of adaptation strategies 	ategies and adaptation measures		
	 Practical thinking: inclusion of restrictions, appl 	ication of calculation approaches, meth	ods, numerica	al models, plannii
	methods			
	 Consideration of complex tasks 			
Demonstration of the second				
Personal Competence				
Social Competence	 Working in heterogenous groups 			
	 Working in international groups 			
	Working with different scientific / non-scientific di	sciplines		
	Self reflection			
Autonomy	Application oriented use of knowledge and skills			
	Autonomous work on complex tasks			
	Autonomous work on complex tasks			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
Examination duration and	Preparation of a written report on a complex task with	a presentation and subsequent discussion	on. The work o	on the complex ta
	happens in the course of the lecture.			
Scale	Civil Engineering: Specialisation Coastal Engineering: Ele	ective Compulsory		
	s Engineering. specialisation coustal Engineering. Ele			
Assignment for the	Civil Engineering: Specialisation Gentechnical Engineering			
Assignment for the	Civil Engineering: Specialisation Geotechnical Engineering:			
Assignment for the	Civil Engineering: Specialisation Structural Engineering:	Elective Compulsory		
Assignment for the	Civil Engineering: Specialisation Structural Engineering: Civil Engineering: Specialisation Water and Traffic: Elect	Elective Compulsory ive Compulsory		
Assignment for the	Civil Engineering: Specialisation Structural Engineering: Civil Engineering: Specialisation Water and Traffic: Elect Environmental Engineering: Specialisation Environment	Elective Compulsory ive Compulsory and Climate: Elective Compulsory		
Assignment for the	Civil Engineering: Specialisation Structural Engineering: Civil Engineering: Specialisation Water and Traffic: Elect	Elective Compulsory ive Compulsory and Climate: Elective Compulsory ties: Elective Compulsory		

Course L2926: Sustainable N	ature-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 M1844: Mode	rn discretization methods in stru	ictural mechanics			
Courses					
Title		Тур	Hrs/wk	СР	
Modern discretization methods in structural mechanics (L3043)		Lecture	2	3	
Modern discretization methods in s	tructural mechanics (L3044)	Recitation Section (small)	2	3	
Module Responsible	Prof. Bastian Oesterle				
Admission Requirements	None				
Recommended Previous Knowledge	Finite Element MethodsFlächentragwerke				
Educational Objectives	After taking part successfully, students have rea	ached the following learning results			
Professional Competence					
Knowledge	After successful completion of this module, students can express the basic aspects of modern discretization methods in structura mechanics.				
Skills	After successful completion of this module, the students will be able to use and further improve modern discretization methods for problems in structural mechanics.				
Personal Competence					
Social Competence	Students can				
	 participate in subject-specific and interdisting the subject specific and interdisting the subject specific and interdisting the subject specific and specific an	sciplinary discussions.			
	 participate in subject-specific and interdisciplinary discussions, defend their own work results in front of others promote the scientific development of colleagues 				
	Furthermore, they can give and accept p	ofessional constructive criticism			
Autonomy	Students are able to gain knowledge of the subject area from given and other sources and apply it to new problems. Furthermore				
, according	Students are able to gain knowledge of the subject area from given and other sources and apply it to new problems. Furthermore they are able to structure the solution process for problems in the area of modern discretization methods.				
Workload in Hours	Independent Study Time 124, Study Time in Leo	ture 56			
Credit points	6				
Course achievement	None				
Examination	Written exam				
Examination duration and	90 min				
scale					
Assignment for the	Civil Engineering: Specialisation Coastal Engine	ering: Elective Compulsory			
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering	ngineering: Elective Compulsory			
	Civil Engineering: Specialisation Structural Engin	neering: Elective Compulsory			
	Civil Engineering: Specialisation Computational	Engineering: Elective Compulsory			
	Theoretical Mechanical Engineering: Specialisat	on Simulation Technology: Elective Compulso	ry		

Course L3043: Modern discre	etization methods in structural mechanics
Тур	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Bastian Oesterle
Language	EN
Cycle	WiSe
Content	 The course covers variational formulations, various locking phenomena and alternative formulations for finite elements and modern discretization schemes in the context of structural mechanics, like isogeometric analysis. variational formulation of finite elements, mixed variational principles geometrical and material locking effects in structural and solid mechanics hybrid-mixed and enhanced assumed strain finite element formulations, reduced integration and stabilization, DSG method, u-p formulations patch test, stability, convergence linear and non-linear analyses introduction to isogeometric analysis isogeometric beam, plate and shell formulations locking effects and their avoidance in modern, smooth discretization schemes, like isogeometric analysis
Literature	 lecture notes and selected scientific papers O.C. Zienkiewicz, R.L. Taylor, and J.Z. Zhu: Finite Element Method: Its Basis and Fundamentals. Elsevier, 2013. J. Austin Cottrell, Thomas J. R Hughes, Yuri Bazilevs: Isogeometric Analysis: Toward Integration of CAD and FEA. Wiley, 2009.

Course L3044: Modern discre	ourse L3044: Modern discretization methods in structural mechanics		
Тур	Recitation Section (small)		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Bastian Oesterle		
Language	EN		
Cycle	WiSe		
Content	See interlocking course		
Literature	See interlocking course		

Courses				
Title		Тур	Hrs/wk	СР
Construction law BGB and VOB - lay Construction disputes from constru	v in (excavation) practice (L3182) ction (excavation) practice (L3181)	Lecture Lecture	2	3 3
Module Responsible				-
Admission Requirements				
Recommended Previous	Complete modules: Geotechnics I-III			
Knowledge				
Educational Objectives	After taking part successfully, students have rea	ched the following learning results		
Professional Competence Knowledge	Students will gain knowledge of			
	 the history of civil engineering law, 			
	basics of foundation and civil engineering	law,		
	 legal aspects of technical regulations in c 	ivil engineering (with case studies),		
	 the civil engineering contract, 			
	 the liability of the designer and contractor 	r in civil engineering,		
	 the subsoil risk and the system risk, 			
	 the total debt in (civil) engineering law, 			
	 the (construction) conflict, dispute avoida 		ess,	
	the systematics of construction contract	aw,		
	• the BGB construction contract law,			
	 responsibilities on the construction site, 			
	 remuneration and contract management, 			
	liability for defects,			
	public procurement law			
	Disturbed construction processes: How m	uch money am I entitled to?		
	Correct calculation of supplements.			
Skille	Students learn to apply legal aspects in plannir	a and construction in a legally balance	od way Students learn	how to use legal
JKIIIS	construction management aspects in practice (
	to manage the construction project optimally.	planning and construction, on the con	struction site in a targe	
	to manage the construction project optimality.			
Personal Competence		the state of a line set of		
Social Competence	Students can work in groups and support each o	other in finding solutions.		
Autonomy	Students are able to assess their own strengths	and weaknesses and organize their tir	ne and learning manage	ement based on th
	Independent Study Time 124, Study Time in Leo	ture 56		
Credit points				
	None			
Examination	Oral exam			
Examination duration and	30 min			
scale		dans Election Comercial		
•	Civil Engineering: Specialisation Coastal Engineering: Specialisation Geotechnical Engineering: Specialisation Geotechn	• • •		
Following Curricula	Civil Engineering: Specialisation Geotechnical El Civil Engineering: Specialisation Structural Engin	5 5 1 5		
	Civil Engineering: Specialisation Structural Engineering: Specialisation Water and Trafi			
	Civil Engineering: Specialisation Water and Tran	.e. Elective comparatily		

Course L3182: Construction law BGB and VOB - law in (excavation) practice		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Günther Schalk	
Language	DE	
Cycle	WiSe	
Content		
Literature	Literatur:	
	- Folienskript (in der Vorlesung erhältlich)	
	- Fuchs/Maurer/Schalk: Handbuch Tiefbaurecht	

Course L3181: Construction	ourse L3181: Construction disputes from construction (excavation) practice		
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Ingo Junker		
Language	DE		
Cycle	WiSe		
Content			
Literature			

Courses					
Title		Тур		Hrs/wk	СР
Coastal- and Flood Protection (L080	8)	Lecture		пі 5/ w к 2	3
Coastal- and Flood Protection (L141	- /		m-based Learning	1	1
Maintenance and Defence of Flood	Protection Structures (L1411)	Lecture	5	2	2
Module Responsible	Prof. Peter Fröhle				
Admission Requirements	None				
Recommended Previous	Coastal Engineering I				
Knowledge					
Educational Objectives	After taking part successfully, students have	e reached the following learning res	ults		
Professional Competence					
Knowledge	The students have the capability to define and explain in detail the important aspects of erosion protection and flood protect and are able to apply the aspects to practical coastal protection problems. They are able to design and dimension import				and flood protecti
					dimension importa
	coastal protection measures from the functional and from the constructional point of view.				
Skills	Skills The students are able to select design approaches for the functional and constructional design of erosion a			and flood protect	
Skiis	measures and apply these approaches to practical design tasks.				
		5			
Personal Competence					
Social Competence	The students are able to deploy their gained knowledge in applied problems such as the functional and constructive design				-
	coastal and flood protection structures. Add				isciplines.
-	The students will be able to independently extend their knowledge and apply it to new problems.				
	Independent Study Time 110, Study Time in	Lecture 70			
Credit points					
Course achievement	None				
Examination	Written exam				
Examination duration and	The duration of the examination is 130 m	in. The examination includes tasks	s with respect to	the general u	inderstanding of t
scale	lecture contents and calculations tasks.				
Assignment for the	Civil Engineering: Specialisation Coastal Eng	jineering: Compulsory			
Following Curricula	Civil Engineering: Specialisation Geotechnic	al Engineering: Elective Compulsor	ý		
	Civil Engineering: Specialisation Structural E				
	Environmental Engineering: Specialisation E	nvironment and Climate: Elective C	Compulsory		
	Environmental Engineering: Specialisation V Water and Environmental Engineering: Specialisation			lsory	

Course L0808: Coastal- and F	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
Literature	Flood-Protection Walls Drainage of the hinterland Vorlesungsumdruck
	Coastal Engineering Manual CEM

Course L1415: Coastal- and F	urse 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

Courses				
Title		Тур	Hrs/wk	СР
Waste and Environmental Chemist	, , , , , , , , , , , , , , , , , , , 	Practical Course	2	2
Biological Waste Treatment (L0318		Project-/problem-based Learning	3	4
Module Responsible	Prof. Kerstin Kuchta			
Admission Requirements	None			
	chemical and biological basics			
Knowledge				
Educational Objectives	After taking part successfully, students have	reached the following learning results		
Professional Competence				
Knowledge	design and layout of anaerobic and aerobic w	ing the planning of biological waste treatment plant aste treatment plants in detail, describe different te nd explain different methods for waste analytics.		
Skills	control measurements. The students can rec	ion of design and layout of plants. They can criticall herché and evaluate literature and date connected f reflecting and evaluating findings in the group.	-	
Personal Competence				
	Students can participate in subject-specific a	and interdisciplinary discussions, develop cooperate	ed solutions a	and defend their
	work results in front of others and promote accept professional constructive criticism.	the scientific development in front of colleagues.	Furthermore	e, they can give
Autonomy	are capable, in consultation with supervisors	rom literature, business or test reports and transfo as well as in the interim presentation, to assess the efine targets for new application-or research-orient t.	ir learning lev	vel and define fur
Workload in Hours	Independent Study Time 110, Study Time in I	ecture 70		
Credit points	1 3 1 3			
Course achievement	Compulsory Bonus Form	Description		
course demeterment	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 Engi	neering: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical	Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Structural En	gineering: Elective Compulsory		
	Civil Engineering: Specialisation Water and Tr	affic: Elective Compulsory		
	Bioprocess Engineering: Specialisation A - Ge	neral Bioprocess Engineering: Elective Compulsory		
	Chemical and Bioprocess Engineering: Specia	lisation General Process Engineering: Elective Comp	oulsory	
	Chemical and Bioprocess Engineering: Specia	lisation Bioprocess Engineering: Elective Compulsor	у	
	Chemical and Bioprocess Engineering: Specia	lisation Chemical Process Engineering: Elective Com	npulsory	
	Chemical and Bioprocess Engineering: Specia	lisation Chemical and Bio process Engineering: Elec	tive Compuls	ory
	Environmental Engineering: Core Qualification	n: Compulsory		
		Specialisation II. Renewable Energy: Elective Compu	lsory	
		ental Process Engineering: Elective Compulsory		
	Water and Environmental Engineering: Specia	alisation Cities: Elective Compulsory		
	Water and Environmental Engineering: Specia			

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

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

_				
Courses				
Title		Тур	Hrs/wk	СР
Finite element modeling of structures (L3046)		Lecture	2	3
Finite element modeling of structur		Recitation Section (small)	2	3
Module Responsible				
Admission Requirements	None			
Recommended Previous	Finite Element Methods			
Knowledge	Thin-walled structures			
Educational Objectives	After taking part successfully, students have	ve reached the following learning results		
Professional Competence				
Knowledge	After successful completion of this module,	, students can express the basic aspects of modell	ing of structures	with finite elements
Skills	After successful completion of this module, the students will be able to model structures with finite elements and to analys			
Skiis	structures using appropriate computationa			
Personal Competence				
Social Competence	Students can			
	 participate in subject-specific and in 	terdisciplinary discussions		
	 defend their own work results in fror 			
	• promote the scientific development	of colleagues		
	 Furthermore, they can give and acce 	-		
		subject area from given and other sources and apply it to new problems. Furthermor		
	they are able to structure the solution proc	tess for problems in the area of finite element mod	elling of structure	25.
Workload in Hours	Independent Study Time 124, Study Time i	n Lecture 56		
Credit points	6			
Course achievement	None			
Examination				
Examination duration and	written elaboration of a project work (10-1	5 pages)		
scale				
Assignment for the	Civil Engineering: Specialisation Computati	onal Engineering: Compulsory		
Following Curricula	Civil Engineering: Specialisation Coastal En	gineering: Elective Compulsory		
	Civil Engineering: Specialisation Geotechni	cal Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Structural	Engineering: Elective Compulsory		
	Theoretical Mechanical Engineering: Specia	alisation Simulation Technology: Elective Compulso	orv	

Course L3046: Finite element modeling of structures		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Bastian Oesterle	
Language	EN	
Cycle	WiSe	
Content	Basic phenomena and aspects of the finite element modelling of structures are discussed. Besides theoretical decription of the phenomena and methods, a strong focus is on the practical use a commercial finite element software within computer-based exercises. The covered topics are: • finite element modeling of trusses/beams/frames, plates subject to in-plane/out-of-plane loading and shells • convergence properties of displacements and stresses • singularities • locking effects • critical assessment, interpretation and check of results • mixed-dimensional coupling of finite elements • geometrically linear and non-linear, and material linear and non-linear analyses • stability: bifurcation and snap-through problems	
Literature	dynamic problems, modal analyses Vorlesungsmanuskript, Vorlesungsfolien	

Course L3047: Finite elemen	Irse L3047: Finite element modeling of structures		
Тур	Recitation Section (small)		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Bastian Oesterle		
Language	EN		
Cycle	WiSe		
Content	See interlocking course		
Literature	See interlocking course		

Courses					
Title		Тур	Hrs/wk	СР	
Modeling of Subsurface Processes (L2731)		Recitation Section (small)	3	3	
Subsurface Solute Transport (L2728)		Lecture	2	2	
Subsurface Solute Transport (L272)		Recitation Section (large)	1	1	
Module Responsible					
Admission Requirements	None				
Recommended Previous	Basic Mathematics, Hydrology				
Knowledge					
Educational Objectives	After taking part successfully, students have	ve reached the following learning results			
Professional Competence					
Knowledge	e Upon completion of this module, the students will understand the mechanisms controlling solute transport in soil and natur				
	porous media and will be able to work with the equations that govern the fate and transport of solutes in porous media. Analytica				
	numerical and experimental tools and tech	nniques will be used in this module.			
Skille	In addition to the physical insights, the stu	idents will be exposed to analytical experimental	and numerical to	ols and techniques	
JKIIIS	s In addition to the physical insights, the students will be exposed to analytical, experimental and numerical tools and techniques this module. This provides them with an excellent opportunity to improve their skills on multiple fronts which will be useful in the				
	future career.				
Personal Competence					
	Teamwork & problem solving				
Social Competence Teamwork & problem solving		individual reports and presentation. This will c	ontribute to the	students' ability a	
hatohomy	r The students will be involved in writing individual reports and presentation. This will contribute to the students' abil willingness to work independently and responsibly.			stadents ability a	
Workload in Hours	Independent Study Time 96, Study Time in	,			
Credit points					
Course achievement					
Examination					
Examination duration and	Report				
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				
	Civil Engineering: Specialisation Computational Engineering: Elective Compulsory				
	Chemical and Bioprocess Engineering: Technical Complementary Course: Elective Compulsory				
	Environmental Engineering: Core Qualification: Compulsory				
	Process Engineering: Specialisation Environmental Process Engineering: Elective Compulsory				
	Process Engineering: Specialisation Process Engineering: Elective Compulsory				
	Water and Environmental Engineering: Specialisation Water: 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	Dr. Milad Aminzadeh	
Language	EN	
Cycle	WiSe	
Content	Basic usage and background of chosen computer software to calculate flow and transport in the saturated and unsaturated zone and to analyze field data like pumping test data	
Literature		

Course L2728: Subsurface So	olute Transport
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Nima Shokri
Language	EN
Cycle	WiSe
Content	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	rse L2729: Subsurface Solute Transport		
Тур	citation Section (large)		
Hrs/wk	1		
СР	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Hannes Nevermann		
Language	EN		
Cycle	WiSe		
Content	See interlocking course		
Literature	See interlocking course		

Specialization Structural Engineering

Module M0699: Geote	chnics III			
Courses				
Title		Тур	Hrs/wk	СР
Numerical Methods in Geotechnics	(L0375)	Lecture	3	3
Advanced Foundation Engineering	(L0497)	Lecture	2	2
Advanced Foundation Engineering	(L0498)	Recitation Section (large)	1	1
Module Responsible	Prof. Jürgen Grabe			
Admission Requirements	None			
Recommended Previous	Geotechnics I and II, Mathematics I-III			
Knowledge				
	After taking part successfully, students have reached	the following learning results		
Professional Competence				
	 After successfully completing the module, students w describe individual procedures for the geotech reproduce exploration and investigation method select suitable types of field and laboratory test state the differences between various stress a and distortion tensor, outline the standard and special soil mechanic describe continuum models and the resulting b as well as define boundary value problems frounambiguously. Students will be able to dimension vertical drains for soil improvement calculate depth compaction using various apprive apply principles of horizontal bearing capacity verify the internal and external stability of fluid evaluate the boundary conditions for the diexcavation, perform, evaluate and interpret tests for the die computationally implement numerical algorith select and apply the types of analyses depend determine appropriate model parameters for compaction computational parameters for compaction compared to the compaction of the computational parameters for computational parameters for computational parameters for compared to the computational parameters for computationa	nical monitoring of civil engineering me ods of the subsoil, sts for subsoil investigation and evaluate nd deformation states and the physical s tests used to determine the stress-stre boundary value problems, m the field of geotechnical engineering of soft soils, ropriate methods, of piles, d-supported diaphragm walls, esign of a deep excavation and design escription and classification of soils accord ms to solve boundary value problems, ing on the degree of saturation, the imp	e their results, significance of inv ain behavior of so in such a way tha gn the individual ording to applicab pact, and the mate	il, It they can be solved components of the le standards, rial behavior
	of soils.			
Personal Competence		the C sector sector between		
Social Competence	Students can work in groups and support each other	in finding solutions.		
Autonomy	Students are able to assess their own strengths and and think in terms of processes.	weaknesses and, based on this, organize	e their time and le	earning management
Workload in Hours	Independent Study Time 96, Study Time in Lecture 8	4		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	120 min			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Engineering	ng: Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engine	ering: Compulsory		
	Civil Engineering: Specialisation Coastal Engineering:	• • •		
	Civil Engineering: Specialisation Water and Traffic: El			
	Civil Engineering: Specialisation Computational Engin			
	International Management and Engineering: Specialis	• • •	pulsory	
	meeting. Specialis	in the second seco	20.0013	

Course L0375: Numerical Me	thods in Geotechnics		
Тур	Lecture		
Hrs/wk	3		
СР	3		
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42		
Lecturer	Dr. Hans Mathäus Stanford		
Language	DE		
Cycle	WiSe		
Content	Topics:		
	 Introduction to numerical soil mechanics Introduction to numerical mathematics Finite Element Method (analysis procedures, algorithms) Finite Element Method (application in geotechnical engineering) 		
Literature	 Wriggers P. (2001): Nichtlineare Finite-Elemente-Methoden. Springer Wriggers P. (2008): Nonlinear Finite Element Methods. Springer Deutsche Gesellschaft für Geotechnik e.V. (Hrsg., 2014): Empfehlungen des Arbeitskreises "Numerik in der Geotechnik". Ernst & Sohn 		

Course L0497: Advanced Fou	Indation Engineering	
Тур	Lecture	
Hrs/wk	2	
СР		
Workload in Hours	ndependent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Jürgen Grabe	
Language	DE	
Cycle	WiSe	
Content	 Vertical drains Piles Ground improvement (Deep Compaction, Soil mixing) Vibration driving Jet grouting Slurry wall Deep excavation 	
Literature	 EAK (2002): Empfehlungen für Küstenschutzbauwerke EAU (2004): Empfehlungen des Arbeitsausschusses Uferbauwerke EAB (1988): Empfehlungen des Arbeitskreises Baugruben Grundbau-Taschenbuch, Teil 1-3, (1997), Ernst & Sohn Verlag 	

Course L0498: Advanced Fou	urse L0498: Advanced Foundation Engineering		
Тур	itation Section (large)		
Hrs/wk	1		
СР	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Prof. Jürgen Grabe		
Language	DE		
Cycle	WiSe		
Content	See interlocking course		
Literature	See interlocking course		

		S				
Courses						
Title			Ty		Hrs/wk	СР
Concrete Structures (L0579)				ninar	1	1
Structural Concrete Members (L0577) Lecture 2 Structural Concrete Members (L0578) Recitation Section (large) 2			2	3 2		
	-		Rec	citation Section (large)	Z	Z
Module Responsible						
Admission Requirements						
Recommended Previous	Basics of structural	analysis, conception ar	nd dimensioning of structu	iral concrete		
Knowledge	Modules: Reinforced	d Concrete Structures I	+II, Structural Analysis I+I	I, Mechanics I+II		
Educational Objectives	After taking part suc	ccessfully, students hav	ve reached the following le	earning results		
Professional Competence						
Knowledge	The students broade	en their skills in structu	iral engineering, especially	y in the field of buildings	(houses, roofs, ha	alls). They dispose
	the knowledge for the	he conception and desi	gn of concrete buildings a	nd structural members tl	hat are often used	l.
Chille	The students are able to apply procedures of the conception and dimensioning to to practical problems of structural engineering					
SKIIIS						
	They are capable to draft concrete buildings and to design them for general action effects and to plan their d execution. Moreover, they can make design and construction sketches and draw up technical descriptions.			their detailing a		
	execution. Moreover	r, they can make desig	n and construction sketch	es and draw up technical	descriptions.	
Personal Competence	The students are able to obtain results of high quality in teamwork.					
	The students are ab	ple to obtain results of h	high quality in teamwork.			
Social Competence						
Social Competence			nigh quality in teamwork. < conception and dimensio	ning tasks of structures	under the guidanc	ce of tutors.
Social Competence Autonomy	The students are ab		conception and dimensio	ning tasks of structures	under the guidanc	ce of tutors.
Social Competence Autonomy Workload in Hours	The students are ab	ble to carry out complex	conception and dimensio	ning tasks of structures	under the guidand	ce of tutors.
Social Competence Autonomy Workload in Hours Credit points	The students are ab	ble to carry out complex	conception and dimensio	ning tasks of structures	under the guidand	ce of tutors.
Social Competence Autonomy Workload in Hours	The students are ab Independent Study ⁻ 6	ble to carry out complex Time 110, Study Time	conception and dimension in Lecture 70 Description	oning tasks of structures of s	under the guidand	ce of tutors.
Social Competence Autonomy Workload in Hours Credit points Course achievement	The students are ab Independent Study ⁻ 6 Compulsory Bonus	ole to carry out complex Time 110, Study Time Form	conception and dimension in Lecture 70 Description		under the guidand	ce of tutors.
Social Competence Autonomy Workload in Hours Credit points Course achievement	The students are ab Independent Study ⁷ 6 Compulsory Bonus No None Written exam	ole to carry out complex Time 110, Study Time Form	conception and dimension in Lecture 70 Description		under the guidand	ce of tutors.
Social Competence Autonomy Workload in Hours Credit points Course achievement Examination	The students are ab Independent Study ⁷ 6 Compulsory Bonus No None Written exam	ole to carry out complex Time 110, Study Time Form	conception and dimension in Lecture 70 Description		under the guidand	ce of tutors.
Social Competence Autonomy Workload in Hours Credit points Course achievement Examination Examination duration and scale	The students are ab Independent Study ⁻ 6 Compulsory Bonus No None Written exam 120 minutes	ole to carry out complex Time 110, Study Time Form Presentation	c conception and dimension in Lecture 70 Description Es werden 2 Refe	erate ausgegeben	under the guidanc	ce of tutors.
Social Competence Autonomy Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	The students are ab Independent Study ⁻ 6 Compulsory Bonus No None Written exam 120 minutes Civil Engineering: Sp	ole to carry out complex Time 110, Study Time Form Presentation	conception and dimension in Lecture 70 Description	erate ausgegeben	under the guidand	ce of tutors.
Social Competence Autonomy Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	The students are ab Independent Study ⁻ 6 Compulsory Bonus No None Written exam 120 minutes Civil Engineering: Sp Civil Engineering: Sp	Die to carry out complex Time 110, Study Time Form Presentation pecialisation Structural pecialisation Geotechni	conception and dimension in Lecture 70 Description Es werden 2 Refe	erate ausgegeben	under the guidand	ce of tutors.
Social Competence Autonomy Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	The students are ab Independent Study ⁻ 6 Compulsory Bonus No None Written exam 120 minutes Civil Engineering: Sp Civil Engineering: Sp Civil Engineering: Sp	Die to carry out complex Time 110, Study Time Form Presentation pecialisation Structural pecialisation Geotechni pecialisation Coastal Er	conception and dimension in Lecture 70 Description Es werden 2 Refe Engineering: Compulsory cal Engineering: Elective (erate ausgegeben Compulsory ulsory	under the guidand	ce of tutors.
Social Competence Autonomy Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	The students are ab Independent Study ⁻ 6 Compulsory Bonus No None Written exam 120 minutes Civil Engineering: Sp Civil Engineering: Sp Civil Engineering: Sp Civil Engineering: Sp	Die to carry out complex Time 110, Study Time Form Presentation pecialisation Structural pecialisation Geotechni pecialisation Coastal Er pecialisation Water and	Conception and dimension in Lecture 70 Description Es werden 2 Refe Engineering: Compulsory cal Engineering: Elective Compu	compulsory ulsory ory	under the guidand	ce of tutors.

Course L0579: Concrete Structures		
Тур	Seminar	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	NN	
Language	DE	
Cycle	WiSe	
Content	With help of a project teamwork the subjects of the course "Concrete Structures" is practiced, discussed and presented.	
Literature	- Projektbezogene Unterlagen werden abgegeben.	

Course L0578: Structural Concrete Members	
Тур	Recitation Section (large)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	NN
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M0963: Steel	and Composite Structures				
Courses					
Title		Тур	Hrs/wk	СР	
Steel and Composite Structures (L1	204)	Lecture	2	2	
Steel and Composite Structures (L1205)		Recitation Section (large)	2	2	
Steel Bridges (L1097)		Lecture	2	2	
Module Responsible	Prof. Marcus Rutner				
Admission Requirements	None				
Recommended Previous	Basics of steel construction (i.e. Steel Structures I and II, BUBC)				
Knowledge					
Educational Objectives	After taking part successfully, students have reached	the following learning results			
Professional Competence					
	After successful completition, students can				
	describe the phenomenon of local buckling				
	explain warping torsion				
	illustrate the behaviour of composite structure				
	specify the principles in design of composite s				
	sketch the contructions of steel and composite	e bridges			
Skills	After successful participation students are able to				
	 check stiffened and unstiffened plated structu 	res			
	 recognize and verify warping tosion in strucure 	es			
	 design composite structures 				
	 design bridges and o perform the detailing 				
Personal Competence					
Social Competence					
Autonomy					
Workload in Hours	Independent Study Time 96, Study Time in Lecture 8	4			
Credit points					
Course achievement	None				
Examination	Written exam				
Examination duration and	180 min				
scale					
Assignment for the	Civil Engineering: Specialisation Structural Engineering	ng: Compulsory			
Following Curricula	Civil Engineering: Specialisation Geotechnical Engine				
-	Civil Engineering: Specialisation Coastal Engineering				
	Civil Engineering: Specialisation Water and Traffic: El	lective Compulsory			
	Civil Engineering: Specialisation Computational Engir				
	International Management and Engineering: Specialis	sation II. Civil Engineering: Elective Com	oulsory		

Course L1204: Steel and Con	Course L1204: Steel and Composite Structures		
Тур	Lecture		
Hrs/wk	2		
СР	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Prof. Marcus Rutner		
Language	DE		
Cycle	WiSe		
Content	 Local-buckling of plated structures Warping torsion Composite-girders, -columns, -slabs, -bridges Principles in composite constructions Bridge-design and -construction 		
Literature	Petersen, C.: Stahlbau, 4.Auflage 2013, Springer-Vieweg Verlag Minnert, J. Wagenknecht, G.: Verbundbau-Praxis - Berechnung und Konstruktion nach Eurocode 4, 2.Auflage 2013, Bauwerk Beuth Verlag		

Course L1205: Steel and Con	ourse L1205: Steel and Composite Structures		
Тур	Recitation Section (large)		
Hrs/wk	2		
СР	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Prof. Marcus Rutner		
Language	DE		
Cycle	WiSe		
Content	See interlocking course		
Literature	See interlocking course		

Course L1097: Steel Bridges	
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Yves Freundt
Language	
Cycle	
Content	Lecture Contents ,Steel Bridge Construction' DrIng. Jörg Ahlgrimm
	Dring. Jorg Angrinnin
	- From tendering and contracting to completion - the development of a steel bridge
	- Contents of a bridge static - structural details, examples of analysis in detail:
	-> effective width in regard to the longitudinal stiffeners
	-> Bearing point, bearing stiffener
	-> Crossbeam breakthrough, crossbeam reinforcement
	-> Analysis of the Rib-to-Floorbeam (RF) connection (web-tooth of the floorbeam between trapezoidal shaped Ribs)
	- Steel grades, -designation, testing methods and approval certificates
	- Nondestructive weld inspecting
	- Corrosion protection
	- Bridge bearing - types, format, function, dimensioning, installation
	- Expansion Joints
	- Oscillation of bridge hangers and cables - oscillation damper
	- Opening bridges- Detailed reviews to different assembling procedures and - implements
	- Selective damage events
	Requirements: Basic knowledge in the calculation, dimensioning, and construction of structural elements and joints of constructional steelwork
Literature	
	Herbert Schmidt, Ulrich Schulte, Rainer Zwätz, Lothar Bär: Ausführung von Stahlbauten
	Petersen, Christian: Stahlbau, Abschnitt Brückenbau
	• Ahlgrimm, J., Lohrer, I.: Erneuerung der Eisenbahnüberführung in Fulda-Horas über die Fulda, Stahlbau 74 (2005), Heft 2, S. 114

1odule M1748: Const	
Courses	
Fitle Construction Robotics (L2867)	TypHrs/wkCPProject-/problem-based Learning66
Module Responsible	Prof. Kay Smarsly
Admission Requirements	None
Recommended Previous	Basics of project-oriented programming
Knowledge	
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	Basics of robotics
Kilowieuge	
	Applications in civil engineering
	Kinematics
Skills	Use of specific hardware
	Development of software routines
	Python programming language
	Image processing
	Basics of localization (LIDAR, SLAM)
Personal Competence	
Social Competence	Teamwork
	Communication skills
Autonomy	Independent work
	Independent decisions
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84
Credit points	6
Course achievement	None
Examination	Written elaboration
Examination duration and	ca. 10 Seiten
scale	
•	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory
Following Curricula	
	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory
	Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory
	Civil Engineering: Specialisation Computational Engineering: Elective Compulsory
	Computer Science: Specialisation II: Intelligence Engineering: Elective Compulsory
	Mechatronics: Core Qualification: Elective Compulsory
	Theoretical Mechanical Engineering: Specialisation Robotics and Computer Science: Elective Compulsory

Course L2867: Construction	ourse L2867: Construction Robotics		
Тур	Project-/problem-based Learning		
Hrs/wk	6		
СР	6		
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84		
Lecturer	Prof. Kay Smarsly, Jan Stührenberg		
Language	EN		
Cycle	WiSe		
Content	 Introduction: Robotics in civil engineering Presentation of potential topics Programming of algorithms in Python Application of software systems: LINUX distribution, ROS, CloudCompare, Application of hardware systems: Petoi Bittle Dog, Raspberry Pi, Arduino, sensing Topics considered for robotics using the Petoi Bittle Dog: Movement Use of sensors (camera, infrared,) Data structures/data acquisition Programming Topics technically relevant to building inspection: Geodetic evaluations Image processing Localization 		
Literature	Bock/Linner: Construction Robotics		
	Verl et al.: Soft Robotics		
	Pasquale: New Laws of robotics		

Courses				
Title		Тур	Hrs/wk	СР
Digital Twinning in Civil Engineerin	g (L3136)	Lecture	2	2
Digital Twinning in Civil Engineerin	g (L3137)	Seminar	2	4
Module Responsible	Alexander Chmelnizkij			
Admission Requirements	None			
Recommended Previous				
Knowledge				
Educational Objectives	After taking part successfully, students ha	ave reached the following learning results		
Professional Competence				
Knowledge				
Skills				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 124, Study Time	e in Lecture 56		
Credit points	6			
Course achievement	None			
Examination	Presentation			
Examination duration and	20 min presentation and 5 pages handou	t		
scale				
Assignment for the	Civil Engineering: Specialisation Computa	tional Engineering: Compulsory		
Following Curricula	Civil Engineering: Specialisation Coastal E	Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Geotech	nical Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Structure	al Engineering: Elective Compulsory		

Course L3136: Digital Twinning in Civil Engineering	
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Alexander Chmelnizkij, Prof. Bastian Oesterle, Prof. Kay Smarsly
Language	DE
Cycle	SoSe
Content	
Literature	

Course L3137: Digital Twinn	Course L3137: Digital Twinning in Civil Engineering	
Тур	Seminar	
Hrs/wk	2	
СР	4	
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28	
Lecturer	Alexander Chmelnizkij, Prof. Bastian Oesterle, Prof. Kay Smarsly	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Courses				
Title		Тур	Hrs/wk	СР
Design of Prestressed Structures a	nd Concreet Bridges (L0603)	Lecture	3	4
Design of Prestressed Structures a	nd Concreet Bridges (L0604)	Recitation Section (large)	2	2
Module Responsible	NN			
Admission Requirements	None			
Recommended Previous	Detailed knowledge on the design of concr	rete structures.		
Knowledge	Madulas, Dainfanad Cananata Churchuras I	U. Chrysteinel Analysia I. U. Mashanina I. U. Conser	-t- Church uno	
	Modules: Reinforced Concrete Structures I	+II, Structural Analysis I+II, Mechanics I+II, Concre	ete Structures	
Educational Objectives	After taking part successfully, students ha	ve reached the following learning results		
Professional Competence				
Knowledge	The students know the main bridge types, their applications and the various loads. They can explain the basic design method			
	They can explain the design of a prestress	ed bridge.		
CI-ill-	The shudents are able to design asinfarred			
SKIIIS	The students are able to design reinforced	for prestressed concrete bridges.		
Personal Competence				
Social Competence	The students can design in teamwork a rea	al concrete bridge.		
4	The students are able to desire a grant			
Αυτοποτηγ	The students are able to design a prestres	sed concrete bridge and discuss the problems and	i results with othe	r students.
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 minutes			
scale				
Assignment for the	Civil Engineering: Specialisation Structural	Engineering: Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechni	ical Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Coastal Er	ngineering: Elective Compulsory		
	Civil Engineering: Specialisation Computat	ional Engineering: Elective Compulsory		
	International Management and Engineering			

ανΤ	Lecture
Hrs/wk	
СР	4
	Independent Study Time 78, Study Time in Lecture 42
Lecturer	
Language	DE
Cycle	
-	prestressed structures
	 basis of prestressed structures, field of application differences between reinforced and prestressed concrete structures history of prestressing construction materials: concrete, tendons, ducts, anchorage systems construction: prestressing methods prestressing forces and member forces (friction, elongation)
	 tendon layout time dependant prestressing losses design of prestressed structures design of anchorage region non-bonded prestressing prestressed flat slabs
	Concrete bridges history of bridges design of bridges loads on bridges loads on bridges member forces for slab, T-beam, hollow box, frame and arch bridges precast bridges - precast segmental bridges bearings abutments, columns construction methods damages - checking of bridges
Literature	 Vorlesungsumdruckim STUDiP Rombach, G. (2003): Spannbetonbau. Ernst & Sohn, Berlin Wicke, M. (2002): Anwendung des Spannbetons. Betonkalender 2002, Teil II, S. 113-180, Verlag Ernst & Sohn, Berlin Leonhardt, F. (1980): Vorlesungen über Massivbau. Teil 5: Spannbeton. Berlin Mehlhorn, G. (2007): Handbuch Brücken, Springer Verlag Schäfer, H.; Kaufeld, K. (1997): Massivbrücken. Betonkalender Teil II, S. 443ff, Ernst & Sohn, Berlin Menn, Ch. (1986): Stahlbetonbrücken. Springer Verlag, Wien

Course L0604: Design of Pre	ourse L0604: Design of Prestressed Structures and Concreet Bridges	
Тур	Recitation Section (large)	
Hrs/wk	2	
CP	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	NN	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Courses				
Title		Тур	Hrs/wk	СР
Soil Mechanics - Selected Topics (L	0374)	Lecture	2	2
Soil Dynamics (L0452)		Lecture	2	2
Experimental Researches in Geoted	hnics (L0706)	Practical Course	2	2
Module Responsible	Prof. Jürgen Grabe			
Admission Requirements	None			
Recommended Previous	Modules: Mathematics I-III, Mechanics I-II, Geoter	chnics I		
Knowledge	Courses: Soil laboratory course, (Applied structu	ral dynamics)		
Educational Objectives	After taking part successfully, students have rea	ched the following learning results		
Professional Competence				
Knowledge	Students will be able to,			
	 describe wave propagation in the ground to measure vibrations and to interpret the justify when elastodynamic methods are s to reproduce the collapse theorems of pla describe the viscous behavior of cohesis shear strengths as well as to determine the effect of partial 	data obtained with regard to their effe ufficient and when plastodynamic effect sticity theory, ve soils and computationally account to	ct on people and struc ts must be taken into for creep deformation	tures, account,
Skills	Skills After the successful completion of the module the students should be able to:			
	• to derive and apply the basic equation of	a simple mass oscillator,		
	 to understand the wave propagation in the 	e soil under dynamic excitation and to o	detect the relevant par	rameters,
	 to know the essential laboratory and field 	tests to determine soil dynamic charac	teristics and to evaluat	te them,
	 to design machine foundations to dynamic 	c load,		
	 to measure shocks to perform vibration for 	recast,		
	 to evaluate shocks in terms of their effect 	on people and buildings,		
	 to evaluate possibilities of isolation, 			
	 to understand mechanisms that cause ear 	thquakes and evaluate earthquakes in	terms of their magnitu	ide and intensity,
	 to know methods to determine axial pile of 	apacity, integrity, and the dynamic bed	lding modulus,	
	 to know the mechanisms that lead to a demathematically, 	eformation accumulation due to cyclic l	oading and to estimat	e these deformatio
	 to distinguish the area of application of th 	e method of elastodynamics and plasto	dynamics,	
	 to detect the undrained shear strength as 	a function of a number of state variable	es,	
	 to capture the visous behaviour of cohesi calculations, 	ve soils and to consider the effects of c	reep and rate-depend	ent shear strength
	 to consider the impact of the partly satura 	ited of a seepage and shear strength.		
Personal Competence				
Social Competence	Students will be able to work in teams to achie	ve results on measurement and experi	mental principles and	present their resu
	together at the end of the semester.			
Autonomy	Students are able to assess their own strengths	and weaknesses and organize their time	e and learning manage	ement based on thi
Workload in Hours	Independent Study Time 96, Study Time in Lectu	ire 84		
Credit points	6			
Course achievement	,	Description Ind		
Evamination	practical work			
Examination	Written exam			
Examination duration and scale	135 min			
Assignment for the	Civil Engineering: Specialisation Structural Engin	eering: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Structural Engine			
. Showing curriculd	Civil Engineering: Specialisation Coastal Enginee			
	Civil Engineering: Specialisation Coastal Engineer			

Course L0374: Soil Mechanic	s - Selected Topics
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Hans Mathäus Stanford
Language	DE
Cycle	SoSe
Content	selected topis:
Literature	 Stress-strain behaviour (experiments, observations, models) Hydraulic behaviour (experiments, observations, models) Physical modelling (similarity theory, 1g model tests, ng model tests) Limit and safety analysis (collapse theorems of plasticity theory, upper and lower bound analysis, limit equilibrium analysis, numerical analysis) Heat transport (heat conduction, convective heat transport, freezing/thawing) Kolymbas D. (2019): Geotechnik - Bodenmechanik, Grundbau und Tunnelbau. Springer Verlag, 5. Auflage Muir Wood D. (2004). Geotechnical modelling. CRC Press Nova, R. (2010). Soil mechanics. Wiley Verruijt, A. (2012). Soil mechanics. u r l: https://geo.verruijt.net
	Verruijt, A. (2012). Soli mechanics. u Fi: https://geo.verruijt.net Verrujit A. (2018). An introduction to soil mechanics. Vol. 30, Springer Series Theory and Applications of Transport in Porous Media

Course L0452: Soil Dynamics	
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Anne Hagemann
Language	DE
Cycle	SoSe
Content	• mass-spring-damper systems,
	• wave propagation in soils,
	• dynamic soil parameters,
	• Determination of dynamic soil parameters,
	• machine foundations,
	• in-situ measurement of ground motion, ground motion prediction, evaluation of ground motion,
	• ground motion shielding,
	introduction into earthquake engineering,
	• dynamic pile tests,
	• cyclic accumulation,
	• plastodynamics
Literature	 Das B.M.: Fundamentals of Soil Dynamics, Elsevier Empfehlungen des Arbeitskreises Baugrunddynamik. Hrsg. Deutsche Gesellschaft für Geotechnik (DGGT) Haupt W.: Bodendynamik. Vieweg und Teubner Meskouris K. und Hinzen KG.: Bauwerke und Erdbeben. Vieweg Verlag Studer J.A., Koller M.G. und Laue J.: Bodendynamik, Springer Verlag

Course L0706: Experimental	Researches in Geotechnics
Тур	Practical Course
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Hans Mathäus Stanford, Göta Bürkner
Language	DE
Cycle	SoSe
	 The students are supposed to: become acquainted with geotechnical model tests, field tests and laboratory tests as well as corresponding measurement techniques. These compromise amongst others inclinometer measurements and geophone measurements as well as high-grade laboratory tests on the stress-strain relationship of soil specimens, e. g. triaxial tests, simple shear tests and resonant column tests. gain insight into current soil mechanical research. plan, coordinate, perform and evaluate soil mechanical tests in a team. discuss, reflect, review and present the obtained results in a group. An important learning target is the introduction to scientific work for students who plan a scientific career, and for those who will
	work in practice with the responsibility to order corresponding tests and evaluate the results. The practical laboratory work is based on annualy changing problems, which are however related to the experience and results of the preceding year's course group.
Literature	 - Grabe, J. (2004): Bodenmechanik und Grundbau, Band 3 der Veröffentlichungsreihe des Instituts für Geotechnik und Baubetrieb, Technische Universität Hamburg-Harburg. - Kolymbas, D. (2007): Geotechnik - Bodenmechanik, Grundbau und Tunnelbau. 2., korrigierte und ergänzte Auflage, Springer Verlag.
	 Normen zu geotechnischen Versuchsgeräten und Versuchsverfahren: - DIN 18135:2012-04: Baugrund, Untersuchung von Bodenproben - Eindimensionaler Kompressionsversuch, Deutsches Institut für Normung, e. V. - DIN 18137-2:2011-04: Baugrund, Untersuchung von Bodenproben - Bestimmung der Scherfestigkeit - Teil 2: Triaxialversuch, Deutsches Institut für Normung e. V.

Module M0827: Mode	ling in Water Management			
Courses				
Title		Тур	Hrs/wk	СР
Groundwater Modeling using Modfle		Lecture	1	1
Groundwater Modeling using Modfle Modeling of Water Supply Network		Recitation Section (small) Project-/problem-based Learning	2 2	2 3
Module Responsible			2	5
Admission Requirements				
Recommended Previous				
Knowledge	oroundwater			
	 groundwater hydraulics and transport of su 	bstances		
	Pipe Systems			
		s, in particular drinking water systemsand u	irban drainag	e systems including
	special structures			
	Hydraulics of drinking water supply system:Basic knowledge on water management	s and sewer systems		
	Basic knowledge on water management			
Educational Objectives	After taking part successfully, students have reach	ned the following learning results		
Professional Competence				
Knowledge	The students are able to describe the modelling of	f groundwater flow and transport as well as urb	oan water infra	astructures. They ca
	carry out systems analyses and can detect techni	cal and conceptual weak points within the sys	tems in case	studies. Besides the
	are able to analyse interdependencies of hydrauli	c and toxic phenomena in soil and water.		
Skills	The students are able to construct and apply scientific groundwater models indipendently. They can work on differen			
and can compare or assess different solutions for existing problems by application of selected software products. T		cts. The students are		
	able to use different software solutions (e.g. EPAN	ET, EPA-SWMM).		
Personal Competence				
Social Competence	Wird nicht vermittelt.			
Autor	Wird nicht vormittalt			
Аисопоту	Wird nicht vermittelt.			
Workload in Hours	Independent Study Time 110, Study Time in Lectu	re 70		
Credit points	6			
Course achievement	None			
Examination	Oral exam			
Examination duration and	30 min			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Engine	ering: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Eng	ineering: Elective Compulsory		
	Civil Engineering: Specialisation Coastal Engineeri	• • •		
	Civil Engineering: Specialisation Water and Traffic			
	Civil Engineering: Specialisation Computational En			
	Water and Environmental Engineering: Specialisat			
	Water and Environmental Engineering: Specialisat			
	Water and Environmental Engineering: Specialisat	ion water: Elective Compulsory		

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

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

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

Courses				
Title		Тур	Hrs/wk	СР
Noise Protection (L1109) Urban Infrastructures (L0874)		Lecture Project-/problem-based Learning	2 2	2 4
		Project-/problem-based Learning	Z	4
•	Dr. Dorothea Rechtenbach			
Admission Requirements	None			
Recommended Previous	Knowledge on Urban planning			
Knowledge	 Knowledge on measures for climate protection 			
	 General knowledge of scientific writing/working 			
	After taking part successfully, students have reached the followi	ng learning results		
Professional Competence				
Knowledge	Students can describe urban development corridors as well as c	urrent and future urban environ	mental probler	ns. They are able
	explain the causes of environmental problems (like noise).			
	Students can specify applications for various technical innovatio		bute to the im	provement of urb
	life. They can, for example, derive and discuss measures for effe	ective noise abatement.		
Skills	kills Students are able to develop specific solutions for correcting existing or future environment-related problems development. They can define a range of conceptual and technical solutions for environmental problems for different development.		problems of urb	
	paths. To solve specific urban environmental problems they can select technical innovations and integrate them into			hem into the urb
	context.			
Personal Competence				
Social Competence	The students can work together in international groups.			
			21. 12	
Autonomy	Students are able to organize their work flow to prepare thems		cributions to tr	ie discussions. Tr
	can acquire appropriate knowledge by making enquiries indeper	identiy.		
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: Elect	ive Compulsory		
	Civil Engineering: Specialisation Coastal Engineering: Elective Co	ompulsory		
	Civil Engineering: Specialisation Water and Traffic: Elective Com	pulsory		
	Environmental Engineering: Core Qualification: Elective Compuls	sory		
	Joint European Master in Environmental Studies - Cities and Sust	ainability: Core Qualification: Co	mpulsory	
	Logistics, Infrastructure and Mobility: Specialisation Infrastructur	e and Mobility: Elective Compuls	ory	
	Water and Environmental Engineering: Specialisation Environme	nt: Elective Compulsory		

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

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

Courses				
Title		Тур	Hrs/wk	СР
Harbour Engineering (L0809)		Lecture	2	2
Harbour Engineering (L1414)		Project-/problem-based Learning	1	2
Port Planning and Port Construction	n (L0378)	Lecture	2	2
Module Responsible	Prof. Peter Fröhle			
Admission Requirements	None			
Recommended Previous	Basics of coastal engineering			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the foll	owing learning results		
Professional Competence				
Knowledge	The students are able to define in details and to choose des	ign approaches for the functional c	lesign of a po	rt and apply them
	design tasks. They can design the fundamental elements of a	port.		
CI-III-				
SKIIIS	The students are able to select and apply appropriate approaches for the functional design of ports.			
Personal Competence				
Social Competence	The students are able to deploy their gained knowledge in	applied problems such as the funct	tional design	of ports. Additiona
	they will be able to work in team with engineers of other disc	plines.		
Autonomy	The students will be able to independently extend their know	ledge 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 examinat	on includes tasks with respect to	the general u	understanding of
scale	lecture contents and calculations tasks.			
Assignment for the	Civil Engineering: Specialisation Structural Engineering: Elect	ive Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering: E	ective Compulsory		
	Civil Engineering: Specialisation Coastal Engineering: Compu	sory		
	Civil Engineering: Specialisation Water and Traffic: Elective C	ompulsory		
	International Management and Engineering: Specialisation II.	Civil Engineering: Elective Compuls	onv	

Course L0809: Harbour Engineering	
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Peter Fröhle
Language	DE
Cycle	SoSe
Content	 Fundamentals of harbor engineering Maritime transportation and waterways engineering Ships Elements of harbors Harbor approaches and water-side harbor areas Terminal design and handling of cargo Quay-walls and piers Equipment of harbors Sluices and other special constructions Connection to inland transportation / inland waterway transportation Protection of harbors Breakwaters and Jetties Wave protection of harbors Fishery and other small harbors
Literature	Brinkmann, B.: Seehäfen, Springer 2005

Course L1414: Harbour Engi	urse L1414: Harbour 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	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Lecturer F Language [ndependent Study Time 32, Study Time in Lecture 28 irank Feindt
Vorkload in Hours Lecturer Language	ndependent Study Time 32, Study Time in Lecture 28 irank Feindt
Lecturer F Language [rank Feindt
Language	
Cycle S	
	oSe
Lecture Frank Feindt Language DE Cycle SoSe Content Planning and implementation of major projects Market analysis and traffic relations Planning process and plan Port planning in urban neighborhood Development of the logistics center "Port of Hamburg" in the metropolis Quays and waterfront structure Special planning Law Harbor - securing of a flexible use of the port Dimensioning of quays Flood protection structures Port of Hamburg - Infrastructure and development Preparation of areas Scour formation in front of shore structures 	

Courses					
Title		Түр	Hrs/wk	СР	
Hydraulic Models (L0813)		Project-/problem-based Learning	1	1	
Modelling of Waves (L0812)		Project-/problem-based Learning	1	1	
Modelling of Flow in Rivers and Est	uaries (L0810)	Lecture	3	4	
Module Responsible	Prof. Peter Fröhle				
Admission Requirements	None				
Recommended Previous	Coastal Hydraulic Engineering I				
Knowledge					
Educational Objectives	After taking part successfully, students have reached the following part successfully and the students have reached the following part successfully and the students have reached the students have been successfully as the students have reached the students have been successfully as the stude	owing learning results			
Professional Competence					
Knowledge	Knowledge Students are able to define in detail the basic processes that are related to the modelling of flows in hydro			ydraulic engineerir	
	Besides, they can describe the basic aspects of numerical modelling and actual numerical models for the simulation of flows and				
	waves.				
Skills	Students are able to apply hydrodynamic-numerical models t	o practical hydraulic engineering ta	ckc		
JKIIIS	students are usic to upply hydrodynamic-hamenear models t	b practical hydraulic clighteering ta	585.		
Personal Competence					
Social Competence	The students are able to deploy their gained knowledge in si	mple applied problems. Additionaly	, they will be able to work in tea		
	with others.				
Autonomy	The students will be able to independently extend their know	ledge 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 3 hours. The examination	on includes tasks with respect to	the general ι	understanding of t	
scale	lecture contents and calculations tasks.				
Assignment for the	Civil Engineering: Specialisation Structural Engineering: Elect	ve Compulsory			
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering: El	ective Compulsory			
	Civil Engineering: Specialisation Coastal Engineering: Elective	Compulsory			
	Civil Engineering: Specialisation Computational Engineering:				

Course L0813: Hydraulic Mod	dels
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	DE/EN
Cycle	SoSe
Content	 Fundamentals of hydraulic models Model laws Pi theorem of Buckingham Practical examples of hydraulic models
Literature	Strobl, Zunic: Wasserbau, Kap. 11 Hydraulische Modelle, Springer

Course L0812: Modelling of	Waves		
Тур	Project-/problem-based Learning		
Hrs/wk	1		
СР	1		
Workload in Hours	endent Study Time 16, Study Time in Lecture 14		
Lecturer	Prof. Peter Fröhle		
Language	DE/EN		
Cycle	SoSe		
Content	 Waves, interactions with shallow water and constructions Wave theories Sea state and surges Development of waves Wave spectra Modelling of Waves / phase averaged and phase resolved models Application of a phase averaged model for wave prediction (SWAN) Application of phase resolved wave models (Mike) 		
Literature	Vorlesungsumdruck		

-	Flow in Rivers and Estuaries
	Lecture
Hrs/wk	
СР	4
	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
	Bund der Ingenieure für Wasserwirtschaft, Abfallwirtschaft und Kulturbau (1997): Hydraulische Berechnung von naturnaher 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 de 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 fü Wasserwirtschaft und Kulturbau. Bonn: Wirtschafts- und VerlGes. Gas und Wasser (Schriftenreihe des Deutschen Verbandes für Wasserwirtschaft und Kulturbau, 127).

Module M0874: Waste	ewater Systems					
-	-					
Courses						
Title		Ту		Hrs/wk	СР	
Biological Wastewater Treatment (I			cture	2	2	
Biological Wastewater Treatment (citation Section (large)	1 2	1	
Advanced Wastewater Treatment (Advanced Wastewater Treatment (
Module Responsible		ne	citation Section (large)	Ŧ	Ŧ	
Admission Requirements	None					
	Knowledge of wastewater management	and the key processes invol	ved in wastewater treatr	nent		
Knowledge	Knowledge of wastewater management	and the key processes invol	ved in wastewater treati	nent.		
	After taking part successfully, students h	any reached the following l	oproing results			
	After taking part successfully, students h	lave reached the following i	earning results			
Professional Competence						
Knowledge	Students are able to outline key areas o	-	•	-		
	dependence for sustainable water protection. They can describe relevant economic, environmental and social factors.					
Skills	Students are able to pre-design and explain the available wastewater treatment processes and the scope of their application in					
	municipal and for some industrial treatment plants.					
Personal Competence						
Social Competence	Social skills are not targeted in this mode	ule.				
Autonomy	Students are in a position to work on a	a subject and to organize t	their work flow indepen	dently They can	also present on th	
, lacenemy	subject.		anen ment neu maepen			
Workload in Hours	Independent Study Time 96, Study Time	in Lecture 84				
Credit points						
Course achievement	None					
Examination	Written exam					
Examination duration and	120 min					
scale						
Assignment for the	Civil Engineering: Specialisation Structur	ral Engineering: Elective Cor	mpulsory			
Following Curricula	Civil Engineering: Specialisation Geotech	nnical Engineering: Elective	Compulsory			
	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory					
	Civil Engineering: Specialisation Water and Traffic: Compulsory					
	Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory					
	Environmental Engineering: Specialisation Water Quality and Water Engineering: Elective Compulsory					
	International Management and Engineering: Specialisation II. Process Engineering and Biotechnology: Elective Compulsory					
	International Management and Engineering: Specialisation II. Energy and Environmental Engineering: Elective Compulsory					
	Process Engineering: Specialisation Envi	ronmental Process Engineer	ing: Elective Compulsory	/		
	Process Engineering: Specialisation Proc	ess Engineering: Elective Co	ompulsory			
	Water and Environmental Engineering: S	Specialisation Water: Compu	llsory			
	Water and Environmental Engineering: S	Specialisation Environment:	Elective Compulsory			
	Water and Environmental Engineering: S	Specialisation Cities: Compu	lsory			

Course L0517: Biological Wa	rse 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
Weinheim : WILEY-VCH, 2007
TUB_HH_Katalog

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

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

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

		Hrs/wk	СР
t-/problem-based Learni	ng (L1066)		6
	Iodule Responsible Prof. Carsten Gertz		
	sion Requirements None		
	mmended Previous for "Principles of Urban Planning": none		
	Knowledge		
ning, e.g. through taki	for "Designing Urban Streetscapes": some knowledge of t	g. through taking the undergrad	duate class "Tran
	Planning and Traffic Engineering"		
ming results	cational Objectives After taking part successfully, students have reached the	esults	
	sional Competence		
	Knowledge Students are able to:		
	 use technical terms of urban planning. 		
	describe the main determinants of urban developm		
oment can be influence	explain and compare different possibilities of how u	can be influenced.	
	 discuss requirements for public streetscapes. 		
	explain the importance of street design.		
	Skills Students are able to:		
streetscapes	 read and analyze urban development concepts and 	capes	
	 appraise such concepts in the context of competing 	•	
	 design, justify and reflect their own solutions for co 		
	rsonal 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:		
owing a broadly pre-de	independently complete a written report including	a broadly pre-defined process.	
a analala se se s	 assess the consequences of their proposed solution 	1	
or problem areas.	 independently acquire knowledge and apply this to 	iem areas.	
	Workload in Hours Independent Study Time 124, Study Time in Lecture 56		
	Credit points 6		
	ourse achievement None		
	Examination Written elaboration		
	action duration and written assignment, designwork during the semester scale		
ulsory	Assignment for the Civil Engineering: Specialisation Structural Engineering: E		
	Following Curricula Civil Engineering: Specialisation Geotechnical Engineering	ory	
ory	Civil Engineering: Specialisation Coastal Engineering: Elec		
/	Civil Engineering: Specialisation Water and Traffic: Electiv		
Mobility: Elective Com	Logistics, Infrastructure and Mobility: Specialisation Infras	y: Elective Compulsory	
ctive Compulsory	Water and Environmental Engineering: Specialisation Env	Compulsory	
Mobility: El ctive Comp	Logistics, Infrastructure and Mobility: Specialisation Infras		

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

Courses					
Title	Тур)	Hrs/wk	СР	
Construction Logistics (L1163)	Lect	ure	1	2	
Construction Logistics (L1164)		tation Section (small)	1	2	
Project Development and Managen		ure ect-/problem-based Learning	1	1	
Project Development and Managen		ect-/problem-based Learning	1	1	
Module Responsible					
Admission Requirements Recommended Previous					
Kecommended Previous Knowledge	none				
	After taking part successfully, students have reached the following lea	arping recults			
Educational Objectives	After taking part successiony, students have reached the following lea	arning results			
Professional Competence	Students con				
Knowledge	Students can				
	• give definitions of the main terms of construction logistics and	project development and m	anagement		
	 name advantages and disadvantages of internal or external co 	nstruction logistics			
	explain characteristics of products, demand and production of	construction objects and the	eir consequer	nces for constructio	
	specific supply chains				
	 differentiate constructions logistics from other logistics system 	S			
Skills	Students can				
	carry out project life cycle assessments				
	 apply methods and instruments of construction logistics 				
	apply methods and instruments of project development and methods	anagement			
	apply methods and instruments of conflict management				
	 design supply and waste removal concepts for a construction p 	project			
Personal Competence					
Social Competence	Students can				
	hold presentations in and for groups	- 1			
	 apply methods of conflict solving skills in group work and case 	studies			
Autonomy	Students can				
	 solve problems by holistic, systemic and flow oriented thinking improve their graptivity, prosting skills, conflict and graps 		mothoda of	moderation in car	
	 improve their creativity, negotiation skills, conflict and crises studies 	s solution skills by applying	methous of	moderation in cas	
	Studies				
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56				
Credit points	6				
Course achievement	None				
Examination	Written elaboration				
Examination duration and	Two written papers with presentations				
scale					
Assignment for the	Civil Engineering: Specialisation Structural Engineering: Elective Com	pulsory			
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering: Elective C	ompulsory			
	Civil Engineering: Specialisation Coastal Engineering: Elective Compu	lsory			
	Civil Engineering: Specialisation Water and Traffic: Elective Compulso	ry			
	International Management and Engineering: Specialisation II. Civil Eng	gineering: Elective Compulso	ory		
	International Management and Engineering: Specialisation II. Logistics	s: Elective Compulsory			
	Logistics, Infrastructure and Mobility: Specialisation Production and Lo	ogistics: Elective Compulsory	/		
	Logistics, Infrastructure and Mobility: Specialisation Infrastructure and	d Mobility: Elective Compuls	orv		

Course L1163: Construction	Logistics
Тур	Lecture
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Heike Flämig
Language	DE
Cycle	SoSe
Content	The lecture gives deeper insight how important logistics are as a competetive factor for construction projects and which issues are to be adressed. The following toppics are covered: • competetive factor logistics • the concept of systems, planning and coordination of logistics • material, equipment and reverse logistics • IT in construction logistics
	 elements of the planning model of construction logistics and their connections flow oriented logistics systems for construction projects logistics concepts for ready to use construction projects (especially procurement and waste removel logistics) best practice examples (construction logistics Potsdamer Platz, recent case study of the region) Contents of the lecture are deepened in special exercises.
Literature	 Flämig, Heike: Produktionslogistik in Stadtregionen. In: Forschungsverbund Ökologische Mobilität (Hrsg.) Forschungsbericht Bd 15.2. Wuppertal 2000. Krauss, Siri: Die Baulogistik in der schlüsselfertigen Ausführung, Bauwerk Verlag GmbH Berlin 2005. Lipsmeier, Klaus: Abfallkennzahlen für Neubauleistungen im Hochbau : Verlag Forum für Abfallwirtschaft und Altlasten, 2004. Schmidt, Norbert: Wettbewerbsfaktor Baulogistik. Neue Wertschöpfungspotenziale in der Baustoffversorgung. In: Klaus, Peter: Edition Logistik. Band 6. Deutscher Verkehrs-Verlag. Hamburg 2003. Seemann, Y.F. (2007): Logistikkoordination als Organisationseinheit bei der Bauausführung Wissenschaftsverlag Mainz in Aachen, Aachen. (Mitteilungen aus dem Fachgebiet Baubetrieb und Bauwirtschaft (Hrsg. Kuhne, V.): Heft 20)

Course L1164: Construction Logistics		
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	2	
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14	
Lecturer	Prof. Heike Flämig	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L1161: Project Develo	opment and Management
Тур	Lecture
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Heike Flämig, Dr. Anton Worobei
Language	DE
Cycle	SoSe
Content	Within the lecture, the main aspects of project development and management are tought:
	Terms and definitions of project management
	 Advantages and disadvantages of different ways of project handling
	 organization, information, coordination and documentation
	 cost and fincance management in projects
	time- and capacity management in projects
	 specific methods and instruments for successful team work
	Contents of the lecture are deepened in special exercises.
Literature	Projektmanagement-Fachmann. Band 1 und Band 2. RKW-Verlag, Eschborn, 2004.

Course L1162: Project Devel	rse L1162: Project Development and Management			
Тур	Project-/problem-based Learning			
Hrs/wk	1			
СР	1			
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14			
Lecturer	Prof. Heike Flämig, Dr. Anton Worobei			
Language	DE			
Cycle	SoSe			
Content	See interlocking course			
Literature	See interlocking course			

Courses				
Title		Тур	Hrs/wk	СР
Structural Dynamics (L1202)		Lecture	2	2
Structural Dynamics (L1203)		Recitation Section (large)	2	2
Fracture mechanics and fatigue in		Lecture	1	1
Fracture mechanics and fatigue in	steel structures (L0565)	Recitation Section (large)	1	1
Module Responsible	Prof. Bastian Oesterle			
Admission Requirements	None			
Recommended Previous	Knowledge of linear structural analysis of	f statically determinate and indeterminate structu	ures; Mechanics	I/II, Mathematics
Knowledge	Differential equations I			
Educational Objectives	After taking part successfully, students have	ve reached the following learning results		
		ve reached the following learning results		
Professional Competence		- the student concerns the basis concerns of d		
Knowledge	respective methods.	e, the student can explain the basic aspects of d	ynamic enects o	n structures and
<i>Skills</i> Personal Competence <i>Social Competence</i>	dynamics loading using the appropriate co	ule, the students will be able to predict the res mputational approaches and methods.	ponse of materi	al and structures
,				
	 participate in subject-specific and in 	terdisciplinary discussions,		
	 defend their own work results in from 	nt of others		
	promote the scientific development	of colleagues		
	Furthermore, they can give and account of the second	ept professional constructive criticism		
Autonomy	Students are able to gain knowledge of th	e subject area from given and other sources and a	only it to new pr	oblems Furthermo
hatehenny		cess for problems in the area of Structural Analysis.		blems. Fulleme
	they are usic to structure the solution proc			
Workload in Hours	Independent Study Time 96, Study Time in	Lecture 84		
Workload in Hours Credit points		Lecture 84		
	6	Lecture 84		
Credit points Course achievement	6	Lecture 84		
Credit points Course achievement	6 None Written exam	Lecture 84		
Credit points Course achievement Examination	6 None Written exam	Lecture 84		
Credit points Course achievement Examination Examination duration and scale	6 None Written exam			
Credit points Course achievement Examination Examination duration and scale	6 None Written exam 150 min Civil Engineering: Specialisation Structural	Engineering: Compulsory		
Credit points Course achievement Examination Examination duration and scale Assignment for the	6 None Written exam 150 min Civil Engineering: Specialisation Structural Civil Engineering: Specialisation Geotechni	Engineering: Compulsory cal Engineering: Elective Compulsory		
Credit points Course achievement Examination Examination duration and scale Assignment for the	6 None Written exam 150 min Civil Engineering: Specialisation Structural Civil Engineering: Specialisation Geotechni Civil Engineering: Specialisation Coastal Er	Engineering: Compulsory cal Engineering: Elective Compulsory ngineering: Elective Compulsory		
Credit points Course achievement Examination Examination duration and scale Assignment for the	6 None Written exam 150 min Civil Engineering: Specialisation Structural Civil Engineering: Specialisation Geotechni	Engineering: Compulsory cal Engineering: Elective Compulsory ngineering: Elective Compulsory I Traffic: Elective Compulsory		

Course L1202: Structural Dy	namics			
Тур	Lecture			
Hrs/wk	2			
СР	2			
Workload in Hours	ependent Study Time 32, Study Time in Lecture 28			
Lecturer	Prof. Bastian Oesterle			
Language	DE			
Cycle	SoSe			
Content	 mechanical background of dynamics harmonic vibrations, damped and undamped free and forced vibrations frequency and time domain modelling aspects principle of d'Alembert systems with multiple degrees of freedom consistent and lumped mass matrices finite elements for dynamics problems impact problems eigenvalue problems and modal analysis direct time integration schemes, transient analyses 			
Literature	 Vorlesungsmanuskript Clough, R.W., Penzien, J.: Dynamics of Structures. 2. Aufl., McGraw-Hill, New York, 1993. 			

Course L1203: Structural Dy	Course L1203: Structural Dynamics		
Тур	Recitation Section (large)		
Hrs/wk	2		
СР	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Prof. Bastian Oesterle		
Language	DE		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Тур	Lecture
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dr. Jürgen Priebe
Language	DE
Cycle	SoSe
Content	 basics of fatigue stress and fatigue resistance and determination of fatigue strength,
	 determination and use of S-N-curves and classification of notch effects,
	set up of determination of fatigue strength under dynamic load using the accumulation formula by Palmgren-Miner,
	 set up of determination of fatigue strength in different examples,
	 basics of construction and design regarding the problem of material fatigue,
	 basics of linear elastic fracture mechanics under static and dynamic load,
	determination of lifetime of steel construction based on linear elastic fracture mechanics in different examples.
Literature	Seeßelberg, C.; Kranbahnen - Bemessung und konstruktive Gestaltung; 3. Auflage; Bauwerk-Verlag; Berlin 2009
	Kuhlmann, Dürr, Günther; Kranbahnen und Betriebsfestigkeit; in Stahlbau Kalender 2003; Verlag Ernst & Sohn; Berlin 200
	Deutscher Stahlbau-Verband (Hrsg.); Stahlbau Handbuch Band 1 Teil B; 3. Auflage; Stahlbau-Verlagsgesellschaft; Köln 19
	Petersen, C.; Stahlbau; 3. überarb. und erw. Auflage; Vieweg-Verlag; Braunschweig 1993
	 DIN V ENV 1993-1-1: Eurocode 3; Bemessung und Konstruktion von Stahlbauwerken; Teil 1-1: Allgemeine Bemessungsre Bemessungsregeln für den Hochbau; 1993
	• DIN V ENV 1993-6: Eurocode 3; Bemessung und Konstruktion von Stahlbauwerken; Teil 6: Kranbahnen; 2001
	• DIN-Fachbericht 126. Richtlinie zur Anwendung von DIN V ENV 1993-6; Nationales Anwendungsdokument (NAD); Berlin 20

Course L0565: Fracture mec	Course L0565: Fracture mechanics and fatigue in steel structures		
Тур	Recitation Section (large)		
Hrs/wk	1		
СР	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Dr. Jürgen Priebe		
Language	DE		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Module M0593: Building Materials and Building Preservation

Courses						
Title			Тур		Hrs/wk	СР
Repair of Structures (L0255)			Lecture		1	1
Mineral Building Materials (L0253)			Lecture		2	2
Technology of mineral Building Mat	erials (L0256)		Project-/problem-	based Learning	1	2
Transport Processes in Building Ma	erials and Damage Processes (L02	254)	Lecture		1	1
Module Responsible	Prof. Frank Schmidt-Döhl					
Admission Requirements	None					
Recommended Previous	Basic knowledge about buildin	ng materials, buildir	ng physics and building chem	nistry, for examp	ole by the m	nodules Principles
Knowledge	Building Materials and Building	Physics and Buildin	g Materials and Building Chem	istry.		
Educational Objectives	After taking part successfully,	students have reach	ed the following learning result	ts		
Professional Competence						
Knowledge	The students are able to descr	ibe the components	of mineral building materials a	nd their function	in detail and	d to use them for t
	manufacture of special minera	l building materials.	They are able to show the cha	racteristics of mi	neral building	g materials. They a
	able to describe the manufactu	ire, properties and f	ields of application of special n	nortars and spec	ial concretes	and the correlation
	of their material parameters. T	hey are able to show	v the principles of anchor techr	nology and desig	n.	
Chille	The students are able to perfe	m on optimization of	of aronulomotry of a minoral h	uilding material	They are abl	a ta dacian a chac
SKIIIS	The students are able to perform an optimization of granulometry of a mineral building material. They are able to design a special					
	mineral mortar and to manufacture this mortar. The students are able to manufacture post installed rebar connections. They are					
	able to recognize damages, to assess possible causes, to use the fundamentals of construction preservation and to se and strengthening measures.					and to select rep
Personal Competence						
Social Competence						
	other students. In a critical di	-	d and adjust their results. Th	e students are a	ible to manu	facture their spec
	building material on the basis of	of this feedback.				
Autonomy	The students are able to respo	onsibly use the resou	urces of materials and lab equ	ipment for their	project and 1	o investigate and
	get missing components.					
Workload in Hours	Independent Study Time 110, 9	Study Time in Lectur	re 70			
Credit points	6					
Course achievement	Compulsory Bonus Form		Description			
	Yes 20 % Subject	theoretical and	1			
	practica	al work				
Examination	Written exam					
Examination duration and	120 min					
scale						
Assignment for the	Civil Engineering: Specialisatio	n Geotechnical Engi	neering: Compulsory			
Following Curricula	Civil Engineering: Specialisatio	n Coastal Engineerin	g: Elective Compulsory			
	Civil Engineering: Specialisatio	n Structural Enginee	ring: Elective Compulsory			
	Civil Engineering: Specialisatio					

Course L0255: Repair of Structures	
Тур	Lecture
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Frank Schmidt-Döhl
Language	DE
Cycle	SoSe
Content	Maintenance of structures, repair and strengthening, subsequent waterproofing of structures
Literature	BetonMarketing Deutschland (Hrsg.): Stahlbetonoberflächen - schützen, erhalten, instandsetzen

Course L0253: Mineral Buildi	ing Materials
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Frank Schmidt-Döhl
Language	DE
Cycle	SoSe
Content	Components of mineral building materials and their function, binding materials, concrete and mortar, special mortars, special concretes
Literature	Taylor, H.F.W.: Cement Chemistry
	Springenschmid, R.: Betontechnologie für die Praxis

Course L0256: Technology of	Course L0256: Technology of mineral Building Materials	
Тур	Project-/problem-based Learning	
Hrs/wk	1	
СР	2	
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14	
Lecturer	Prof. Frank Schmidt-Döhl	
Language	DE	
Cycle	SoSe	
Content	Design and production of a special mineral building material	
Literature	Taylor, H.F.W.: Cement Chemistry	
	Springenschmid, R.: Betontechnologie für die Praxis	

Course L0254: Transport Pro	Course L0254: Transport Processes in Building Materials and Damage Processes	
Тур	Lecture	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Frank Schmidt-Döhl	
Language	DE	
Cycle	SoSe	
Content	Transport Processes in Building Materials and Damage Processes	
Literature	Blaich, J.: Bauschäden, Analyse und Vermeidung	

Courses				
Fitle		Тур	Hrs/wk	СР
Steel Construction Project (L1206)		Project Seminar	4	6
Module Responsible	Prof. Marcus Rutner			
Admission Requirements	None			
Recommended Previous	Steel and Composite Structures			
Knowledge				
Educational Objectives	After taking part successfully, students h	ave reached the following learning results		
Professional Competence				
Knowledge	Students are able to prepare a part of th	e whole project and explain it to the others.		
Skills	Students can produce sketches and calculations of their part of the project. They are able to adjust their work in reaction			
	changing conditions resulting from other	participants of the project.		
Personal Competence				
Social Competence	Students can present their results to othe	er members of the group.		
	They have the ability to work for a broad	agreement with respect to intergroup depend	lencies.	
	They can distribute and process tasks inc	dependently.		
Autonomy	Students can handle their part of the pro	ject on their own resposibility-		
Workload in Hours	Independent Study Time 124, Study Time	e in Lecture 56		
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
Examination duration and	approx. 15-20 pages (without appendix)			
scale				
Assignment for the	Civil Engineering: Specialisation Geotech	nical Engineering: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Coastal	Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Structur			
	Civil Engineering: Specialisation Compute	ational Engineering: Elective Compulsory		

Course L1206: Steel Constru	Course L1206: Steel Construction Project	
Тур	Project Seminar	
Hrs/wk	4	
СР	6	
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56	
Lecturer	Prof. Marcus Rutner	
Language	DE	
Cycle	SoSe	
Content	Design of a big construction project (i.e skyscraper, large bridge, roof of a stadiuim) in small groups	
Literature	Wird je nach Projekt individuell angegeben.	

Courses				
Title		Тур	Hrs/wk	СР
Marine Geotechnics (L0548)		Lecture	1	2
Marine Geotechnics (L0549) Steel Structures in Foundation and	Hydraulic Engineering (11146)	Recitation Section (large) Lecture	2	2
Module Responsible		Lecture	Z	Z
Admission Requirements				
	Complete modules: Geotechnics I-III, Math	ematics LIII		
Keconniended Previous	Complete modules. Geotechnics I-III, Math			
Riomeuge	Courses: Soil laboratory course			
Educational Objectives	After taking part successfully, students ha	ve reached the following learning results		
Professional Competence				
Knowledge	The students get a deeper knowledge of steel and ground engineering as well as constructions knowledge concerning quay wal			
Furthermore, the students get all the necessary knowledge to design singular construction ele		elements for shee	et pile walls and th	
	know how to choose the right construction	elements depending on the influencing conditions	i.	
Skills	Furthermore, the students are able to dimension sheet pile wall construction regarding all construction elements, to choose			ments to choose t
	suitable construction elements with respect to the influencing conditions, to design all kinds of sheet pile walls (
	walls and combined sheet pile walls) and to dimension all construction elements and connections.			(,
Personal Competence				
Social Competence				
	Students are able to assess their own stre	ngths and weaknesses and organize their time and	learning manage	ment based on thi
, lateriority			icaning manage	
Workload in Hours	Independent Study Time 110, Study Time	in Lecture 70		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	Civil Engineering: Specialisation Geotechni	ical Engineering: Compulsory		
Following Curricula	Civil Engineering: Specialisation Structural	Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Coastal Er	ngineering: Compulsory		
	Civil Engineering: Specialisation Computat	ional Engineering: Elective Compulsory		

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

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

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

Module M0858: Coast	tal Hydraulic Engineering I			
Courses				
Title		Тур	Hrs/wk	СР
Basics of Coastal Engineering (L08		Lecture	3	4
Basics of Coastal Engineering (L14	13)	Project-/problem-based Learn	ing 1	2
Module Responsible	Prof. Peter Fröhle			
Admission Requirements	None			
Recommended Previous	Basics of hydraulic engineering, hydrolog	gy and hydromechanics		
Knowledge				
Educational Objectives	After taking part successfully, students h	nave reached the following learning results		
Professional Competence				
Knowledge	The students are able to define and expl	lain the basic concepts of coastal engineering and po	ort engineering. T	hey are able to app
	the concepts to selected practical proble	ems of coastal engineering. Students can define an	d determine the b	pasics for design a
	dimensioning of coastal engineering con-	structions.		
Skills	The students are capable to apply basic	design approaches to selected and pre-defined desi	gn tasks in coasta	l engineering.
Personal Competence				
•		ained knowledge in applied problems such as the d	lesion of coastal r	protection structur
Social competence		team with engineers of other disciplines, for instance		
			acongrining of cou	
Autonomy	The students will be able to independent	tly extend their knowledge and applyit to new proble	ems.	
Workload in Hours	Independent Study Time 124, Study Time	e in Lecture 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	The duration of the examination is 2 h	nours. The examination includes tasks with respect	to the general u	understanding of t
scale	lecture contents and calculations tasks.			
Assignment for the	Civil Engineering: Specialisation Coastal	Engineering: Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotech	nnical Engineering: Compulsory		
	Civil Engineering: Specialisation Structur	al Engineering: Elective Compulsory		
	Environmental Engineering: Specialisation	on Environment and Climate: Elective Compulsory		
	Environmental Engineering: Specialisation	on Water Quality and Water Engineering: Elective Co	mpulsory	
	International Management and Engineer	ing: Specialisation II. Civil Engineering: Elective Com	pulsory	
	Water and Environmental Engineering: S	pecialisation Environment: Elective Compulsory		
	Water and Environmental Engineering: S	pecialisation Water: Elective Compulsory		

Course L0807: Basics of Coastal Engineering		
Тур	Lecture	
Hrs/wk	3	
СР	4	
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42	
Lecturer	Prof. Peter Fröhle	
Language	EN	
Cycle	SoSe	
Content	Design of planning and design	
	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	
L		

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

Courses				
Courses				
Title Smart Monitoring (L2762)		Typ Integrated Lecture	Hrs/wk	CP 2
Smart Monitoring (L2762) 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 modelin	g programming and sensor technol	ogies are helpful	Interest in mor
Knowledge	research and teaching areas, such as Internet of Thing			
-	skills of scientific working, are required. Basic knowledge			
Educational Objections				
	After taking part successfully, students have reached the	e following learning results		
Professional Competence	The students will become familiar with the principles	and practices of smart monitoring	The students wi	II ha ahla ta da
Kilowiedye	The students will become familiar with the principles decentralized smart systems to be applied for contin	,		
	environment. In addition, the students will learn to design			
	analysis techniques, modern software design concepts, also part of this module, which will be conducted throu			
	students will design smart monitoring systems that integ	-	-	•
	Specific focus will be put on the application of machine			
	real-world (built or natural) systems, such as bridges or			
	every group will be documented in a paper. All students			
	system in the annual "Smart Monitoring" competition. Th	5 1		
	will be taught in English. Limited enrollment.	ie written papers and orar examinate		grades. The mo
Skills	The students will gain insights into operating state-of-th	e-art smart sensor systems, used for	monitoring a wi	de range of phys
	processes relevant to engineering, such as environme	ntal, structural, or comfort monitori	ng. The students	s will be capabl
	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 w			
	be able to document the findings of their projects in sho	rt reports.		
Personal Competence				
	The students will be able to work in groups, share parts	of the work for their projects, and de	evelop communio	ation skills, tow
	achieving the common project goals.			
Autonomy	The students will be able to gain a solid basis on appr		ineering, as well	as on documen
	results, through their involvement in their monitoring gro	oup 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: Elect	ve Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering	ig: Elective Compulsory		
	Civil Engineering: Specialisation Coastal Engineering: Ele	1 5		
	Civil Engineering: Specialisation Structural Engineering:			
	Computer Science: Specialisation II: Intelligence Enginee	• • •		
	Environmental Engineering: Specialisation Energy and R			
	Environmental Engineering: Specialisation Environment			
	Environmental Engineering: Specialisation Water Quality		pulsory	
	Mechatronics: Technical Complementary Course: Electiv	e Compulsory		
	Mechatronics: Core Qualification: Elective Compulsory			
	Theoretical Mechanical Engineering: Specialisation Robo		ompulsory	
	Water and Environmental Engineering: Specialisation Cit			
	Water and Environmental Engineering: Specialisation En Water and Environmental Engineering: Specialisation Wa			

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

Course L2763: Smart Monito	ring
	Recitation Section (small)
Hrs/wk	
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. The course contents couples different fields, such as signal processing, sensing technologies, data analytics, environmental engineering, civil engineering, artificial intelligence, database systems, and many more. The basics will be taught in this course.
	However, specific literature that covers all these topics does not exist. Instead, literature will be referenced in the lectures, all of which are papers that are freely available online.

Courses					
Title	-	Тур	Hrs/wk	СР	
Offshore Geotechnical Engineering	(L0067)	Lecture	1	1	
Hydro Power Use (L0013)		Lecture	1	1	
Wind Turbine Plants (L0011)	(10012)	Lecture	2	3	
Nind Energy Use - Focus Offshore (Lecture	1	1	
	Dr. Marvin Scherzinger				
Admission Requirements					
Kecommended Previous Knowledge	Module: Technical Thermodynamics I,				
Knowledge	Module: Technical Thermodynamics II,				
	Module: Fundamentals of Fluid Mechanics				
Educational Objectives	After taking part successfully, students have reac	hed the following learning results			
Professional Competence					
Kilowiedge	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 a to describe fundamentally the use of water power to generate electricity. The students reproduce and explain the basic proced in the implementation of renewable energy projects in countries outside Europe. Through active discussions of various topics within the seminar of the module, students improve their understanding and application of the theoretical background and are thus able to transfer what they have learned in practice.				
Skills	Students are able to apply the acquired theoretical foundations on exemplary water or wind power systems and evaluate a assess technically the resulting relationships in the context of dimensioning and operation of these energy systems. They car compare critically the special procedure for the implementation of renewable energy projects in countries outside Europe with 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-speci	ificly and multidisciplinary within a se	eminar.		
Autonomy	Students can independently exploit sources in the context of the emphasis of the lecture material to clear the contents of the lecture and to acquire the particular knowledge about the subject area.				
Workload in Hours	Independent Study Time 110, Study Time in Lectu	ure 70			
Credit points	6				
Course achievement	None				
Examination	Written exam				
Examination duration and	180 min				
scale					
Assignment for the	Civil Engineering: Specialisation Structural Engine	eering: Elective Compulsory			
Following Curricula	Civil Engineering: Specialisation Geotechnical Eng	gineering: Elective Compulsory			
	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory				
	International Management and Engineering: Specialisation II. Energy and Environmental Engineering: Elective Compulsory				
	International Management and Engineering: Specialisation II. Renewable Energy: Elective Compulsory				
	Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory				
	Product Development, Materials and Production: Specialisation Production: Elective Compulsory				
	Product Development, Materials and Production: Specialisation Materials: Elective Compulsory				
	Renewable Energies: Core Qualification: Compulsory Theoretical Mechanical Engineering: Specialisation Energy Systems: Elective Compulsory				
		•	on/		
	Theoretical Mechanical Engineering: Specialisatio	n Energy Systems: Elective Compuls			
	Theoretical Mechanical Engineering: Specialisatio Process Engineering: Specialisation Environmenta	n Energy Systems: Elective Compuls al Process Engineering: Elective Com			
	Theoretical Mechanical Engineering: Specialisatio	n Energy Systems: Elective Compuls al Process Engineering: Elective Com tion Cities: Elective Compulsory	pulsory		

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

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

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

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

Module M1845: Thin-	walled structures			
Module Milo45. Mili-				
Courses				
Title		Тур	Hrs/wk	СР
Thin-walled structures (L1199)		Lecture	2	3
Thin-walled structures (L3045)		Recitation Section (large)	2	3
Module Responsible	Prof. Bastian Oesterle			
Admission Requirements	None			
Recommended Previous				
Knowledge	Structural Analysis I			
	Structural Analysis II			
	Finite Element Methods			
Educational Objectives	After taking part successfully, students have read	ched the following learning results		
Professional Competence				
Knowledge	After successful completion of this module, the	students can express the basic aspects of	the load-carryin	g behaviour of thi
	walled structures.			
CI-III-				
Skills	s After successful completion of this module, the students will be able to predict load-carrying behaviour of thin-walled structur			
	using appropriate analytical and coputational me	thods.		
Personal Competence				
Social Competence	Students can			
	 participate in subject-specific and interdisc 	ciplinary discussions,		
	• defend their own work results in front of o	thers		
	 promote the scientific development of coll 	eagues		
	 Furthermore, they can give and accept pro 	•		
Autonomy	Students are able to gain knowledge of the subje	-		
	they are able to structure the solution process fo	r problems in the area of modelling and analy	sis of thin-walled	d structures.
Workload in Hours	Independent Study Time 124, Study Time in Lect	ure 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	Civil Engineering: Specialisation Coastal Engineer	ring: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Eng	gineering: Elective Compulsory		
	Civil Engineering: Specialisation Computational E	ngineering: Compulsory		
	Civil Engineering: Specialisation Structural Engine	eering: Elective Compulsory		
	Theoretical Mechanical Engineering: Specialisatic	on Simulation Technology: Elective Compulso	ry	

Тур	Lecture
Hrs/wk	
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
	Prof. Bastian Oesterle
Language	DE
Cycle	SoSe
Content	Plates loaded in-plane
	Governing equations (equilibrium, kinematics, constitutive law)
	Differential equation
	Airy stress function
	Plane stress / plane strain
	Structural behaviour of plates loaded in-plane
	 Structural behaviour of plates loaded in-plane finite elements for plates loaded in-plane, modelling apsects, interpretation and critical assessment of results
	• Inite elements for plates loaded in-plane, modelling apsects, interpretation and childar assessment of results
	Plates in bending
	 Governing equations (equilibrium, kinematics, constitutive law)
	Differential equation
	Navier solution / Fourier series expansion
	Approximation procedures
	Circular and rectangular plates
	Structural behaviour of plates in bending
	 finite elements for plates in bending, modelling apsects, interpretation and critical assessment of results
	Shells
	Phenomenona of the structural behaviour of shells
	Membrane and bending theory
	Equilibrium equations of shells of revolution
	Stress resultants and deformations of the spherical shell, the half spherical shell, and the cylindrical shell
	finite elements for shells
	Stability problems (overview)
	Plate buckling
	Shell buckling
Literature	• Verlegungemanuskript
	Vorlesungsmanuskript Deservice V (1995), Machaelle des Elächenterseurles, Viewan Varles, Desurschweis, Wischeder,
	Basar, Y.: Krätzig, W.B. (1985): Mechanik der Flächentragwerke. Vieweg-Verlag, Braunschweig, Wiesbaden
	Girkmann, K. (1963): Flächentragwerke, Springer Verlag, Wien, 1963, unveränderter Nachdruck 1986
	• Zienkiewicz, O.C. (1977): The Finite Element Method in Enginieering Science. McGraw-Hill, London

Course L3045: Thin-walled st	ourse L3045: Thin-walled structures	
Тур	Recitation Section (large)	
Hrs/wk	2	
CP	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Bastian Oesterle	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Courses				
Title		Тур	Hrs/wk	СР
oining of Polymer-Metal Lightweig	nt Structures (L0500)	Lecture	2	2
oining of Polymer-Metal Lightweig		Practical Course	1	1
Metallic Light-weight Materials (L16	560)	Lecture	2	3
Module Responsible	Prof. Marcus Rutner			
Admission Requirements	None			
Recommended Previous				
Knowledge				
Educational Objectives	After taking part successfully, students h	ave reached the following learning results		
Professional Competence				
Knowledge				
Skills				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 110, Study Time	e in Lecture 70		
Credit points	6			
Course achievement	None			
Examination	Oral exam			
Examination duration and	45 min			
scale				
Assignment for the	Civil Engineering: Specialisation Structur	al Engineering: Elective Compulsory		
Following Curricula	Materials Science and Engineering: Spec	ialisation Engineering Materials: Elective Comp	ilsory	
	Materials Science: Specialisation Enginee	ering Materials: Elective Compulsory		
	Theoretical Mechanical Engineering: Spe	cialisation Materials Science: Elective Compulso		

	ymer-Metal Lightweight Structures
	Lecture
Hrs/wk	
СР	
	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Marcus Rutner
Language	EN
Cycle	WiSe
Content	Contents:
	The lecture and the related laboratory exercises intend to provide an insight on advanced joining technologies for polymer-meta lightweight structures used in engineering applications. A general understanding of the principles of the consolidated and net technologies and its main fields of applications is to be accomplished through theoretical and practical lectures.
	Theoretical Lectures:
	 Review of the relevant properties of Lightweight Alloys, Engineering Plastics and Composites in Joining Technology Introduction to Welding of Lightweight Alloys, Thermoplastics and Fiber Reinforced Plastics Mechanical Fastening of Polymer-Metal Hybrid Structures Adhesive Bonding of Polymer-Metal Hybrid Structures Fusion and Solid State Joining Processes of Polymer-Metal Hybrid Structures Hybrid Joining Methods and Direct Assembly of Polymer-Metal Hybrid Structures Laboratory Exercises: Joining Processes: Introduction to state-of-the-art joining technologies Introduction to metallographic specimen preparation, optical microscopy and mechanical testing of polymer-metal joints Course Outcomes: After successful completion of this unit, students should be able to understand the principles of welding and joining of polymer metal lightweight structures as well as their application fields.
Literature	 S. T. Amancio-Filho, LA. Blaga, Joining of Polymer-Metal Hybrid Structures, Wiley, 2018 J.F. Shackelford, Introduction to materials science for engineers, Prentice-Hall International J. Rotheiser, Joining of Plastics, Handbook for designers and engineers, Hanser Publishers D.A. Grewell, A. Benatar, J.B. Park, Plastics and Composites Welding Handbook D. Lohwasser, Z. Chen, Friction Stir Welding, From basics to applications, Woodhead Publishing Limited J. Friedrich, Metal-Polymer Systems: Interface Design and Chemical Bonding, Wiley, 2017

Course L0501: Joining of Poly	urse L0501: Joining of Polymer-Metal Lightweight Structures	
Тур	Practical Course	
Hrs/wk	1	
СР		
Workload in Hours	ndependent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Marcus Rutner	
Language	EN	
Cycle	Cycle WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Тур	Lecture
Hrs/wk	
СР	3
	Independent Study Time 62, Study Time in Lecture 28
	Dr. Domonkos Tolnai
Language Cycle	
-	Lightweight construction
	- Structural lightweight construction
	- Material lightweight construction
	- Choice criteria for metallic lightweight construction materials
	Steel as lightweight construction materials
	- Introduction to the fundamentals of steels
	- Modern steels for the lightweight construction
	- Fine grain steels
	- High-strength low-alloyed steels
	- Multi-phase steels (dual phase, TRIP)
	- Weldability
	- Applications
	Aluminium alloys:
	Introduction to the fundamentals of aluminium materials
	Alloy systems
	Non age-hardenable Al alloys: Processing and microstructure, mechanical qualities a applications
	Age-hardenable Al alloys: Processing and microstructure, mechanical qualities and applications
	Magnesium alloys
	Introduction to the fundamental of magnesium materials
	Alloy systems
	Magnesium casting alloys, processing, microstructure and qualities
	Magnesium wrought alloys, processing, microstructure and qualities
	Examples of applications
	Titanium alloys
	Introduction to the fundamental of the titanium materials
	Alloy systems
	Processing, microstructure and properties
	Examples of applications

	Exercises and excursions
Literature	George Krauss, Steels: Processing, Structure, and Performance, 978-0-87170-817-5, 2006, 613 S.
	Hans Berns, Werner Theisen, Ferrous Materials: Steel and Cast Iron, 2008. http://dx.doi.org/10.1007/978-3-540-71848-2
	C. W. Wegst, Stahlschlüssel = Key to steel = La Clé des aciers = Chiave dell'acciaio = Liave del acero ISBN/ISSN: 3922599095
	Bruno C., De Cooman / John G. Speer: Fundamentals of Steel Product Physical Metallurgy, 2011, 642 S.
	Harry Chandler, Steel Metallurgy for the Non-Metallurgist 0-87170-652-0 , 2006, 84 S.
	Catrin Kammer, Aluminium Taschenbuch 1, Grundlagen und Werkstoffe, Beuth, 16. Auflage 2009. 784 S., ISBN 978-3-410-22028-2
	Günter Drossel, Susanne Friedrich, Catrin Kammer und Wolfgang Lehnert, Aluminium Taschenbuch 2, Umformung von Aluminium-Werkstoffen, Gießen von Aluminiumteilen, Oberflächenbehandlung von Aluminium, Recycling und Ökologie, Beuth, 16. Auflage 2009. 768 S., ISBN 978-3-410-22029-9
	Catrin Kammer, Aluminium Taschenbuch 3, Weiterverarbeitung und Anwendung, Beuith,17. Auflage 2014. 892 S., ISBN 978-3-410-22311-5
	G. Lütjering, J.C. Williams: Titanium, 2nd ed., Springer, Berlin, Heidelberg, 2007, ISBN 978-3-540- 71397
	Magnesium - Alloys and Technologies, K. U. Kainer (Hrsg.), Wiley-VCH, Weinheim 2003, ISBN 3- 527-30570-x
	Mihriban O. Pekguleryuz, Karl U. Kainer and Ali Kaya "Fundamentals of Magnesium Alloy Metallurgy", Woodhead Publishing Ltd, 2013,ISBN 10: 0857090887

Courses				
Title		Тур	Hrs/wk	СР
Water Protection and Wastewater I	-	Lecture	3	3
Water Protection and Wastewater I	-	Project Seminar	3	3
Module Responsible				
Admission Requirements	None			
Recommended Previous	 Basic knowledge in water management. 			
Knowledge	 Good knowledge in urban drainage; 			
	 Good knowledge of wastewater treatment 	ent techniques;		
	 Good knowledge of pollutants (e.g. COD 	, BOD, TS, N, P) and their properties;		
Educational Objectives	After taking part successfully, students have re	eached the following learning results		
Professional Competence	After taking part successfully, students have h	carried the following learning results		
•	The students can describe the basic principles	of the regulatory framework related to the	e international and Eu	ropean water secto
	They can explain limnological processes, sul			
	problems related to water protection, such a			
	solutions, remediation measures as well as co	nceptual approaches.		
Cl://-			least southout These	
SKIIIS	Students can accurately assess current proble actions to contribute to the planning of tom		-	
	administrative and legislative solutions to solv	, , , , , , , , , , , , , , , , , , , ,	they can suggest a	ppropriate technica
	administrative and regislative solutions to solv	e triese problems.		
Personal Competence				
Social Competence	The students can work together in international groups.			
Autonomv	Students are able to organize their work flow	to prepare presentations and discussions	. They can acquire ap	propriate knowled
	by making enquiries independently.			, , , , , , , , , , , , , , , , , , ,
Workload in Hours	Independent Study Time 96, Study Time in Leo	cture 84		
Credit points	6			
Course achievement	None			
Examination				
	Term paper plus presentation			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Eng	jineering: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical			
-	Civil Engineering: Specialisation Coastal Engin	eering: Elective Compulsory		
	Civil Engineering: Specialisation Water and Tra	affic: Elective Compulsory		
	Environmental Engineering: Specialisation Wat	ter Quality and Water Engineering: Elective	e Compulsory	
	International Management and Engineering: S	pecialisation II. Civil Engineering: Elective (Compulsory	
	Water and Environmental Engineering: Special	lisation Cities: Elective Compulsory		
	Water and Environmental Engineering: Special	lisation Water: Elective Compulsory		
	Water and Environmental Engineering: Special	lisation Environment: Compulsory		

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

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

Courses				
Title		Тур	Hrs/wk	СР
Examination of Materials, Structura	-	Lecture	3	4
Examination of Materials, Structura	I Condition and Damages (L0261)	Recitation Section (small)	1	2
Module Responsible	Prof. Frank Schmidt-Döhl			
Admission Requirements	None			
Recommended Previous	Basic knowledge about building materials or i	material science, for example by the mo-	dule Building Ma	terials and Build
Knowledge	Chemistry.			
Educational Objectives	After taking part successfully, students have read	ched the following learning results		
Professional Competence				
Knowledge	The students are able to describe the rules for t methods for the testing of building material prop testing methods.	• • •		
Skills	The students are able to responsibly discover the rules for trading and using of building products in Germany. They are able to chose suitable methods for the testing and inspection of construction products, the examination of damages and the examination of the structural conditions of buildings. They are able to conclude from symptons to the cause of damages. The are able to describe an examination in form of a test report or expert opinion.			
Personal Competence				
Social Competence	The students can describe the different roles of framework of material testing. They can describe	• ·	-	on bodies within t
Autonomy	The students are able to make the timing and the	e operation steps to learn the specialist knov	ledge of a very e	xtensive field.
Workload in Hours	Independent Study Time 124, Study Time in Lect	ure 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	120 min			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Engine	eering: Elective Compulsory		
Following Curricula				
-	Civil Engineering: Specialisation Coastal Engineer			
	Civil Engineering: Specialisation Water and Traffic			
	International Management and Engineering: Spec	cialisation II. Civil Engineering: Elective Com	oulsory	
	Materials Science and Engineering: Specialisation	Engineering Materials: Elective Compulsory		
	Materials Science: Specialisation Engineering Mat	cerials: Elective Compulsory		

Course L0260: Examination of	Course L0260: Examination of Materials, Structural Condition and Damages		
Тур	Lecture		
Hrs/wk			
СР	4		
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42		
Lecturer	Prof. Frank Schmidt-Döhl		
Language	DE		
Cycle	WiSe		
Content	Materials testing and marking process of construction products, testing methods for building materials and structures, testir		
	reports and expert opinions, describing the condition of a structure, from symptons to the cause of damages		
Literature	Frank Schmidt-Döhl: Materialprüfung im Bauwesen. Fraunhofer irb-Verlag, Stuttgart, 2013.		

Course L0261: Examination of	ourse L0261: Examination of Materials, Structural Condition and Damages	
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	2	
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14	
Lecturer	Prof. Frank Schmidt-Döhl	
Language	DE	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Courses					
Title		Тур	Hrs/wk	СР	
Nonlinear Structural Analysis (L0277)		Lecture	3	4	
Nonlinear Structural Analysis (L0279)		Recitation Section (small)	1	2	
Module Responsible Pr	of. Alexander Düster				
Admission Requirements No	one				
Recommended Previous Kr	nowledge of partial differential equations	is recommended.			
Knowledge					
Educational Objectives Af	ter taking part successfully, students ha	ve reached the following learning results			
Professional Competence					
Knowledge St	udents are able to				
+	give an overview of the different nonline	ear phenomena in structural mechanics.			
+	explain the mechanical background of n	onlinear phenomena in structural mechanics.			
+	to specify problems of nonlinear structu	ral analysis, to identify them in a given situation	and to explain the	eir mathematical a	
m	echanical background.				
<i></i>					
	udents are able to				
	+ model nonlinear structural problems.				
		oblem a suitable computational procedure.			
	apply finite element procedures for non				
	critically verify and judge results of nonl				
+	to transfer their knowledge of nonlinear	solution procedures to new problems.			
Personal Competence					
Social Competence St	udents are able to				
+	solve problems in heterogeneous groups	5.			
+	present and discuss their results in front	of others.			
+	give and accept professional constructiv	e criticism.			
Automotive Ch					
-	udents are able to	vision and E Learning			
	assess their knowledge by means of exe				
		knowledge to solve research oriented tasks.			
+	to transform the acquired knowledge to	similar problems.			
Workload in House In	dependent Study Time 124 Study Time	in Lastura EG			
	dependent Study Time 124, Study Time				
Credit points 6					
Course achievement No					
Examination W					
Examination duration and 12	20 min				
scale					
-	vil Engineering: Specialisation Structural				
-	vil Engineering: Specialisation Computat		anulcon		
		g: Specialisation II. Civil Engineering: Elective Cor	ipulsory		
	aterials Science: Specialisation Modeling				
	echatronics: Technical Complementary C				
	echatronics: Core Qualification: Elective				
		Iction: Core Qualification: Elective Compulsory			
		: Core Qualification: Elective Compulsory			
	nip and Offshore Technology: Core Qualif neoretical Mechanical Engineering: Speci				

Course L0277: Nonlinear Str	ourse L0277: Nonlinear Structural Analysis		
Тур	Lecture		
Hrs/wk	3		
СР	4		
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42		
Lecturer	Prof. Alexander Düster		
Language	EN		
Cycle	WiSe		
Content	1. Introduction		
	2. Nonlinear phenomena		
	3. Mathematical preliminaries		
	4. Basic equations of continuum mechanics		
	5. Spatial discretization with finite elements		
	6. Solution of nonlinear systems of equations		
	7. Solution of elastoplastic problems		
	8. Stability problems		
	9. Contact problems		
Literature	[1] Alexander Düster, Nonlinear Structrual Analysis, Lecture Notes, Technische Universität Hamburg-Harburg, 2014.		
	[2] Peter Wriggers, Nonlinear Finite Element Methods, Springer 2008.		
	[3] Peter Wriggers, Nichtlineare Finite-Elemente-Methoden, Springer 2001.		
	[4] Javier Bonet and Richard D. Wood, Nonlinear Continuum Mechanics for Finite Element Analysis, Cambridge University Press,		
	2008.		

Course L0279: Nonlinear Structural Analysis	
Тур	Recitation Section (small)
Hrs/wk	1
СР	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Alexander Düster
Language	EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Courses					
Title		Тур	Hrs/wk	СР	
Title Chemistry of Drinking Water Treatment (L0311)		Lecture	2	1	
Chemistry of Drinking Water Treatr		Recitation Section (large)	1	2	
Water Resource Management (L04		Lecture	2	2	
Water Resource Management (L04)3)	Recitation Section (small)	1	1	
Module Responsible	Prof. Mathias Ernst				
Admission Requirements	None				
Recommended Previous	Knowledge of water management and the	ne key processes involved in water treatment.			
Knowledge					
Educational Objectives	After taking part successfully, students h	nave reached the following learning results			
Professional Competence					
Knowledge	Students will be able to outline key are	eas of conflict in water management, as well as th	neir mutual depend	dence for sustaina	
	water supply. They will understand rele	evant economic, environmental and social factors	. Students will be	able to explain a	
	outline the organisational structures of v	water companies. They will be able to explain the a	vailable water trea	atment processes	
	the scope of their application.	·····			
	the scope of their application.				
Skills	Students will be able to assess com	plex problems in drinking water production ar	id establish solut	ions involving w	
	management and technical measures. They will be able to assess the evaluation methods that can be used for this. Students wil				
	be able to carry out chemical calculati	ons for selected treatment processes and apply	generally accepted	d technical rules	
	standards to these processes.				
Personal Competence					
Social Competence	ce Working in a diverse group of specialists, students will be able to develop and document complex solutions for the ma		for the managem		
	and treatment of drinking water. They	will be able to take an appropriate professional p	osition, for examp	ole representing u	
	interests. They will be able to develop jo	int solutions in teams of diverse experts and prese	nt these solutions t	to others.	
Autonomy	Students will be in a partition to work on	a subject independently and present on this subject	+		
Autonomy	Students will be in a position to work on	a subject independency and present on this subject			
Workload in Hours	Independent Study Time 96, Study Time	in Lecture 84			
Credit points	6				
Course achievement	None				
Examination	Written exam				
	60 min (chemistry) + presentation				
scale					
Assignment for the	Civil Engineering: Specialisation Structur				
Following Curricula	Civil Engineering: Specialisation Geotech				
	Civil Engineering: Specialisation Water a				
	Civil Engineering: Specialisation Coastal	Engineering: Elective Compulsory			
	Chemical and Bioprocess Engineering: T	echnical Complementary Course: Elective Compuls	ory		
	International Management and Engineer	ing: Specialisation II. Energy and Environmental En	gineering: Elective	Compulsory	
	Process Engineering: Specialisation Envi	ronmental Process Engineering: Elective Compulso	ry		
	Process Engineering: Specialisation Proc	ess Engineering: Elective Compulsory			
	Water and Environmental Engineering: S	Specialisation Water: Compulsory			
	Water and Environmental Engineering: S	Specialisation Environment: Elective Compulsory			

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

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

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

Course L0403: Water Resour	urse 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				
Title Integrated Transportation Planning	(11068) Typ	t-/problem-based Learning	Hrs/wk 4	CP 6
		c-problem-based Learning	7	0
Module Responsible				
Admission Requirements	None			
Recommended Previous Knowledge	some knowledge of transport planning, e.g. through taking the undergr	raduate class "Transport P	lanning and T	anic Engineerin
Educational Objectives	After taking part successfully, students have reached the following least	ming recults		
-	After taking part successfully, students have reached the following lear	ning results		
Professional Competence	Ctudente are able to			
Knowledge	Students are able to:			
	describe interdependencies between land-use/location choice ar	nd transportation/mobility	behaviour	
	 explain and evaluate the social, ecological and economic effects 	of transport and land-use	policy measu	res.
	 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 of 	or are influenced by it		
	 comprehensively examine a pre-defined or self-selected topic fr 		es perspectiv	e and document t
	results in accordance with scientific conventions.			
Personal 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. 			
Autonomu	Ctudente are able to			
Autonomy	Students are able to:			
	assess potential consequences of their future professional activi	ties		
	 independently plan working on a pre-defined project topic, acqu 	ire the necessary knowled	ge and use ap	propriate means
	its execution.			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
Examination duration and	written assignment with presentation during the semester			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Engineering: Elective Compo	ulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering: Elective Con	mpulsory		
	Civil Engineering: Specialisation Coastal Engineering: Elective Compuls	ory		
	Civil Engineering: Specialisation Water and Traffic: Compulsory			
	Logistics, Infrastructure and Mobility: Specialisation Infrastructure and		ory	
	Water and Environmental Engineering: Specialisation Cities: Compulsor	ry		

Course L1068: Integrated Tr	ansportation Planning
Тур	Project-/problem-based Learning
Hrs/wk	4
СР	6
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Lecturer	Prof. Carsten Gertz, Dr. Philine Gaffron, Jacqueline Bianca Maaß
Language	DE
Cycle	WiSe
	The course will provide students with an understanding of interdependencies between land-use and transportation. Specific topics include a.o.:
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)

Courses					
Title			Тур	Hrs/wk	СР
Applied Tunnel Constructions (L240	17)		Lecture	2	3
ntroduction to tunnel construction	(L0707)		Lecture	1	2
ntroduction to tunnel construction	(L1811)		Recitation Section (large)	1	1
Module Responsible	Prof. Jürgen Grabe				
Admission Requirements	None				
Recommended Previous	Modules from Bachelor	studies Civil and environme	ental engineering:		
Knowledge	Geotechnics I-II				
Educational Objectives	After taking part succes	ssfully, students have reach	ed the following learning results		
Professional Competence					
Knowledge	Knowledge of different tunnel construction types as well as special methods and techniques of subsoil construction.				
Skills	Basic knowledge of tunnel design as well as practical skills in structural tunnel analysis.				
Personal Competence					
Social Competence	Capacity for teamwork concerning project management and design of tunnels.				
Autonomy	Promotion of independent and creative work flow in the framework of a design exercise.				
Workload in Hours	Independent Study Time	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6	-			
· · · · · · · · · · · · · · · · · · ·		Description			
	No 5% E	Excercises			
Examination	Written exam				
Examination duration and	120 minutes				
scale					
Assignment for the	Civil Engineering: Specia	ialisation Structural Engine	ering: Elective Compulsory		
Following Curricula	Civil Engineering: Specia	ialisation Geotechnical Engi	neering: Compulsory		
	Civil Engineering: Specia	ialisation Coastal Engineeri	ng: Compulsory		
	Civil Engineering: Specia	ialisation Water and Traffic:	Elective Compulsory		
	Civil Engineering: Specia	ialisation Computational En	gineering: Elective Compulsory		
		ent and Engineering: Speci			

Course L2407: Applied Tunnel Constructions	
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Jürgen Grabe, Tim Babendererde
Language	DE
Cycle	WiSe
Content	
Literature	

Course L0707: Introduction t	to tunnel construction	
Тур	Lecture	
Hrs/wk		
СР	2	
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14	
Lecturer	Dr. Julian Bubel	
Language	DE	
Cycle	WiSe	
Content	 Definitions Historical development in tunneling Geology for tunneling Hard rock tunneling (construction composite and machines) Tunnelung in temporarly stable soil with conventional construction methods Tunneling in soft soils (form of supports, shield types, compressed air application) Pipe jacking Tunnel Lining, tunnel supporting structures 	
Literature	 Calculation approaches for supporting structures in shield-driven tunnels Surveying for tunneling Safety requirements Construction Contract Literature and sources 	
	Vorlesung/Übung s. www.tu-harburg.de/gbt	

Course L1811: Introduction t	Course L1811: Introduction to tunnel construction	
Тур	Recitation Section (large)	
Hrs/wk	1	
CP	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Dr. Julian Bubel	
Language	DE	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Module M0969: Selected Topics in Civil Engineering

Courses				
Title		Тур	Hrs/wk	СР
Design of Composite Bridges (L3092)		Integrated Lecture	2	3
Analysis of Offshore Structures (L1867)		Lecture	1	1
Energy Geotechnics (L3227)		Lecture	3	3
Solid Matter Process Technology fo	r Biomass (L0052)	Lecture	2	3
Forum I - Geotechnics and Construe	ction Management (L1634)	Seminar	1	1
Forum II - Geotechnics and Constru	ction Management (L1635)	Seminar	1	1
Timber Structures (L1151)		Seminar	2	2
Innovative Timber Construction (L2	666)	Lecture	2	4
Glass Structures (L1152)		Lecture	2	2
Glass Structures (L1447)		Recitation Section (large)	1	1
Sustainable landfill design and ope	ration (L3270)	Integrated Lecture	3	3
Special Topics in Steel Design (L30	91)	Integrated Lecture	2	3
Special topics of civil engineering 1	CP (L2378)		1	1
Special topics of civil engineering 2	LP (L2379)		2	2
Special topics of civil engineering 3	LP (L2380)		3	3
Structural Design (L2789)		Seminar	2	2
Module Responsible	Prof. Frank Schmidt-Döhl			
Admission Requirements	None			
Recommended Previous	none			
Knowledge				
Educational Objectives	After taking part successfully, students have reached	d the following learning results		
Professional Competence				
Knowledge				
	 Students are able to find their way through se 			
	 Students are able to explain basic models and 	I procedures in selected special areas of	civil and structura	al engineering.
	Students are able to interrelate scientific and	technical knowledge.		
Skills	• Students are able to apply basic methods in se	elected areas of civil and structural engin	eering.	
Personal Competence				
Social Competence				
Autonomy				
Autonomy	 Students can chose independently, in which to courses. 	fields they want to deepen their knowled	dge and skills th	rough the election o
Workload in Hours	Depends on choice of courses			
Credit points	6			
Assignment for the	Civil Engineering: Specialisation Structural Engineering	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: El			
	Civil Engineering: Specialisation Computational Engin			
	civit Engineering, specialisation computational Engli	icening. Elective compulsory		

Course L3092: Design of Composite Bridges	
Тур	Integrated Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and	90 min
scale	
Lecturer	Prof. Marcus Rutner
Language	DE
Cycle	SoSe
Content	
Literature	

Тур	Lecture
Hrs/wk	
CP	
Examination Form	
Examination duration and	30 min
scale	
Lecturer	Dr. Said Fawad Mohammadi
Language	DE/EN
Cycle	SoSe
Content	Topic 1: Types of Offshore Structures, Fixed and floating structures for Oil & Gas and Offshore Wind industry
	Topic 2: Wave Forces, Morisons equation
	Topic 3: Irregular Seastates, Power spectrum and application of FFT
	Topic 4: Additional Environmental Forces, wind spectra, current forces
	Topic 5: Linear-Time-Invariant Systems, response of an LTI-system in frequency domain
	Topic 6: Tubular Welded Connections, stress concentration factors, weld geometry
	Topic 7: Introduction to Fracture Mechanics, criteria for fracture initiation and crack growth
	Topic 8: Time and Frequency Domain Fatigue Analyses, rainflow counting, application of LTI-systems for frequency domain fatigu
	Topic 9: Offshore Installation and Exam, installation of structures, pile driving, pipe laying techniques
Literature	Chakrabarti, Handbook of Offshore Engineering, 2005
	Sarpkaya, Wave Forces on Offshore Structures, 2010
	Faltinsen, Sea Loads on Ships and Offshore Structures, 1998
	Sorensen, Basic Coastal Engineering, 2006
	Dowling, Mechanical Behavior of Materials, 2007
	Haibach, Betriebsfestigkeit, 2006
	Marshall, Design of Welded Tubular Connections, 1992
	Newland, Random vibrations, spectral and wavelet analysis, 1993

Course L3227: Energy Geotechnics		
Тур	Lecture	
Hrs/wk	3	
СР	3	
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42	
Examination Form	Schriftliche Ausarbeitung (laut FPrO)	
Examination duration and	wird zu Beginn der Lehrveranstaltung festgelegt	
scale		
Lecturer	Pauline Kaminski	
Language	DE/EN	
Cycle	WiSe	
	Energy geotechnics is a young field in geotechnical engineering with the aim of developing sustainable geotechnical solutions for future-oriented issues relating to the production, transport, operation, decommissioning, and waste utilisation of various energy sources. Examples of possible fields of activity in energy geotechnics include geothermal energy and thermally activated foundation components, foundations for onshore and offshore wind turbines, the decommissioning of mining facilities and the handling of waste products from fossil fuels such as tailings and the geological storage of CO2. Relevant soil mechanical processes in these applications include the thermo-hydro-mechanically coupled behaviour of soils, multiphase flow in porous media and partially saturated soils. The lecture gives an overview of various aspects of energy geotechnics and provides in-depth knowledge of the associated soil mechanical processes. In addition, CO2-scarce geotechnical applications are discussed and emission estimates as well as the optimisation of geotechnical structures according to sustainability aspects are addressed.	
Literature		

	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 L1634: Forum I - Geotechnics and Construction Management	
Тур	Seminar
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Examination Form	Mündliche Prüfung
Examination duration and	30 min
scale	
Lecturer	Prof. Jürgen Grabe
Language	DE
Cycle	WiSe
Content	Lectures about projects and issues with practical and scientific relevance.
Literature	

Course L1635: Forum II - Geotechnics and Construction Management	
Тур	Seminar
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Examination Form	Mündliche Prüfung
Examination duration and	30 min
scale	
Lecturer	Prof. Jürgen Grabe
Language	DE
Cycle	SoSe
Content	Lectures about projects and issues with practical and scientific relevance.
Literature	

Course L1151: Timber Structures	
Тур	Seminar
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Referat
Examination duration and	90 min
scale	
Lecturer	Prof. Torsten Faber
Language	DE
Cycle	WiSe
Content	
Literature	

Course L2666: Innovative Tin	nhar Construction
	Lecture
Hrs/wk	
	Independent Study Time 92, Study Time in Lecture 28
Examination Form	Schriftliche Ausarbeitung
Examination duration and	45 Minuten
scale	
Lecturer	Dr. Andreas Meisel
Language	DE
Cycle	WiSe
Content	
Literature	- Blass, J.: "Ingenieurholzbau"
	- Schickhofer, G.: "BSPhandbuch: Holz-Massivbauweise in Brettsperrholz"
	- Informationsdienst Holz: div. Merkblätter und Broschüren
	- Wallner-Novak M.: Brettsperrholz Bemessung, Band 1 und 2
	- Gerner M.: "Fachwerk: Entwicklung, Instandsetzung, Neubau"
	- Meisel, A.: "Historische Dachwerke: Beurteilung, realitätsnahe statische Analyse und Instandsetzung"
	- Kempe K.: "Dokumentation Holzschädlinge"
	- Huckfeldt T.: "Hausfäule- und Bauholzpilze"

Course L1152: Glass Structures	
Тур	Lecture
Hrs/wk	
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and	
scale	
Lecturer	Marvin Matzik
Language	DE
Cycle	WiSe
Content	Glass structures
	- Introduction of the material glass (production, refinement, material characteristic)
	- design of facades
	- facade types
	- static calculation of glazing
	- static calculation of facades
	- load bearing behavior of glazing (plate or membrane stiffness)
	- vertical / horizontal glazing with safety-related requirements
	- glass structures
	- fire safety of glass facades
	- construction physics of facades and glazing
Literature	

Course L1447: Glass Structures	
Тур	Recitation Section (large)
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Examination Form	Mündliche Prüfung
Examination duration and	
scale	
Lecturer	Marvin Matzik
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

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

Course L3091: Special Topics in Steel Design	
Тур	Integrated Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and	90 min
scale	
Lecturer	Prof. Marcus Rutner, Nikolay Lalkovski
Language	DE
Cycle	SoSe
Content	
Literature	

Course L2378: Special topics of civil engineering 1CP			
Тур			
Hrs/wk	1		
CP	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 Lehrveranstaltung festgelegt		
scale			
Lecturer	Dozenten des SD B		
Language	DE		
Cycle	WiSe/SoSe		
Content	The course occurs only if required. The content is defined at short notice.		
Literature	Die Literatur wird kurzfristig festgelegt.		

ourse L2379: Special topics of civil engineering 2 LP		
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 Lehrveranstaltung festgelegt	
scale		
Lecturer	Dozenten des SD B	
Language	DE	
Cycle	WiSe/SoSe	
Content	The course occurs only if required. The content is defined at short notice.	
Literature	Die Literatur wird kurzfristig festgelegt.	

Course L2380: Special topics of civil engineering 3 LP				
Тур				
Hrs/wk	3			
СР	3			
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42			
Examination Form	achtheoretisch-fachpraktische Arbeit			
Examination duration and	wird zu Beginn der Lehrveranstaltung festgelegt			
scale				
Lecturer	Dozenten des SD B			
Language	DE			
Cycle	WiSe/SoSe			
Content	The course occurs only if required. The content is defined at short notice.			
Literature	Die Literatur wird kurzfristig festgelegt.			

Course L2789: Structural Design				
Тур	Seminar			
Hrs/wk	2			
CP	2			
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28			
Examination Form	Mündliche Prüfung			
Examination duration and	20 min			
scale				
Lecturer	Dr. Jan Mittelstädt			
Language	DE/EN			
Cycle	SoSe			
Content				
Literature	[1] Structure Systems by Heino Engel, Hantje Cantz, 3rd edition (Feb 2007), ISBN-10: 3775718761			
	Form and Force, Designing Efficient, Expressive Structures by Allan, E., Zalewski, W. et al, John Wiley and			
	Sons; 1st edition (Sept 2009), ISBN-10: 047017465X			
	[2] Peter Rice: An Engineer Imagines, ISBN-10 : 1849944237			
	[3] Konrad Wachsmann and the Grapevine Structure by C. Sumi et al., Park Books (Oct 2018), ISBN-10:			
	9783038601104			
	[4] Manual of Multi-Story Timber Construction by Hermann Kaufmann, Stefan Krotsch, Stefan Winter, DETAIL,			
	(June 2018), ISBN-10: 3955533948			
	[5] The Art of Structural Design: A Swiss Legacy by B. Billington, Princeton University Art Museum; First Edition			
	edition (Mar 2003), ISBN-10: 0300097867			
	[6] Structured Lineages: Learning from Japanese Structural Design by G. Nordenson et al, The Museum of			
	Modern Art (Jul 2019), ISBN-10: 1633450562			
	[7] The Structure: Works of Mahendra Raj by V. Mehta, R. Mehndiretta, A. Huber, Park Books (Oct 2015),			
	ISBN-10: 3038600253			

Fitle	Typ Hrs/wk CP			
Madula Baspansible	Typ Hrs/wk CP			
module Responsible	Dozenten des SD B			
Admission Requirements	None			
Recommended Previous	Subjects of the Structural Engineering specialisation.			
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 structural and construction engineering. They can exemplify the state of technology and application and discuss critically in the context of actual problems and general conditions o science and society.			
	The students can develop solving strategies and approaches for fundamental and practical problems in structural and constructive engineering. They may apply theory based procedures and integrate safety-related, ecological, ethical, and economic view point 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 for the project work and to justify this choice. They can explain how the methods relate to the field of work and how the context of application has to be adjusted. General findings and furth 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 the presentation and discussion in front of a bigger group. They can lead the discussion and give a feedback on the project to th colleagues.			
Autonomy	The students are capable of independently planning and documenting the work steps and procedures while considering the giv deadlines. This includes the ability to accurately procure the newest scientific information. Furthermore, they can obtain feedba from experts with regard to the progress of the work, and to accomplish results on the state of the art in science and technology			
Workload in Hours	Independent Study Time 180, Study Time in Lecture 0			
Credit points	6			
Course achievement	None			
Examination	Study work			
Examination duration and	see FSPO			
scale				

Courses				
Title		Тур	Hrs/wk	СР
Sustainable Nature-based Coastal	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- an 	d Flood Protection		
Educational Objectives	After taking part successfully, students have reached the	e following learning results		
Professional Competence Knowledge	 Climate and Climate Change General Impacts of Climate Change on Wind Regir Consequences of Climate Change for Coastal Proce Coastal Protection in Taiwan and Germany Fundamentals of Climate Adaptation Nature-based Solutions (NBS) for Coastal Protection 	esses		
Skills	 Critical thinking: analysis of processes and relation Creative thinking: development of adaptation stra Practical thinking: inclusion of restrictions, appli methods Consideration of complex tasks 	tegies and adaptation measures	nods, numerica	al models, plannir
Personal Competence Social Competence	 Working in heterogenous groups Working in international groups Working with different scientific / non-scientific dis Self reflection 	ciplines		
Autonomy	Application oriented use of knowledge and skillsAutonomous work on complex tasks			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
Examination duration and	Preparation of a written report on a complex task with	a presentation and subsequent discussion	on. The work o	on the complex ta
scale	happens in the course of the lecture.			
Assignment for the Following Curricula	Civil Engineering: Specialisation Coastal Engineering: Ele Civil Engineering: Specialisation Geotechnical Engineering: Civil Engineering: Specialisation Structural Engineering: Civil Engineering: Specialisation Water and Traffic: Electi Environmental Engineering: Specialisation Environment a Water and Environmental Engineering: Specialisation Cit	g: Elective Compulsory Elective Compulsory ve Compulsory and Climate: Elective Compulsory		
		ies: Elective Compulsory vironment: Elective Compulsory		

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

Courses	
Title Adaptation to climate change in hy	draulic engineering (L2291)
Module Responsible	Prof. Peter Fröhle
Admission Requirements	
Recommended Previous Knowledge	 Hydrology, Hydraulic Engineering Hydromechanic, Hydraulics Fundamentals of Coastal Engineering, Coastal- and Flood Protection Hydrological Systems
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence Knowledge Skills	 Climate protection and climate adaptation Insights into climate change and its regional characteristics - fundamentals, climate modelling / climate models Impacts of climate change on the components of the regional hydrological cycle Fundamentals of analysis of climate data Consequences of the impact of the climate change Measures for climate adaptation Assessment, prioritization and communication of adaptation measures Fundamentals of the analysis of hydrometeorological and hydrological data Critical thinking: analysis of processes and relations, assessment of needs for action Creative thinking: inclusion of restrictions, application of calculation approaches, methods, numerical models, plann methods Consideration of complex tasks
Personal Competence Social Competence Autonomy	 Working in heterogenous groups Working with different scientific / non-scientific disciplines Self reflection Application oriented use of knowledge and skills
	Autonomous work on complex tasks
Manual Inc. of the state	ledes and act Churk Time 124. Churk Time in Lastrum FC
	Independent Study Time 124, Study Time in Lecture 56
Credit points Course achievement	
	Written elaboration Preparation of a written report and a presentation of a complex task.
•	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory Civil Engineering: Specialisation Structural Engineering: Elective Compulsory Civil Engineering: Specialisation Water and Traffic: Elective Compulsory Water and Environmental Engineering: Specialisation Cities: Elective Compulsory
	Water and Environmental Engineering: Specialisation Environment: Elective Compulsory Water and Environmental Engineering: Specialisation Water: Elective Compulsory

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

Courses				
Title		Тур	Hrs/wk	СР
Modern discretization methods in structural mechanics (L3043)		Lecture	2	3
Modern discretization methods in s	tructural mechanics (L3044)	Recitation Section (small)	2	3
Module Responsible	Prof. Bastian Oesterle			
Admission Requirements	None			
Recommended Previous Knowledge	• Finite Element Methods			
	Flächentragwerke			
Educational Objectives	After taking part successfully, students have reac	hed the following learning results		
Professional Competence				
Knowledge	After successful completion of this module, students can express the basic aspects of modern discretization methods in structura mechanics.			
Skills	After successful completion of this module, the students will be able to use and further improve modern discretization methods for problems in structural mechanics.			
Personal Competence				
Social Competence	Students can			
	 participate in subject-specific and interdisc 	iplinary discussions,		
	• defend their own work results in front of ot	hers		
	promote the scientific development of colleagues			
	• Furthermore, they can give and accept pro	fessional constructive criticism		
Autonomy	Students are able to gain knowledge of the subje	ct area from given and other sources and a	oply it to new pro	blems. Furthermo
	they are able to structure the solution process for	problems in the area of modern discretizati	on methods.	
Workload in Hours	Independent Study Time 124, Study Time in Lectu	ıre 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	Civil Engineering: Specialisation Coastal Engineer	ing: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Eng	ineering: Elective Compulsory		
	Civil Engineering: Specialisation Structural Engine	ering: Elective Compulsory		
	Civil Engineering: Specialisation Computational Er	ngineering: Elective Compulsory		
	Theoretical Mechanical Engineering: Specialisation	n Simulation Technology: Elective Compulso	ry	

Course L3043: Modern discre	etization methods in structural mechanics
Тур	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Bastian Oesterle
Language	EN
Cycle	WiSe
Content	 The course covers variational formulations, various locking phenomena and alternative formulations for finite elements and modern discretization schemes in the context of structural mechanics, like isogeometric analysis. variational formulation of finite elements, mixed variational principles geometrical and material locking effects in structural and solid mechanics hybrid-mixed and enhanced assumed strain finite element formulations, reduced integration and stabilization, DSG method, u-p formulations patch test, stability, convergence linear and non-linear analyses introduction to isogeometric analysis isogeometric beam, plate and shell formulations locking effects and their avoidance in modern, smooth discretization schemes, like isogeometric analysis
Literature	 lecture notes and selected scientific papers O.C. Zienkiewicz, R.L. Taylor, and J.Z. Zhu: Finite Element Method: Its Basis and Fundamentals. Elsevier, 2013. J. Austin Cottrell, Thomas J. R Hughes, Yuri Bazilevs: Isogeometric Analysis: Toward Integration of CAD and FEA. Wiley, 2009.

Course L3044: Modern discre	ourse L3044: Modern discretization methods in structural mechanics		
Тур	Recitation Section (small)		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Bastian Oesterle		
Language	EN		
Cycle	WiSe		
Content	See interlocking course		
Literature	See interlocking course		

Courses				
Title		Тур	Hrs/wk	СР
Scientific Working in Computationa	Engineering (L2764)	Project-/problem-based Learning	4	6
Module Responsible	Prof. Kay Smarsly			
Admission Requirements	None			
Recommended Previous	Basic knowledge in scientific writing. String interest in topics	s related to computing in civil engine	ering.	
Knowledge				
Educational Objectives	After taking part successfully, students have reached the fol	lowing learning results		
Professional Competence				
Personal Competence	course instructors and in collaboration with each other, the thinking, being able to accurately plan, implement and an will be conducted throughout the semester, which will contr this course, a scientific paper will be developed based, whi based on the project conducted within this course. Projec scientific publications are further key activities. The students will be capable (i) of solving a scientific prob effectively in the form of a paper, and (iii) of sharing their w	alyze scientific projects, such as pro ibute to the grade. Since scientific wi ch is a prerequisite for the final exan t meetings in small groups, present lem following a scientific methodolo ork in a presentation.	spective mash iting is of part nination. The p ations, and co gy, (ii) of doc	urer theses. A projecticular importance paper will be writt ritical discussions
Autonomy	The students will be able to extend their knowledge and app	ly it to solve scientific problems by w	vorking indepe	ndently in a proje
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points				
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: B	Elective Compulsory		
	Civil Engineering: Specialisation Coastal Engineering: Electiv	e Compulsory		
	Civil Engineering: Specialisation Structural Engineering: Elec	tive Compulsory		
	Civil Engineering: Specialisation Computational Engineering	Elective Compulsory		
	Computer Science: Specialisation II: Intelligence Engineering	1: Elective Compulsory		

Course L2764: Scientific Wor	rking in Computational 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. Kay Smarsly
Language	EN
Cycle	WiSe/SoSe
Content	In the course, a scientific problem of practical relevance will first be defined, taking into account the interests of the students participating in the course. The scientific problem will then systematically be solved within the framework of a comprehensive project. The principles of scientific working will be taught based on the scientific problem defined previously. As an integral part of scientific working, fundamentals of scientific writing will be presented and applied to a scientific paper to be written during the course. Topics related to scientific writing include structuring in scientific writing (structuring the abstract, the introduction, the main part, the summary and conclusions, and the acknowledgments and references) and recommendations on effective scientific writing (principles of composition, use of English in scientific writing, useful tips, creating figures, writing in mathematics, referencing, and formal email correspondence). A final paper and a final presentation will be assembled by the students.
Literature	Smarsly, K. & Dragos, K., 2019. Scientific Writing in Engineering. Tredition, Hamburg, Germany.

	ing and Excavation Law				
Courses					
Title		Тур	Hrs/wk	СР	
Construction law BGB and VOB - la		Lecture	2	3	
	ction (excavation) practice (L3181)	Lecture	2	3	
Module Responsible					
Admission Requirements					
	Complete modules: Geotechnics I-III				
Knowledge	After taking part successfully, students have re-	ached the following learning results			
Professional Competence	After taking part successfully, students have re	actied the following learning results			
-	Students will gain knowledge of				
	 the history of civil engineering law, 				
	basics of foundation and civil engineering	g law,			
	 legal aspects of technical regulations in a 	civil engineering (with case studies),			
	 the civil engineering contract, 				
	 the liability of the designer and contractor 	or in civil engineering,			
	 the subsoil risk and the system risk, the total debt in (civil) engineering law, the (construction) conflict, dispute avoidance models and the construction process, the systematics of construction contract law, the BGB construction contract law, 				
	 responsibilities on the construction site, 				
	 remuneration and contract management 				
	 liability for defects, 				
	public procurement law				
	 Disturbed construction processes: How n 	nuch money am I entitled to?			
	Correct calculation of supplements.				
Skills	Students learn to apply legal aspects in planni	ng and construction in a legally balance	ed way. Students learn l	now to use legal a	
	construction management aspects in practice				
	to manage the construction project optimally.				
Personal Competence					
-	Students can work in groups and support each	other in finding solutions.			
	Students are able to assess their own strengths		ne and learning manage	ment based on th	
Workload in Hours	Independent Study Time 124, Study Time in Le	cture 56			
Credit points	6				
Course achievement	None				
Examination	Oral exam				
Examination duration and	30 min				
scale					
Assignment for the	Civil Engineering: Specialisation Coastal Engine	• • •			
Following Curricula		5 5 1 5			
	Civil Engineering: Specialisation Structural Engi	• • • •			
	Civil Engineering: Specialisation Water and Traf				
	Civil Engineering: Specialisation Computational	Engineering: Elective Compulsory			

Course L3182: Construction	law BGB and VOB - law in (excavation) practice
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Günther Schalk
Language	DE
Cycle	WiSe
Content	
Literature	Literatur: - Folienskript (in der Vorlesung erhältlich) - Fuchs/Maurer/Schalk: Handbuch Tiefbaurecht

Course L3181: Construction	urse L3181: Construction disputes from construction (excavation) practice		
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Ingo Junker		
Language	DE		
Cycle	WiSe		
Content			
Literature			

Courses					
Title		Тур	Hrs/wk	СР	
Coastal- and Flood Protection (L08	8)	Lecture	2	3	
Coastal- and Flood Protection (L14)	5)	Project-/problem-based Learning	1	1	
Maintenance and Defence of Flood Protection Structures (L1411)		Lecture	2	2	
Module Responsible	Prof. Peter Fröhle				
Admission Requirements	None				
Recommended Previous	Coastal Engineering I				
Knowledge					
Educational Objectives	After taking part successfully, students have reached the	following learning results			
Professional Competence					
Knowledge	The students have the capability to define and explain in	detail the important aspects of erosi	on protection	and flood protection	
	and are able to apply the aspects to practical coastal protection problems. They are able to design and dimension in				
	coastal protection measures from the functional and from the constructional point of view.				
Skills	Skills The students are able to select design approaches for the functional and constructional design of erosion				
Skiis	measures and apply these approaches to practical design tasks.				
	······································				
Personal Competence					
Social Competence	The students are able to deploy their gained knowledge in applied problems such as the functional and constructive de				
	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 ki	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 exami	nation includes tasks with respect to	the general ι	understanding of th	
scale	lecture contents and calculations tasks.				
Assignment for the	Civil Engineering: Specialisation Coastal Engineering: Con	pulsory			
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering	: Elective Compulsory			
	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory				
	Environmental Engineering: Specialisation Environment a	nd Climate: Elective Compulsory			
	Environmental Engineering: Specialisation Water Quality	and Water Engineering: Elective Compu	Ilsory		
	Water and Environmental Engineering: Specialisation Env	ronment: Elective Compulsory			
	Water and Environmental Engineering: Specialisation Wat	an Elective Compulson			

Course L0808: Coastal- and 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 I	ourse 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

Courses				
Title		Тур	Hrs/wk	СР
Waste and Environmental Chemist	-	Practical Course	2	2
Biological Waste Treatment (L0318		Project-/problem-based Learning	3	4
Module Responsible	Prof. Kerstin Kuchta			
Admission Requirements	None			
Recommended Previous	chemical and biological basics			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the	e following learning results		
Professional Competence				
Knowledge	The module aims possess knowledge concerning the pl design and layout of anaerobic and aerobic waste treat plants for biological waste treatment plants and explain	ment plants in detail, describe different te		
Skills	The students are able to discuss the compilation of design and layout of plants. They can critically evaluate techniques and quali 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.			
Personal Competence				
	Students can participate in subject-specific and interdi	sciplinary discussions, develop cooperate	ed solutions a	nd defend their
	work results in front of others and promote the scier 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				
Course achievement	Compulsory Bonus Form Desc	ription		
	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: E	ective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineer	ng: Elective Compulsory		
	Civil Engineering: Specialisation Structural Engineering:	Elective Compulsory		
	Civil Engineering: Specialisation Water and Traffic: Elec	ive Compulsory		
	Bioprocess Engineering: Specialisation A - General Biop	rocess Engineering: Elective Compulsory		
	Chemical and Bioprocess Engineering: Specialisation Ge	eneral Process Engineering: Elective Comp	oulsory	
	Chemical and Bioprocess Engineering: Specialisation Bi	oprocess Engineering: Elective Compulsor	у	
	Chemical and Bioprocess Engineering: Specialisation Ch	emical Process Engineering: Elective Con	npulsory	
	Chemical and Bioprocess Engineering: Specialisation Ch	emical and Bio process Engineering: Elec	tive Compuls	ory
	Environmental Engineering: Core Qualification: Compute	sory		
	International Management and Engineering: Specialisat		lsory	
	Process Engineering: Specialisation Environmental Proc			
	Water and Environmental Engineering: Specialisation C			
	Water and Environmental Engineering: Specialisation E	wireement: Elective Compulsory		

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

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

Courses				
Title		Тур	Hrs/wk	СР
Finite element modeling of structures (L3046)		Lecture	2	3
Finite element modeling of structur	es (L3047)	Recitation Section (small)	2	3
Module Responsible	Prof. Bastian Oesterle			
Admission Requirements	None			
Recommended Previous Knowledge	Finite Element MethodsThin-walled structures			
Educational Objectives	After taking part successfully, students have re	eached the following learning results		
Professional Competence				
Knowledge	After successful completion of this module, stu	dents can express the basic aspects of modelli	ng of structures v	with finite elements
Skills	After successful completion of this module, the students will be able to model structures with finite elements and to analy structures using appropriate computational methods.			
Personal Competence				
Social Competence	Students can			
	 participate in subject-specific and interd 	isciplinary discussions,		
	 defend their own work results in front of 	others		
	 promote the scientific development of compared on the scientific development of compared on the science of the sc	olleagues		
	 Furthermore, they can give and accept p 	professional constructive criticism		
Autonomy	Students are able to gain knowledge of the sub they are able to structure the solution process			
Workload in Hours	Independent Study Time 124, Study Time in Le	ecture 56		
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
Examination duration and	written elaboration of a project work (10-15 pa	ges)		
scale				
Assignment for the	Civil Engineering: Specialisation Computational	Engineering: Compulsory		
Following Curricula	Civil Engineering: Specialisation Coastal Engine	eering: Elective Compulsory		
	Civil Engineering: Specialisation Geotechnical E	Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Structural Eng	ineering: Elective Compulsory		
	Theoretical Mechanical Engineering: Specialisa	tion Simulation Technology: Elective Compulso	ry	

ourse L3046: Finite element modeling of structures		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Bastian Oesterle	
Language	EN	
Cycle	WiSe	
Content	 Basic phenomena and aspects of the finite element modelling of structures are discussed. Besides theoretical decription of the phenomena and methods, a strong focus is on the practical use a commercial finite element software within computer-based exercises. The covered topics are: finite element modeling of trusses/beams/frames, plates subject to in-plane/out-of-plane loading and shells convergence properties of displacements and stresses singularities locking effects critical assessment, interpretation and check of results mixed-dimensional coupling of finite elements geometrically linear and non-linear, and material linear and non-linear analyses stability: bifurcation and snap-through problems dynamic problems, modal analyses 	
Literature	Vorlesungsmanuskript, Vorlesungsfolien	

Course L3047: Finite elemen	urse L3047: Finite element modeling of structures	
Тур	Recitation Section (small)	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Bastian Oesterle	
Language	EN	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Courses				
Courses				
Title		Тур	Hrs/wk	СР
Modeling of Subsurface Processes Subsurface Solute Transport (L272		Recitation Section (sma Lecture	II) 3 2	3 2
Subsurface Solute Transport (L272 Subsurface Solute Transport (L272		Recitation Section (larg		1
Module Responsible				
Admission Requirements	None			
	Basic Mathematics, Hydrology			
Knowledge				
Educational Objectives	After taking part successfully, students ha	ave reached the following learning results		
Professional Competence				
	Upon completion of this module, the st	udents will understand the mechanisms con	trolling solute transp	ort in soil and natu
-	porous media and will be able to work with	th the equations that govern the fate and tran	sport of solutes in po	orous media. Analytic
	numerical and experimental tools and tec	chniques will be used in this module.		
	·			
Skills		tudents will be exposed to analytical, experim		
	·	excellent opportunity to improve their skills or	n multiple fronts whic	h will be useful in th
	future career.			
Personal Competence				
Social Competence	Teamwork & problem solving			
Autonomy	The students will be involved in writing individual reports and presentation. This will contribute to the students' ability and			
	willingness to work independently and re-	sponsibly.		
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			
scale				
Assignment for the	Civil Engineering: Specialisation Structura	al Engineering: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechi	nical Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Coastal E	Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Water an	nd Traffic: Elective Compulsory		
	Civil Engineering: Specialisation Computa	tional Engineering: Elective Compulsory		
	Chemical and Bioprocess Engineering: Te	chnical Complementary Course: Elective Com	pulsory	
	Environmental Engineering: Core Qualific	ation: Compulsory		
	Process Engineering: Specialisation Enviro	onmental Process Engineering: Elective Comp	ulsory	
	Process Engineering: Specialisation Proce	ss Engineering: Elective Compulsory		
	Water and Environmental Engineering: Sp	pecialisation Water: Compulsory		
	Water and Environmental Engineering: Sp	acciplication Environment: Elective Compulsor		

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	Dr. Milad Aminzadeh
Language	EN
Cycle	WiSe
Content	Basic usage and background of chosen computer software to calculate flow and transport in the saturated and unsaturated zone and to analyze field data like pumping test data
Literature	

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

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

Specialization Computational Engineering

1odule M0963: Steel				
Courses				
Title		Тур	Hrs/wk	СР
Steel and Composite Structures (L1	204)	Lecture	2	2
Steel and Composite Structures (L1	205)	Recitation Section (large)	2	2
Steel Bridges (L1097)		Lecture	2	2
Module Responsible	Prof. Marcus Rutner			
Admission Requirements	None			
Recommended Previous	Basics of steel construction (i.e. Steel Structures I and	II, BUBC)		
Knowledge				
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence				
Knowledge	After successful completition, students can			
	 describe the phenomenon of local buckling 			
	explain warping torsion			
	 illustrate the behaviour of composite structures 			
	 specify the principles in design of composite stt 			
	 sketch the contructions of steel and composite 			
Skills	After successful participation students are able to			
	 check stiffened and unstiffened plated structure 	25		
	 recognize and verify warping tosion in strucure 	5		
	design composite structures			
	 design bridges and o perform the detailing 			
Demonal Commentance				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points				
	None			
Examination	Written exam			
Examination duration and	180 min			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Engineering			
Following Curricula	Civil Engineering: Specialisation Geotechnical Enginee	• • •		
	Civil Engineering: Specialisation Coastal Engineering:			
	Civil Engineering: Specialisation Water and Traffic: Ele			
	Civil Engineering: Specialisation Computational Engine	• • •		
	International Management and Engineering: Specialisa	ation II. Civil Engineering: Elective Comp	ulsory	

Course L1204: Steel and Composite Structures				
Тур	Lecture			
Hrs/wk	2			
СР	2			
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28			
Lecturer	Prof. Marcus Rutner			
Language	DE			
Cycle	WiSe			
Content	 Local-buckling of plated structures Warping torsion Composite-girders, -columns, -slabs, -bridges Principles in composite constructions Bridge-design and -construction 			
Literature	Petersen, C.: Stahlbau, 4.Auflage 2013, Springer-Vieweg Verlag Minnert, J. Wagenknecht, G.: Verbundbau-Praxis - Berechnung und Konstruktion nach Eurocode 4, 2.Auflage 2013, Bauwerk Beuth Verlag			

Course L1205: Steel and Con	ourse L1205: Steel and Composite Structures			
Тур	Recitation Section (large)			
Hrs/wk	2			
СР	2			
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28			
Lecturer	Prof. Marcus Rutner			
Language	DE			
Cycle	WiSe			
Content	See interlocking course			
Literature	See interlocking course			

Course L1097: Steel Bridges				
Тур	Lecture			
Hrs/wk	2			
СР	2			
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28			
Lecturer	Yves Freundt			
Language				
Cycle				
Content	Lecture Contents ,Steel Bridge Construction' DrIng. Jörg Ahlgrimm			
	- From tendering and contracting to completion - the development of a steel bridge			
	- Contents of a bridge static - structural details, examples of analysis in detail:			
	-> effective width in regard to the longitudinal stiffeners			
	-> Bearing point, bearing stiffener			
	-> Crossbeam breakthrough, crossbeam reinforcement			
	-> Analysis of the Rib-to-Floorbeam (RF) connection (web-tooth of the floorbeam between trapezoidal shaped Ribs)			
	- Steel grades, -designation, testing methods and approval certificates			
	- Nondestructive weld inspecting			
	- Corrosion protection			
	- Bridge bearing - types, format, function, dimensioning, installation			
	- Expansion Joints			
	- Oscillation of bridge hangers and cables - oscillation damper			
	- Opening bridges- Detailed reviews to different assembling procedures and - implements			
	- Selective damage events			
	Requirements: Basic knowledge in the calculation, dimensioning, and construction of structural elements and joints of constructional steelwork			
Literature				
	Herbert Schmidt, Ulrich Schulte, Rainer Zwätz, Lothar Bär: Ausführung von Stahlbauten			
	Petersen, Christian: Stahlbau, Abschnitt Brückenbau			
	 Ahlgrimm, J., Lohrer, I.: Erneuerung der Eisenbahnüberführung in Fulda-Horas über die Fulda, Stahlbau 74 (2005), Heft 2, S. 114 			

Courses					
Title		Тур	Hrs/wk	СР	
Numerical Methods in Geotechnics	(L0375)	Lecture	3	3	
Advanced Foundation Engineering	(L0497)	Lecture	2	2	
Advanced Foundation Engineering	(L0498)	Recitation Section (large)	1	1	
Module Responsible	Prof. Jürgen Grabe				
Admission Requirements	None				
Recommended Previous	Geotechnics I and II, Mathematics I-III				
Knowledge					
Educational Objectives	After taking part successfully, students have reached	I the following learning results			
Professional Competence					
Knowledge	After successfully completing the module, students v	vill be able to			
	 describe individual procedures for the geotech 		isures,		
	 reproduce exploration and investigation methods 				
	 select suitable types of field and laboratory te 				
	 state the differences between various stress a 	nd deformation states and the physical s	significance of inv	variants of the stre	
	and distortion tensor,				
	outline the standard and special soil mechanic		in behavior of soi	il,	
	describe continuum models and the resulting				
	 as well as define boundary value problems from the second s	m the field of geotechnical engineering i	n such a way tha	it they can be solv	
	unambiguously.				
Skills	Students will be able to				
	 dimension vertical drains for soil improvement 				
	 calculate depth compaction using various appropriate methods, apply principles of horizontal bearing capacity of piles, verify the internal and external stability of fluid-supported diaphragm walls, evaluate the boundary conditions for the design of a deep excavation and design the individual components of a deep excavation. 				
	excavation,				
	 perform, evaluate and interpret tests for the d 	escription and classification of soils acco	rding to applicabl	le standards,	
	 computationally implement numerical algorith 	ms to solve boundary value problems,			
	 select and apply the types of analyses dependence 	ing on the degree of saturation, the impa	act, and the mate	erial behavior	
	determine appropriate model parameters for	different possibilities and limitations of m	naterial models fo	or the grain structu	
	of soils.				
Personal Competence					
	Students can work in groups and support each other	in finding solutions			
social competence	Stadents can work in groups and support each other	m many solutions.			
Autonomy	Students are able to assess their own strengths and weaknesses and, based on this, organize their time and learning managem				
	and think in terms of processes.				
Westles 11. II.	Independent Study Time OC, Study Time in the second	4			
Workload in Hours Credit points	Independent Study Time 96, Study Time in Lecture 84				
Course achievement					
Examination					
Examination duration and	120 min				
scale					
Assignment for the					
Following Curricula	Civil Engineering: Specialisation Geotechnical Engine				
	Civil Engineering: Specialisation Coastal Engineering				
	Civil Engineering: Specialisation Water and Traffic: E				
	Civil Engineering: Specialisation Computational Engin				
	International Management and Engineering: Specialis	sation II. Civil Engineering: Elective Comp	oulsory		

Course L0375: Numerical Me	thods in Geotechnics			
Тур	Lecture			
Hrs/wk	3			
СР	3			
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42			
Lecturer	Dr. Hans Mathäus Stanford			
Language	DE			
Cycle	WiSe			
Content	Topics:			
	 Introduction to numerical soil mechanics Introduction to numerical mathematics Finite Element Method (analysis procedures, algorithms) Finite Element Method (application in geotechnical engineering) 			
Literature	 Wriggers P. (2001): Nichtlineare Finite-Elemente-Methoden. Springer Wriggers P. (2008): Nonlinear Finite Element Methods. Springer Deutsche Gesellschaft für Geotechnik e.V. (Hrsg., 2014): Empfehlungen des Arbeitskreises "Numerik in der Geotechnik". Ernst & Sohn 			

Course L0497: Advanced Fou	Indation Engineering			
Тур	ecture			
Hrs/wk	2			
СР	2			
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28			
Lecturer	Prof. Jürgen Grabe			
Language	DE			
Cycle	WiSe			
Content	 Vertical drains Piles Ground improvement (Deep Compaction, Soil mixing) Vibration driving Jet grouting Slurry wall Deep excavation 			
Literature	 EAK (2002): Empfehlungen für Küstenschutzbauwerke EAU (2004): Empfehlungen des Arbeitsausschusses Uferbauwerke EAB (1988): Empfehlungen des Arbeitskreises Baugruben Grundbau-Taschenbuch, Teil 1-3, (1997), Ernst & Sohn Verlag 			

Course L0498: Advanced Fou	ourse L0498: Advanced Foundation Engineering		
Тур	Recitation Section (large)		
Hrs/wk	1		
СР	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Prof. Jürgen Grabe		
Language	DE		
Cycle	WiSe		
Content	See interlocking course		
Literature	See interlocking course		

Module M0713: Conci	rete Structures						
	iete Structures						
Courses							
Fitle			Ту	/p	Hrs/wk	СР	
Concrete Structures (L0579)				eminar	1	1	
Structural Concrete Members (L05	77)		Le	ecture	2	3	
Structural Concrete Members (L05	78)		Re	ecitation Section (large)	2	2	
Module Responsible	NN						
Admission Requirements	None						
Recommended Previous	Basics of structural ar	nalysis, conception ar	nd dimensioning of struct	ural concrete			
Knowledge							
	Modules: Reinforced (Concrete Structures I-	+II, Structural Analysis I+	II, Mechanics I+II			
Educational Objectives	After taking part succ	essfully, students hav	ve reached the following	learning results			
Professional Competence	· · · · · · · · · · · · · · · · · · ·			·····			
•	The students broader	n their skills in structu	ral engineering especial	ly in the field of buildings	(houses roofs h	alls) They dispose	
Kilomeage				and structural members t			
	and knowledge for and		gir of concrete bananigs .				
Skills	The students are able	e to apply procedures	s of the conception and d	limensioning to to praction	cal problems of st	ructural engineeri	
	They are capable to draft concrete buildings and to design them for general action effects and to plan their				their detailing a		
	execution. Moreover, they can make design and construction sketches and draw up technical descriptions.						
Personal Competence							
-	The students are able	to obtain regults of h	igh quality in teamwork.				
Social Competence	The students are able		light quality in teamwork.				
Autonomy	The students are able	e to carry out complex	conception and dimensi	oning tasks of structures	under the guidan	ce of tutors.	
	Independent Study Ti	me 110, Study Time i	in Lecture 70				
Credit points							
Course achievement		Form	Description				
-	No None	Presentation	ES WEIDEN Z REI	erate ausgegeben			
	Written exam						
Examination duration and	120 minutes						
scale							
-			Engineering: Compulsory				
Following Curricula	• • •		cal Engineering: Elective				
	Civil Engineering: Spe	ecialisation Coastal Er	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory				
	Civil Engineering: Specialisation Water and Traffic: Elective Compulsory						
	Civil Engineering: Spe	ecialisation Water and	Traffic: Elective Compuls	sory			
	• • •		Traffic: Elective Computer in the second s				

Course L0579: Concrete Structures				
Тур	Seminar			
Hrs/wk	1			
СР	1			
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14			
Lecturer	NN			
Language	DE			
Cycle	WiSe			
Content	With help of a project teamwork the subjects of the course "Concrete Structures" is practiced, discussed and presented.			
Literature	- Projektbezogene Unterlagen werden abgegeben.			

Course L0578: Structural Concrete Members	
Тур	Recitation Section (large)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	NN
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Iodule M1748: Const		
Courses		
Fitle	Typ Hrs/wk	СР
Construction Robotics (L2867)	Project-/problem-based Learning 6	6
Module Responsible		
Admission Requirements Recommended Previous		
Knowledge		
Educational Objectives		
Professional Competence	3	
Knowledge	Basics of robotics	
	Applications in civil engineering	
	Kinematics	
Skills	s Use of specific hardware	
	Development of software routines	
	Python programming language	
	Image processing	
	Basics of localization (LIDAR, SLAM)	
Personal Competence		
Social Competence	Teamwork	
	Communication skills	
Autonomy	/ Independent work	
	Independent decisions	
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84	
Credit points	5 6	
Course achievement	t None	
Examination	N Written elaboration	
Examination duration and		
scale		
•	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory	
Following Curricula		
	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory	
	Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory	
	Civil Engineering: Specialisation Computational Engineering: Elective Compulsory	
	Computer Science: Specialisation II: Intelligence Engineering: Elective Compulsory	
	Mechatronics: Core Qualification: Elective Compulsory	
	Theoretical Mechanical Engineering: Specialisation Robotics and Computer Science: Elective Compulsory	

τνρ	Project-/problem-based Learning
Hrs/wk	
CP	
	Independent Study Time 96, Study Time in Lecture 84
	Prof. Kay Smarsly, Jan Stührenberg
Language	
Cycle	
Content	 Introduction: Robotics in civil engineering Presentation of potential topics Programming of algorithms in Python Application of software systems: LINUX distribution, ROS, CloudCompare, Application of hardware systems: Petoi Bittle Dog, Raspberry Pi, Arduino, sensing Topics considered for robotics using the Petoi Bittle Dog: Movement Use of sensors (camera, infrared,) Data structures/data acquisition Programming Topics technically relevant to building inspection: Geodetic evaluations Image processing Localization
Literature	Bock/Linner: Construction Robotics
	Verl et al.: Soft Robotics
	Pasquale: New Laws of robotics

Courses				
Title		Тур	Hrs/wk	СР
Modeling of Subsurface Processes	(L2731)	Recitation Section (sma	I) 3	3
Subsurface Solute Transport (L272	8)	Lecture	2	2
Subsurface Solute Transport (L272	9)	Recitation Section (large	2) 1	1
Module Responsible	Prof. Nima Shokri			
Admission Requirements	None			
Recommended Previous	Basic Mathematics, Hydrology			
Knowledge				
Educational Objectives	After taking part successfully, students ha	ave reached the following learning results		
Professional Competence				
Knowledge	Upon completion of this module, the st	udents will understand the mechanisms cont	rolling solute transpo	ort in soil and natu
	porous media and will be able to work wit	th the equations that govern the fate and tran	sport of solutes in por	ous media. Analyti
	numerical and experimental tools and tec	hniques will be used in this module.		
Skills	In addition to the physical insights, the st	udents will be exposed to analytical, experime	ental and numerical to	ools and techniques
	this module. This provides them with an e	excellent opportunity to improve their skills or	multiple fronts which	n will be useful in th
	future career.			
Personal Competence				
Social Competence	Teamwork & problem solving			
Autonomy	The students will be involved in writing	g individual reports and presentation. This v	vill contribute to the	students' ability a
	willingness to work independently and res	sponsibly.		
Workload in Hours	Independent Study Time 96, Study Time i	n Lecture 84		
Credit points	6			
Course achievement	None			
Examination	Subject theoretical and practical work			
Examination duration and	Report			
scale				
Assignment for the	Civil Engineering: Specialisation Structura	l Engineering: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechr	nical Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Coastal E	ngineering: Elective Compulsory		
	Civil Engineering: Specialisation Water an	d Traffic: Elective Compulsory		
	Civil Engineering: Specialisation Computa	tional Engineering: Elective Compulsory		
	Chemical and Bioprocess Engineering: Te	chnical Complementary Course: Elective Com	oulsory	
	Environmental Engineering: Core Qualific	ation: Compulsory		
	Process Engineering: Specialisation Enviro	onmental Process Engineering: Elective Compu	Ilsory	
	Process Engineering: Specialisation Proce	ss Engineering: Elective Compulsory		
	Water and Environmental Engineering: Sp	pecialisation Water: Compulsory		

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

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

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

Module M1845: Thin-	walled structures			
Courses				
Title		Тур	Hrs/wk	СР
Thin-walled structures (L1199)		Lecture	2	3
Thin-walled structures (L3045)		Recitation Section (large)	2	3
Module Responsible	Prof. Bastian Oesterle			
Admission Requirements	None			
Recommended Previous				
Knowledge	Structural Analysis I			
	Structural Analysis II			
	Finite Element Methods			
Educational Objectives	After taking part successfully, students have	e reached the following learning results		
Professional Competence				
Knowledge	After successful completion of this module	, the students can express the basic aspects	of the load-carryir	ng behaviour of thir
	walled structures.			
Skills	After successful completion of this module.	the students will be able to predict load-carr	ving behaviour of t	hin-walled structure
	using appropriate analytical and coputation		,g	
Personal Competence				
Social Competence	Students can			
	 participate in subject-specific and interview. 	erdisciplinary discussions,		
	defend their own work results in front	of others		
	 promote the scientific development of 	f colleagues		
	 Furthermore, they can give and accept 	-		
Autonomy		subject area from given and other sources and		
	they are able to structure the solution proce	ss for problems in the area of modelling and a	nalysis of thin-walle	d structures.
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 Coastal Eng	ineering: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnic	al Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Computation	nal Engineering: Compulsory		
	Civil Engineering: Specialisation Structural E	ngineering: Elective Compulsory		
	Theoretical Mechanical Engineering: Special	isation Simulation Technology: Elective Compu	ilsory	

Тур	Lecture
Hrs/wk	
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
	Prof. Bastian Oesterle
Language	DE
Cycle	SoSe
Content	Plates loaded in-plane
	 Governing equations (equilibrium, kinematics, constitutive law)
	Differential equation
	Airy stress function
	Plane stress / plane strain
	Structural behaviour of plates loaded in-plane
	• finite elements for plates loaded in-plane, modelling apsects, interpretation and critical assessment of results
	Plates in bending
	Governing equations (equilibrium, kinematics, constitutive law)
	Differential equation
	Navier solution / Fourier series expansion
	Approximation procedures
	Circular and rectangular plates
	Structural behaviour of plates in bending
	• finite elements for plates in bending, modelling apsects, interpretation and critical assessment of results
	Shells
	Phenomenona of the structural behaviour of shells
	Membrane and bending theory
	Equilibrium equations of shells of revolution
	 Stress resultants and deformations of the spherical shell, the half spherical shell, and the cylindrical shell
	finite elements for shells
	Stability problems (overview)
	Plate buckling
	Shell buckling
	• Shell blecking
Literature	
Literature	Vorlesungsmanuskript
	• Basar, Y.: Krätzig, W.B. (1985): Mechanik der Flächentragwerke. Vieweg-Verlag, Braunschweig, Wiesbaden
	• Girkmann, K. (1963): Flächentragwerke, Springer Verlag, Wien, 1963, unveränderter Nachdruck 1986
	• Zienkiewicz, O.C. (1977): The Finite Element Method in Enginieering Science. McGraw-Hill, London

Course L3045: Thin-walled st	urse L3045: Thin-walled structures	
Тур	Recitation Section (large)	
Hrs/wk	2	
CP	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Bastian Oesterle	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Courses				
Title		Түр	Hrs/wk	СР
Hydraulic Models (L0813)		Project-/problem-based Learning	1	1
Modelling of Waves (L0812)		Project-/problem-based Learning	1	1
Modelling of Flow in Rivers and Est	uaries (L0810)	Lecture	3	4
Module Responsible	Prof. Peter Fröhle			
Admission Requirements	None			
Recommended Previous	Coastal Hydraulic Engineering I			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the following part successfully and the students have reached the following part successfully and the students have reached the students have been successfully as the students have reached the students have been successfully as the stude	owing learning results		
Professional Competence				
Knowledge	Students are able to define in detail the basic processes if	hat are related to the modelling	of flows in hy	ydraulic engineerir
	Besides, they can describe the basic aspects of numerical m	odelling and actual numerical mod	els for the sir	mulation of flows a
	waves.			
Skills	Students are able to apply hydrodynamic-numerical models t	o practical hydraulic engineering ta	ckc	
JKIIIS	students are usic to upply hydrodynamic-hamenear models t	b practical hydraulic clighteering ta	585.	
Personal Competence				
Social Competence	The students are able to deploy their gained knowledge in si	mple applied problems. Additionaly	, they will be	able to work in tea
	with others.			
Autonomy	The students will be able to independently extend their know	ledge 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 3 hours. The examination	on includes tasks with respect to	the general ι	understanding of t
scale	lecture contents and calculations tasks.			
Assignment for the	Civil Engineering: Specialisation Structural Engineering: Elect	ve Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering: El	ective Compulsory		
	Civil Engineering: Specialisation Coastal Engineering: Elective	Compulsory		
	Civil Engineering: Specialisation Computational Engineering:			

Course L0813: Hydraulic Mod	Course L0813: Hydraulic Models	
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	DE/EN	
Cycle	SoSe	
Content	 Fundamentals of hydraulic models Model laws Pi theorem of Buckingham Practical examples of hydraulic models 	
Literature	Strobl, Zunic: Wasserbau, Kap. 11 Hydraulische Modelle, Springer	

Course L0812: Modelling of	Waves		
Тур	Project-/problem-based Learning		
Hrs/wk	1		
СР			
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Prof. Peter Fröhle		
Language	DE/EN		
Cycle	SoSe		
Content	 Waves, interactions with shallow water and constructions Wave theories Sea state and surges Development of waves Wave spectra Modelling of Waves / phase averaged and phase resolved models Application of a phase averaged model for wave prediction (SWAN) Application of phase resolved wave models (Mike) 		
Literature	Vorlesungsumdruck		

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

Courses				
Title		Тур	Hrs/wk	СР
Digital Twinning in Civil Engineering (L3136)		Lecture	2	2
Digital Twinning in Civil Engineerin	g (L3137)	Seminar	2	4
Module Responsible	Alexander Chmelnizkij			
Admission Requirements	None			
Recommended Previous				
Knowledge				
Educational Objectives	After taking part successfully, students h	ave reached the following learning results		
Professional Competence				
Knowledge				
Skills				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 124, Study Tim	e in Lecture 56		
Credit points	6			
Course achievement	None			
Examination	Presentation			
Examination duration and	20 min presentation and 5 pages handou	ıt		
scale				
Assignment for the	Civil Engineering: Specialisation Comput	ational Engineering: Compulsory		
Following Curricula	Civil Engineering: Specialisation Coastal	Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Geotech	nical Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Structur	al Engineering: Elective Compulsory		

Course L3136: Digital Twinning in Civil Engineering		
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Alexander Chmelnizkij, Prof. Bastian Oesterle, Prof. Kay Smarsly	
Language	DE	
Cycle	SoSe	
Content		
Literature		

Course L3137: Digital Twinn	ourse L3137: Digital Twinning in Civil Engineering		
Тур	Seminar		
Hrs/wk	2		
СР	4		
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28		
Lecturer	Alexander Chmelnizkij, Prof. Bastian Oesterle, Prof. Kay Smarsly		
Language	DE		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Courses					
Title		Тур	Hrs/wk	СР	
Marine Geotechnics (L0548)		Lecture	1	2	
Marine Geotechnics (L0549)		Recitation Section (large)	2	2	
Steel Structures in Foundation and		Lecture	Z	Z	
Module Responsible Admission Requirements					
	Complete modules: Geotechnics I-III, Math	amatics LIII			
Kecommended Previous Knowledge	Complete modules: Geotechnics I-III, Math				
Kilowiedge	Courses: Soil laboratory course				
Educational Objectives	After taking part successfully, students ha	ve reached the following learning results			
Professional Competence					
Knowledge	The students get a deeper knowledge of steel and ground engineering as well as constructions knowledge concerning quay wal				
	Furthermore, the students get all the necessary knowledge to design singular construction elements for sheet pile walls				
	know how to choose the right construction	elements depending on the influencing conditions	i.		
	E alternational de la desta constituit de la				
SKIIIS	Furthermore, the students are able to dimension sheet pile wall construction regarding all construction elements, to choose the				
	suitable construction elements with respect to the influencing conditions, to design all kinds of sheet pile walls and combined sheet pile walls) and to dimension all construction elements and connections.				
	waits and combined sneet pile waits) and t	o dimension all construction elements and connect	LIONS.		
Personal Competence					
Social Competence					
Autonomy	Students are able to assess their own stree	ngths and weaknesses and organize their time and	learning manage	ement based on th	
Workload in Hours	Independent Study Time 110, Study Time	in Lecture 70			
Credit points	6				
Course achievement	None				
Examination	Written exam				
Examination duration and	90 min				
scale					
Assignment for the	Civil Engineering: Specialisation Geotechni	ical Engineering: Compulsory			
Following Curricula	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory				
	Civil Engineering: Specialisation Coastal Engineering: Compulsory				
	Civil Engineering: Specialisation Computat	ional Engineering: Elective Compulsory			
	5 S S S				

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

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

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

Courses					
Title		Тур	Hrs/wk	СР	
Steel Construction Project (L1206)		Project Seminar	4	6	
Module Responsible	Prof. Marcus Rutner				
Admission Requirements	None				
Recommended Previous	Steel and Composite Structures				
Knowledge					
Educational Objectives	After taking part successfully, students h	ave reached the following learning results			
Professional Competence					
Knowledge	Students are able to prepare a part of th	e whole project and explain it to the others.			
Skills	Students can produce sketches and calculations of their part of the project. They are able to adjust their work in reaction				
	changing conditions resulting from other	participants of the project.			
Personal Competence					
Social Competence	ence Students can present their results to other members of the group.				
	They have the ability to work for a broad	agreement with respect to intergroup depen	dencies.		
	They can distribute and process tasks inc	dependently.			
Autonomy	Students can handle their part of the pro	ject on their own resposibility-			
Workload in Hours	Independent Study Time 124, Study Time	e in Lecture 56			
Credit points	6				
Course achievement	None				
Examination	Written elaboration				
Examination duration and	approx. 15-20 pages (without appendix)				
scale					
Assignment for the	Civil Engineering: Specialisation Geotech	nical Engineering: Elective Compulsory			
Following Curricula	Civil Engineering: Specialisation Coastal	Engineering: Elective Compulsory			
	Civil Engineering: Specialisation Structur	al Engineering: Compulsory			
	Civil Engineering: Specialisation Compute	ational Engineering: Elective Compulsory			

Course L1206: Steel Constru	Course L1206: Steel Construction Project		
Тур	Project Seminar		
Hrs/wk	4		
CP	6		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56		
Lecturer	Prof. Marcus Rutner		
Language	DE		
Cycle	SoSe		
Content	Design of a big construction project (i.e skyscraper, large bridge, roof of a stadiuim) in small groups		
Literature	Wird je nach Projekt individuell angegeben.		

Courses					
Title		Тур	Hrs/wk	СР	
Numerical Algorithms in Structural Mechanics (L0284)		Lecture	2	3	
Numerical Algorithms in Structural	Mechanics (L0285)	Recitation Section (small)	2	3	
Module Responsible	Prof. Alexander Düster				
Admission Requirements	None				
Recommended Previous	Knowledge of partial differential equations	is recommended.			
Knowledge					
Educational Objectives	After taking part successfully, students have	ve reached the following learning results			
Professional Competence					
Knowledge	Students are able to				
		nms that are used in finite element programs.			
	+ explain the structure and algorithm of fir				
		s, to identify them in a given situation and to explanation a	plain their mather	matical and comput	
	science background.				
Skills	Students are able to				
	+ construct algorithms for given numerical methods.				
	+ select for a given problem of structural mechanics a suitable algorithm.				
	+ apply numerical algorithms to solve problems of structural mechanics.				
	+ implement algorithms in a high-level programming languate (here C++).				
	+ critically judge and verfiy numerical algo	rithms.			
Personal Competence					
Social Competence	Students are able to				
	+ solve problems in heterogeneous groups	i.			
	+ present and discuss their results in front	of others.			
	+ give and accept professional constructiv	e criticism.			
Autonomy	Students are able to				
	+ assess their knowledge by means of exe	rcises and E-Learning.			
	+ acquaint themselves with the necessary knowledge to solve research oriented tasks.				
	+ to transform the acquired knowledge to	similar problems.			
Workload in Hours	Independent Study Time 124, Study Time i	n Lecture 56			
Credit points	6				
Course achievement	None				
Examination	Written exam				
Examination duration and scale	2h				
	Civil Engineering: Specialisation Computati	onal Engineering: Elective Compulsory			
Following Curricula	Materials Science: Specialisation Modeling:				
i onowing curricula	Naval Architecture and Ocean Engineering				
	Technomathematics: Specialisation III. Eng				
	Theoretical Mechanical Engineering: Specia		sorv		

Course L0284: Numerical Algorithms in Structural Mechanics	
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Alexander Düster
Language	EN
Cycle	SoSe
Content	1. Motivation
	2. Basics of C++
	3. Numerical integration
	4. Solution of nonlinear problems
	5. Solution of linear equation systems
	6. Verification of numerical algorithms
	7. Selected algorithms and data structures of a finite element code
Literature	[1] D. Yang, C++ and object-oriented numeric computing, Springer, 2001.
	[2] KJ. Bathe, Finite-Elemente-Methoden, Springer, 2002.

Course L0285: Numerical Alg	rse L0285: Numerical Algorithms in Structural Mechanics		
Тур	Recitation Section (small)		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Alexander Düster		
Language	EN		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

-					
Courses					
Title	(10000)	Тур	Hrs/wk	СР	
Computational Structural Dynamics Computational Structural Dynamics		Lecture Recitation Section (small)	3 1	4	
		Necleation Section (smail)	Ŧ	2	
Module Responsible					
Admission Requirements		and the second			
	Knowledge of partial differential equation	ins is recommended.			
Knowledge					
	After taking part successfully, students	have reached the following learning results			
Professional Competence					
Knowledge	Students are able to				
		l procedures for problems of structural dynamics.			
		nt programs to solve problems of structural dynam			
		ructural dynamics, to identify them in a given situ	lation and to expla	in their mathematic	
	and mechanical background.				
Skills	Students are able to				
	+ model problems of structural dynamics.				
	+ select a suitable solution procedure for	or a given problem of structural dynamics.			
	+ apply computational procedures to so	lve problems of structural dynamics.			
	+ verify and critically judge results of co	omputational structural dynamics.			
Personal Competence					
Social Competence	Students are able to				
	+ solve problems in heterogeneous grou				
	+ present and discuss their results in fro				
	+ give and accept professional construct	tive criticism.			
Autonomy	Students are able to				
	+ assess their knowledge by means of e	exercises and E-Learning.			
	+ acquaint themselves with the necessa	ary knowledge to solve research oriented tasks.			
	$\mbox{+}$ to transform the acquired knowledge	to similar problems.			
Workload in Hours	Independent Study Time 124, Study Tim	ne in Lecture 56			
Credit points	6				
Course achievement	None				
Examination	Written exam				
Examination duration and	2h		-	-	
scale					
Assignment for the	Civil Engineering: Specialisation Comput	tational Engineering: Elective Compulsory			
Following Curricula	International Management and Engineer	ring: Specialisation II. Mechatronics: Elective Comp	ulsory		
-	Materials Science: Specialisation Modeli	ng: Elective Compulsory			
	Mechatronics: Technical Complementary	y Course: Elective Compulsory			
	Naval Architecture and Ocean Engineeri	ng: Core Qualification: Elective Compulsory			
	Theoretical Mechanical Engineering: Spe	ecialisation Simulation Technology: Elective Comp	ilsory		

Course L0282: Computationa	Course L0282: Computational Structural Dynamics		
Тур	Lecture		
Hrs/wk	3		
СР	4		
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42		
Lecturer	Prof. Alexander Düster		
Language	EN		
Cycle	SoSe		
Content	1. Motivation		
	2. Basics of dynamics		
	3. Time integration methods		
	4. Modal analysis		
	5. Fourier transform		
	6. Applications		
Literature	[1] K. L. Datha, Finite Flamante Mathadan, Envinger, 2002		
Literature	[1] KJ. Bathe, Finite-Elemente-Methoden, Springer, 2002.		
	[2] J.L. Humar, Dynamics of Structures, Taylor & Francis, 2012.		

Course L0283: Computationa	urse L0283: Computational Structural Dynamics		
Тур	Recitation Section (small)		
Hrs/wk	1		
СР	2		
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14		
Lecturer	Prof. Alexander Düster		
Language	EN		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Module M0604: High-	Order FEM				
Courses					
			-	11	
Title			Typ Lecture	Hrs/wk 3	СР 4
High-Order FEM (L0280) High-Order FEM (L0281)			Recitation Section (large)	1	2
	Prof. Alexander Dü	tor	Reclution Section (large)	Ŧ	2
Module Responsible	Prof. Alexander Düs	ster			
Admission Requirements	None	1 HCC 11 1 1			
Recommended Previous	Knowledge of partia	al differential equations	is recommended.		
Knowledge					
Educational Objectives	After taking part su	ccessfully, students hav	e reached the following learning results		
Professional Competence					
Knowledge	Students are able to				
	-		o) finite element procedures.		
		er finite element procedu			
			cedures, to identify them in a given situation	and to explain the	eir mathematical a
	mechanical backgro	ound.			
Skills	Students are able to	0			
0			ems of structural mechanics.		
			nechanics a suitable finite element procedure.		
	_	sults of high-order finite			
			hite elements to new problems.		
		······································			
Personal Competence					
Social Competence	Students are able to	0			
	+ solve problems in	n heterogeneous groups			
	+ present and discu	uss their results in front	of others.		
	+ give and accept (professional constructive	e criticism.		
Autonomy	Students are able to	2			
Autonomy			reises and E Learning		
		vledge by means of exer			
	-		knowledge to solve research oriented tasks.		
		acquired knowledge to s	sinilar problems.		
Workload in Hours	Independent Study	Time 124, Study Time in	n Lecture 56		
Credit points	6				
Course achievement	Compulsory Bonus	Form	Description		
	No 10 %	Presentation	Forschendes Lernen		
Examination	Written exam				
Examination duration and	120 min				
scale					
Assignment for the	Civil Engineering: S	pecialisation Computation	onal Engineering: Elective Compulsory		
Following Curricula	International Manag	gement and Engineering	: Specialisation II. Product Development and Pr	oduction: Elective C	Compulsory
	Materials Science: S	Specialisation Modeling:	Elective Compulsory		
	Mechanical Enginee	ering and Management:	Specialisation Product Development and Produ	ction: Elective Comp	oulsory
	Mechatronics: Tech	nical Complementary Co	ourse: Elective Compulsory		
	Product Developme	ent, Materials and Produc	ction: Core Qualification: Elective Compulsory		
	Naval Architecture	and Ocean Engineering:	Core Qualification: Elective Compulsory		
			ineering Science: Elective Compulsory		
			Qualification: Elective Compulsory		

Course L0280: High-Order FE	EM
Тур	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Alexander Düster
Language	EN
Cycle	SoSe
Content	1. Introduction
	2. Motivation
	3. Hierarchic shape functions
	4. Mapping functions
	5. Computation of element matrices, assembly, constraint enforcement and solution
	6. Convergence characteristics
	7. Mechanical models and finite elements for thin-walled structures
	8. Computation of thin-walled structures
	9. Error estimation and hp-adaptivity
	10. High-order fictitious domain methods
Literature	[1] Alexander Düster, High-Order FEM, Lecture Notes, Technische Universität Hamburg-Harburg, 164 pages, 2014
	[2] Barna Szabo, Ivo Babuska, Introduction to Finite Element Analysis - Formulation, Verification and Validation, John Wiley & Sons,
	2011

Course L0281: High-Order F	ourse L0281: High-Order FEM		
Тур	Recitation Section (large)		
Hrs/wk	1		
СР	2		
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14		
Lecturer	Prof. Alexander Düster		
Language	EN		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Courses				
Title		Тур	Hrs/wk	СР
Structural Dynamics (L1202)		Lecture	2	2
Structural Dynamics (L1203)		Recitation Section (large)	2	2
Fracture mechanics and fatigue in	steel structures (L0564)	Lecture	1	1
Fracture mechanics and fatigue in	steel structures (L0565)	Recitation Section (large)	1	1
Module Responsible	Prof. Bastian Oesterle			
Admission Requirements	None			
Recommended Previous	Knowledge of linear structural analysis of	of statically determinate and indeterminate struct	ures; Mechanics	I/II, Mathematics
Knowledge	Differential equations I			
Educational Objectives	After taking part successfully, students ha	we reached the following learning results		
Professional Competence				
Knowledge	After successful completion of this modu	le, the student can explain the basic aspects of d	ynamic effects o	on structures and t
	respective methods.			
Personal Competence Social Competence	dynamics loading using the appropriate co Students can • participate in subject-specific and ii • defend their own work results in fro	nterdisciplinary discussions,		
	 promote the scientific development 	t of colleagues		
		cept professional constructive criticism		
Autonomy		ne subject area from given and other sources and a		oblems. Furthermo
	they are able to structure the solution pro	cess for problems in the area of Structural Analysis.		
Workload in Hours	Independent Study Time 96, Study Time i	n Lecture 84		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	150 min			
scale				
	Civil Engineering: Specialisation Structura	Engineering: Compulsory		
-				
Following Curricula	Civil Engineering: Specialisation Geotechn			
	Civil Engineering: Specialisation Coastal E			
	Civil Engineering: Specialisation Water an			
	Civil Engineering: Specialisation Computation	tional Engineering: Elective Compulsory		
		g: Specialisation II. Civil Engineering: Elective Comp		

Course L1202: Structural Dy	namics
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Bastian Oesterle
Language	DE
Cycle	SoSe
Content	 mechanical background of dynamics harmonic vibrations, damped and undamped free and forced vibrations frequency and time domain modelling aspects principle of d'Alembert systems with multiple degrees of freedom consistent and lumped mass matrices finite elements for dynamics problems impact problems eigenvalue problems and modal analysis direct time integration schemes, transient analyses
Literature	 Vorlesungsmanuskript Clough, R.W., Penzien, J.: Dynamics of Structures. 2. Aufl., McGraw-Hill, New York, 1993.

Course L1203: Structural Dy	ourse L1203: Structural Dynamics		
Тур	Recitation Section (large)		
Hrs/wk	2		
CP	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Prof. Bastian Oesterle		
Language	DE		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Тур	Lecture
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dr. Jürgen Priebe
Language	DE
Cycle	SoSe
Content	 basics of fatigue stress and fatigue resistance and determination of fatigue strength,
	determination and use of S-N-curves and classification of notch effects,
	set up of determination of fatigue strength under dynamic load using the accumulation formula by Palmgren-Miner,
	set up of determination of fatigue strength in different examples,
	 basics of construction and design regarding the problem of material fatigue,
	basics of linear elastic fracture mechanics under static and dynamic load,
	determination of lifetime of steel construction based on linear elastic fracture mechanics in different examples.
Literature	Seeßelberg, C.; Kranbahnen - Bemessung und konstruktive Gestaltung; 3. Auflage; Bauwerk-Verlag; Berlin 2009
	Kuhlmann, Dürr, Günther; Kranbahnen und Betriebsfestigkeit; in Stahlbau Kalender 2003; Verlag Ernst & Sohn; Berlin 2003
	Deutscher Stahlbau-Verband (Hrsg.); Stahlbau Handbuch Band 1 Teil B; 3. Auflage; Stahlbau-Verlagsgesellschaft; Köln 199
	Petersen, C.; Stahlbau; 3. überarb. und erw. Auflage; Vieweg-Verlag; Braunschweig 1993
	 DIN V ENV 1993-1-1: Eurocode 3; Bemessung und Konstruktion von Stahlbauwerken; Teil 1-1: Allgemeine Bemessungsre- Bemessungsregeln für den Hochbau; 1993
	• DIN V ENV 1993-6: Eurocode 3; Bemessung und Konstruktion von Stahlbauwerken; Teil 6: Kranbahnen; 2001
	• DIN-Fachbericht 126. Richtlinie zur Anwendung von DIN V ENV 1993-6; Nationales Anwendungsdokument (NAD); Berlin 20

Course L0565: Fracture mechanics and fatigue in steel structures		
Тур	Recitation Section (large)	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Dr. Jürgen Priebe	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Module M0827: Mode	ling in Water Management			
	,			
Courses				
Title		Тур	Hrs/wk	СР
Groundwater Modeling using Modfle		Lecture	1	1
Groundwater Modeling using Modfle Modeling of Water Supply Network		Recitation Section (small) Project-/problem-based Learning	2 2	2 3
Module Responsible		rioject-problem-based Learning	2	5
Admission Requirements				
Recommended Previous				
Knowledge	Groundwater			
	 groundwater hydraulics and transport of s 	substances		
	Pipe Systems			
		res, in particular drinking water systemsand	urban drainag	le systems includin
	special structures	ms and source systems		
	Hydraulics of drinking water supply systemBasic knowledge on water management	na and sewer systems		
Educational Objectives	After taking part successfully, students have rea	ched the following learning results		
Professional Competence				
Knowledge	The students are able to describe the modelling	of groundwater flow and transport as well as un	ban water infr	astructures. They ca
	carry out systems analyses and can detect technical and conceptual weak points within the systems in case studies. Besides the			
	are able to analyse interdependencies of hydraulic and toxic phenomena in soil and water.			
Skills	The students are able to construct and apply scientific groundwater models indipendently. They can work on different scientific groundwater models indipendently. They can work on different scientific groundwater models indipendently. They can work on different scientific groundwater models indipendently.			
	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).			
	able to use different software solutions (e.g. EPA	INET, EPA-SWIMM).		
Personal Competence				
Social Competence	Wird nicht vermittelt.			
Autonomy	Wird nicht vermittelt.			
, lace long				
	Independent Study Time 110, Study Time in Lec	ture 70		
Credit points				
Course achievement				
Examination				
	30 min			
scale				
-	Civil Engineering: Specialisation Structural Engin	•		
Following Curricula	Civil Engineering: Specialisation Geotechnical En			
	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory			
	Civil Engineering: Specialisation Water and Traff			
	Civil Engineering: Specialisation Computational Water and Environmental Engineering: Specialis			
	Water and Environmental Engineering: Specials			
	Water and Environmental Engineering: Specialis			
	specialis			

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

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

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

Courses					
Title		Тур	Hrs	s/wk	СР
Applied Surface Hydrology (L0289)		Lecture	2		2
Applied Surface Hydrology (L1412)		Project-/problem-ba	-		2
nteraction Water - Environment in	1	Project-/problem-ba	ased Learning 1		2
Module Responsible	Prof. Peter Fröhle				
Admission Requirements	None				
Recommended Previous	Fundamentals of Hydromechanics and	Hydraulic Engineering: Hydraulic Engineerin	g I and Hydraulic E	ngineerir	ng II
Knowledge					
Educational Objectives	After taking part successfully, students	have reached the following learning results			
Professional Competence					
Knowledge	The students are able to define the basic concepts of hydrology and water management. They are able to describe and quan				
	the relevant processes of the hydrological water cycle. Besides, the students know the main aspects of rainfall-run-off-models as				
	are able to theoretically derive establis	ned reservoir / storage models and a unit-hy	/drograph.		
Skills	The students are able to use the basic hydrological concepts and approaches and are able to theoretically derive establishe				
	reservoir / storage models or a unit-hydrograph as the basis for rainfall-run-off-models. The student are able to explain the ba				
	concepts of measurements of hydrological and hydrodynamic values in nature and are able to perform, analyze and statistica				
	assess these measurements. Furthermore, they are able to apply a hydrological model to basic hydrological problems.				
Personal Competence					
Social Competence	The students are able to deploy their g	ained knowledge in applied problems of the	hydrology and wat	ter mana	gement. Addition
	they will be able to work in team with	ngineers of other disciplines.			
Autonomy	The students will be able to independe	ntly extend their knowledge and apply it to r	new problems		
,		, , , , , , , , , , , , , , , , , , , ,	•		
Workload in Hours	Independent Study Time 124, Study Ti	ne in Lecture 56			
Credit points	6				
Course achievement	None				
	Written exam				
Examination				l underst	
	The duration of the examination is 90 r	nin. The examination includes tasks with res	spect to the genera		anding of the lec
Examination duration and	The duration of the examination is 90 r contents and calculations tasks.	nin. The examination includes tasks with res	pect to the genera		anding of the lec
Examination duration and scale	contents and calculations tasks.	nin. The examination includes tasks with res	spect to the genera		anding of the lec
Examination duration and scale Assignment for the	contents and calculations tasks.	tational Engineering: Elective Compulsory	pect to the genera		anding of the lec
Examination duration and scale Assignment for the	contents and calculations tasks. Civil Engineering: Specialisation Comp	tational Engineering: Elective Compulsory and Traffic: Compulsory	pect to the genera		anding of the lec
Examination duration and scale Assignment for the	contents and calculations tasks. Civil Engineering: Specialisation Comp Civil Engineering: Specialisation Water Environmental Engineering: Core Quali	tational Engineering: Elective Compulsory and Traffic: Compulsory	·		anding of the lec
Examination duration and scale Assignment for the	contents and calculations tasks. Civil Engineering: Specialisation Comp Civil Engineering: Specialisation Water Environmental Engineering: Core Quali Joint European Master in Environmenta	tational Engineering: Elective Compulsory and Traffic: Compulsory ication: Elective Compulsory	·		anding of the lec
Examination duration and scale Assignment for the	contents and calculations tasks. Civil Engineering: Specialisation Comp Civil Engineering: Specialisation Water Environmental Engineering: Core Quali Joint European Master in Environmenta Water and Environmental Engineering:	tational Engineering: Elective Compulsory and Traffic: Compulsory ication: Elective Compulsory Studies - Cities and Sustainability: Core Qu	alification: Compul		anding of the lec

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	rse 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	-

Courses					
Title		Тур	Hrs/wk	СР	
Design of Prestressed Structures a	nd Concreet Bridges (L0603)	Lecture	3	4	
Design of Prestressed Structures a	nd Concreet Bridges (L0604)	Recitation Section (large)	2	2	
Module Responsible	NN				
Admission Requirements	None				
Recommended Previous	Detailed knowledge on the design of concrete structures.				
Knowledge					
	Modules: Reinforced Concrete Structures I+II, Structural Analysis I+II, Mechanics I+II, Concrete Structures				
Educational Objectives	After taking part successfully, students have reached the following learning results				
Professional Competence					
Knowledge	The students know the main bridge types, their applications and the various loads. They can explain the basic design method				
	They can explain the design of a prestressed bridge.				
Skills	The students are able to design reinforced	or prestressed concrete bridges.			
Personal Competence					
Social Competence	The students can design in teamwork a rea	al concrete bridge.			
Autonomy	The students are able to design a prestres	sed concrete bridge and discuss the problems and	d results with othe	r students.	
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 minutes				
scale					
Assignment for the	Civil Engineering: Specialisation Structural	Engineering: Compulsory			
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory				
	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory				
	Civil Engineering: Specialisation Computat	ional Engineering: Elective Compulsory			
	International Management and Engineering	e. Consideration II. Chill Engineering. Elective Con			

Course L0603: Design of Pre	stressed Structures and Concreet Bridges
Тур	Lecture
Hrs/wk	3
СР	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	NN
Language	DE
Cycle	SoSe
Content	prestressed structures
	 basis of prestressed structures, field of application differences between reinforced and prestressed concrete structures history of prestressing construction materials: concrete, tendons, ducts, anchorage systems construction: prestressing methods prestressing forces and member forces (friction, elongation) tendon layout time dependant prestressing losses design of prestressed structures design of anchorage region non-bonded prestressing prestressed flat slabs
	Concrete bridges history of bridges design of bridges loads on bridges loads on bridges member forces for slab, T-beam, hollow box, frame and arch bridges precast bridges - precast segmental bridges bearings abutments, columns construction methods damages - checking of bridges
Literature	 Vorlesungsumdruckim STUDiP Rombach, G. (2003): Spannbetonbau. Ernst & Sohn, Berlin Wicke, M. (2002): Anwendung des Spannbetons. Betonkalender 2002, Teil II, S. 113-180, Verlag Ernst & Sohn, Berlin Leonhardt, F. (1980): Vorlesungen über Massivbau. Teil 5: Spannbeton. Berlin Mehlhorn, G. (2007): Handbuch Brücken, Springer Verlag Schäfer, H.; Kaufeld, K. (1997): Massivbrücken. Betonkalender Teil II, S. 443ff, Ernst & Sohn, Berlin Menn, Ch. (1986): Stahlbetonbrücken. Springer Verlag, Wien

Course L0604: Design of Pre	ourse L0604: Design of Prestressed Structures and Concreet Bridges		
Тур	Recitation Section (large)		
Hrs/wk	2		
СР	2		
Workload in Hours	endent Study Time 32, Study Time in Lecture 28		
Lecturer	NN		
Language	DE		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Courses					
Title		Тур	Hrs/wk	СР	
Modeling Processes in Vadose Zone	e (L2735)	Recitation Section (sr	mall) 2	2	
Vadose Zone Hydrology (L2732)		Lecture	2	2	
Vadose Zone Hydrology (L2733)		Recitation Section (la	irge) 2	2	
Module Responsible	Prof. Nima Shokri				
Admission Requirements	None				
Recommended Previous	Basic knowledge in water and soil				
Knowledge					
	Comfortable with math and physics, critic	cal thinking, creative problem solving			
	Analytic skills				
Educational Objectives	After taking part successfully, students h	ave reached the following learning results			
Professional Competence					
Knowledge	The students will learn about soil cha	racterization (solid and liquid phase), the	energy state of soil	water, the soil wa	
	characteristic curve, flow in saturated and unsaturated soil as well as about solute transport in soil				
Skills	Students will work on practical examp	oles modelling transport processes in soil	using different guan	titative tools incluc	
	computer simulations and analytical tools. This will help them to apply knowledge in order to solve problems and tasks.				
Personal Competence					
	The module sime at raising awareness	and enthusiasm for new knowledge relat	ed to water coil and	environment This	
Social competence	positively contribute to shape their work	-	eu to water, son and	environment. This	
	positively contribute to shape their work				
Autonomy		ny problem solving exercises. This will o	contribute toward thei	ir willingness to w	
	independently and responsibly.				
	Independent Study Time 96, Study Time	IN LECTURE 84			
Credit points					
Course achievement					
Examination					
Examination duration and	Report and Presentation				
scale					
Assignment for the	Civil Engineering: Specialisation Compute	ational Engineering: Elective Compulsory			
Following Curricula	Civil Engineering: Specialisation Water ar	nd Traffic: Elective Compulsory			
	Environmental Engineering: Core Qualific	ation: Elective Compulsory			
	Water and Environmental Engineering: S	pecialisation Water: Elective Compulsory			
	5 5				

Course L2735: Modeling Processes in Vadose Zone	
Тур	Recitation Section (small)
Hrs/wk	2
CP	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

Module Manual M.Sc. "Civil Engineering"

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 M0756. Soli M	1echanics and -Dynamics			
Courses				
Title		Тур	Hrs/wk	СР
Soil Mechanics - Selected Topics (L	0374)	Lecture	2	2
Soil Dynamics (L0452)		Lecture	2	2
Experimental Researches in Geote		Practical Course	2	2
Module Responsible				
Admission Requirements	None			
Recommended Previous	Modules: Mathematics I-III, Mechanics I-II, Geotechnics			
Knowledge	Courses: Soil laboratory course, (Applied structural dy	namics)		
Educational Objectives	After taking part successfully, students have reached	he following learning results		
Professional Competence				
Knowledge	Students will be able to,			
	 describe wave propagation in the ground under 	dynamic excitation and define the	e relevant parameters	
	 to measure vibrations and to interpret the data 			
	 justify when elastodynamic methods are sufficient 	ent and when plastodynamic effec	ts must be taken into	account,
	 to reproduce the collapse theorems of plasticity 	theory,		
	 describe the viscous behavior of cohesive soil 	s and computationally account f	or creep deformation	and rate-depende
	shear strengths			
	 as well as to determine the effect of partial saturation 	ration on the seepage flow and th	e shear strength.	
Skills	After the successful completion of the module the stud	lents should be able to:		
	 to derive and apply the basic equation of a simple 	ole mass oscillator.		
	 to understand the wave propagation in the soil 		letect the relevant par	ameters,
	 to know the essential laboratory and field tests 			
	• to design machine foundations to dynamic load	-		
	• to measure shocks to perform vibration forecas	t,		
	 to evaluate shocks in terms of their effect on period 	ople and buildings,		
	 to evaluate possibilities of isolation, 			
	 to understand mechanisms that cause earthquarth 	kes and evaluate earthquakes in	terms of their magnitu	ide and intensity,
	 to know methods to determine axial pile capaci 	ty, integrity, and the dynamic bed	ding modulus,	
	 to know the mechanisms that lead to a deform mathematically, 	ation accumulation due to cyclic lo	oading and to estimate	e these deformatio
	 to distinguish the area of application of the met 	hod of elastodynamics and plasto	dynamics,	
	 to detect the undrained shear strength as a fun 	ction of a number of state variable	es,	
	 to capture the visous behaviour of cohesive so 	Is and to consider the effects of c	reep and rate-depend	ent shear strength
	calculations,			
	 to consider the impact of the partly saturated or 	f a seepage and shear strength.		
Personal Competence				
	Students will be able to work in teams to achieve re-	ults on measurement and experi	mental principles and	present their resul
	together at the end of the semester.		- •	
Autonomy	Students are able to assess their own strengths and w	eaknesses and organize their time	e and learning manage	ement based on this
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points	6			
Course achievement		cription		
	Yes None Subject theoretical and			
Francisco Maria	practical work			
Examination	Written exam			
Examination duration and scale	135 min			
Assignment for the	Civil Engineering: Specialisation Structural Engineering	g: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Enginee			
2	Civil Engineering: Specialisation Coastal Engineering:			
	Civil Engineering: Specialisation Computational Engine			

Course L0374: Soil Mechanic	s - Selected Topics
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Hans Mathäus Stanford
Language	DE
Cycle	SoSe
Content	selected topis:
Literature	 Stress-strain behaviour (experiments, observations, models) Hydraulic behaviour (experiments, observations, models) Physical modelling (similarity theory, 1g model tests, ng model tests) Limit and safety analysis (collapse theorems of plasticity theory, upper and lower bound analysis, limit equilibrium analysis, numerical analysis) Heat transport (heat conduction, convective heat transport, freezing/thawing) Kolymbas D. (2019): Geotechnik - Bodenmechanik, Grundbau und Tunnelbau. Springer Verlag, 5. Auflage Muir Wood D. (2004). Geotechnical modelling. CRC Press Nova, R. (2010). Soil mechanics. Wiley Verruijt, A. (2012). Soil mechanics. u r l: https://geo.verruijt.net
	Verrujit A. (2018). An introduction to soil mechanics. Vol. 30, Springer Series Theory and Applications of Transport in Porous Media

Course L0452: Soil Dynamics	
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Anne Hagemann
Language	
Cycle	SoSe
Content	mass-spring-damper systems,
	• wave propagation in soils,
	dynamic soil parameters,
	Determination of dynamic soil parameters,
	• machine foundations,
	• in-situ measurement of ground motion, ground motion prediction, evaluation of ground motion,
	• ground motion shielding,
	• introduction into earthquake engineering,
	• dynamic pile tests,
	• cyclic accumulation,
	• plastodynamics
Literature	 Das B.M.: Fundamentals of Soil Dynamics, Elsevier Empfehlungen des Arbeitskreises Baugrunddynamik. Hrsg. Deutsche Gesellschaft für Geotechnik (DGGT) Haupt W.: Bodendynamik. Vieweg und Teubner Meskouris K. und Hinzen KG.: Bauwerke und Erdbeben. Vieweg Verlag Studer J.A., Koller M.G. und Laue J.: Bodendynamik, Springer Verlag

Course L0706: Experimental	Researches in Geotechnics
Тур	Practical Course
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Hans Mathäus Stanford, Göta Bürkner
Language	DE
Cycle	SoSe
Content	The students are supposed to:
	 become acquainted with geotechnical model tests, field tests and laboratory tests as well as corresponding measurement techniques. These compromise amongst others inclinometer measurements and geophone measurements as well as high-grade laboratory tests on the stress-strain relationship of soil specimens, e. g. triaxial tests, simple shear tests and resonant column tests. gain insight into current soil mechanical research. plan, coordinate, perform and evaluate soil mechanical tests in a team. discuss, reflect, review and present the obtained results in a group. An important learning target is the introduction to scientific work for students who plan a scientific career, and for those who will work in practice with the responsibility to order corresponding tests and evaluate the results. The practical laboratory work is based on annualy changing problems, which are however related to the experience and results of the preceding year's course group.
Literature	- Grabe, J. (2004): Bodenmechanik und Grundbau, Band 3 der Veröffentlichungsreihe des Instituts für Geotechnik und Baubetrieb, Technische Universität Hamburg-Harburg.
	- Kolymbas, D. (2007): Geotechnik - Bodenmechanik, Grundbau und Tunnelbau. 2., korrigierte und ergänzte Auflage, Springer Verlag.
	 Normen zu geotechnischen Versuchsgeräten und Versuchsverfahren: DIN 18135:2012-04: Baugrund, Untersuchung von Bodenproben - Eindimensionaler Kompressionsversuch, Deutsches Institut für Normung, e. V.
	- DIN 18137-2:2011-04: Baugrund, Untersuchung von Bodenproben - Bestimmung der Scherfestigkeit - Teil 2: Triaxialversuch, Deutsches Institut für Normung e. V.

Module M0854: Mathe	ematics IV			
Courses				
		Turn	Hang built	CD
TypHrs/wkCPifferential Equations 2 (Partial Differential Equations) (L1043)Lecture21			1	
Differential Equations 2 (Partial Differential Equations) (L1043) Differential Equations 2 (Partial Differential Equations) (L1044)		Recitation Section (small)	1	1
Differential Equations 2 (Partial Diff		Recitation Section (large)	1	1
Complex Functions (L1038)		Lecture	2	1
Complex Functions (L1041)		Recitation Section (small)	1	1
Complex Functions (L1042)		Recitation Section (large)	1	1
Module Responsible	Prof. Marko Lindner			
Admission Requirements	None			
Recommended Previous	Mathematics I - III			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the f	ollowing learning results		
Professional Competence		5 5		
Knowledge				
Knowledge	 Students can name the basic concepts in Mathemat 	ics IV. They are able to explain the	m using appropria	ate examples.
	 Students can discuss logical connections between t 	hese concepts. They are capable	of illustrating the	ese connections wit
	the help of examples.			
	 They know proof strategies and can reproduce them 	I.		
Skills				
	Students can model problems in Mathematics IV w		ed in this course	. Moreover, they are
	capable of solving them by applying established me			
	 Students are able to discover and verify further logic 			
	 For a given problem, the students can develop an 	d execute a suitable approach, a	nd are able to c	ritically evaluate th
	results.			
Personal Competence				
Social Competence				
	 Students are able to work together in teams. They a 			
	 In doing so, they can communicate new concepts a 		perating partners	. Moreover, they ca
	design examples to check and deepen the understa	nding of their peers.		
Autonomy	. Students are capable of checking their understand	ng of complex concents on their a	when They can an	acify on an avaction
	 Students are capable of checking their understandi 	•	wn. They can sp	ecity open question
	precisely and know where to get help in solving the			
	• Students have developed sufficient persistence to	be able to work for longer period	is in a goal-orien	ted manner on har
	problems.			
Workload in Hours	Independent Study Time 68, Study Time in Lecture 112			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	60 min (Complex Functions) + 60 min (Differential Equatio	ns 2)		
scale				
Assignment for the	General Engineering Science (German program, 7 semeste	r): Specialisation Electrical Enginee	ering: Compulsor	/
5	General Engineering Science (German program, 7 ser		5 1 3	
	Compulsory		J	
	General Engineering Science (German program, 7 semeste	r): Specialisation Naval Architectur	e: Compulsory	
	General Engineering Science (German program, 7 semeste	•		enretical Mechanic
			icening, rocus If	
	Engineering: Elective Compulsory	a Elective Compulsor		
	Engineering: Elective Compulsory Civil Engineering: Specialisation Computational Engineerin	g: Elective Compulsory		
	Engineering: Elective Compulsory Civil Engineering: Specialisation Computational Engineerin Electrical Engineering: Core Qualification: Compulsory			
	Engineering: Elective Compulsory Civil Engineering: Specialisation Computational Engineerin Electrical Engineering: Core Qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Electrical Enginee		
	Engineering: Elective Compulsory Civil Engineering: Specialisation Computational Engineerin Electrical Engineering: Core Qualification: Compulsory General Engineering Science (English program, 7 semester Computer Science in Engineering: Specialisation II. Mathem): Specialisation Electrical Enginee natics & Engineering Science: Elect	ive Compulsory	
	Engineering: Elective Compulsory Civil Engineering: Specialisation Computational Engineerin Electrical Engineering: Core Qualification: Compulsory General Engineering Science (English program, 7 semester Computer Science in Engineering: Specialisation II. Mathen Mechanical Engineering: Specialisation Theoretical Mechan): Specialisation Electrical Enginee natics & Engineering Science: Elect ical Engineering: Elective Compuls	ive Compulsory	
	Engineering: Elective Compulsory Civil Engineering: Specialisation Computational Engineerin Electrical Engineering: Core Qualification: Compulsory General Engineering Science (English program, 7 semester Computer Science in Engineering: Specialisation II. Mathem): Specialisation Electrical Enginee natics & Engineering Science: Elect ical Engineering: Elective Compuls	ive Compulsory	
	Engineering: Elective Compulsory Civil Engineering: Specialisation Computational Engineerin Electrical Engineering: Core Qualification: Compulsory General Engineering Science (English program, 7 semester Computer Science in Engineering: Specialisation II. Mathen Mechanical Engineering: Specialisation Theoretical Mechan): Specialisation Electrical Enginee natics & Engineering Science: Elect ical Engineering: Elective Compuls	ive Compulsory	
	Engineering: Elective Compulsory Civil Engineering: Specialisation Computational Engineerin Electrical Engineering: Core Qualification: Compulsory General Engineering Science (English program, 7 semester Computer Science in Engineering: Specialisation II. Mathen Mechanical Engineering: Specialisation Theoretical Mechar Mechanical Engineering: Specialisation Mechatronics: Com): Specialisation Electrical Enginee natics & Engineering Science: Elect ical Engineering: Elective Compuls	ive Compulsory	

Course L1043: Differential E	ourse L1043: Differential Equations 2 (Partial Differential Equations)		
Тур	Lecture		
Hrs/wk	2		
СР	1		
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28		
Lecturer	Dozenten des Fachbereiches Mathematik der UHH		
Language	DE		
Cycle	SoSe		
Content	Main features of the theory and numerical treatment of partial differential equations		
	 Examples of partial differential equations First order quasilinear differential equations Normal forms of second order differential equations Harmonic functions and maximum principle Maximum principle for the heat equation Wave equation Liouville's formula Special functions Difference methods Finite elements 		
Literature	 http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html 		

Course L1044: Differential Equations 2 (Partial Differential Equations)	
Тур	Recitation Section (small)
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dozenten des Fachbereiches Mathematik der UHH
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L1045: Differential Equations 2 (Partial Differential Equations)	
Тур	Recitation Section (large)
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dozenten des Fachbereiches Mathematik der UHH
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L1038: Complex Functions		
Тур	Lecture	
Hrs/wk	2	
СР	1	
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28	
Lecturer	Dozenten des Fachbereiches Mathematik der UHH	
Language	DE	
Cycle	SoSe	
Content	Main features of complex analysis	
	 Functions of one complex variable Complex differentiation Conformal mappings Complex integration Cauchy's integral theorem Cauchy's integral formula Taylor and Laurent series expansion Singularities and residuals Integral transformations: Fourier and Laplace transformation 	
Literature	 http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html 	

Course L1041: Complex Fund	Course L1041: Complex Functions	
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Dr. Hanna Peywand Kiani	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L1042: Complex Fund	ourse L1042: Complex Functions	
Тур	Recitation Section (large)	
Hrs/wk	1	
CP	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Dozenten des Fachbereiches Mathematik der UHH	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Courses					
Title		Тур	Hrs/wk	СР	
Nonlinear Structural Analysis (L027	7)	Lecture	3	4	
Nonlinear Structural Analysis (L027	9)	Recitation Section (small)	1	2	
Module Responsible	Prof. Alexander Düster				
Admission Requirements	None				
Recommended Previous	Knowledge of partial differential equations	is recommended.			
Knowledge					
Educational Objectives	After taking part successfully, students hav	e reached the following learning results			
Professional Competence					
Knowledge	Students are able to				
	+ give an overview of the different nonline	ar phenomena in structural mechanics.			
	+ explain the mechanical background of no	onlinear phenomena in structural mechanics.			
	+ to specify problems of nonlinear structure	ral analysis, to identify them in a given situation	and to explain the	eir mathematical a	
	mechanical background.				
Skills	Students are able to				
Skiils	+ model nonlinear structural problems.				
	+ select for a given nonlinear structural pro	oblem a suitable computational procedure.			
	+ apply finite element procedures for nonli				
	+ critically verify and judge results of nonli				
	+ to transfer their knowledge of nonlinear solution procedures to new problems.				
Personal Competence					
Social Competence	ce Students are able to				
	+ solve problems in heterogeneous groups				
	+ present and discuss their results in front				
	+ give and accept professional constructive	e criticism.			
Autonomy	Students are able to				
	+ assess their knowledge by means of exer	rcises and E-Learning.			
	+ acquaint themselves with the necessary knowledge to solve research oriented tasks.				
	+ to transform the acquired knowledge to s	similar problems.			
Workload in Hours	Independent Study Time 124, Study Time i	n Lecture 56			
Credit points					
Course achievement	None				
Examination	Written exam				
Examination duration and	120 min				
scale					
Assignment for the	Civil Engineering: Specialisation Structural	Engineering: Elective Compulsory			
Following Curricula	Civil Engineering: Specialisation Computation	onal Engineering: Compulsory			
		9: Specialisation II. Civil Engineering: Elective Com	pulsory		
	Materials Science: Specialisation Modeling:				
	Mechatronics: Technical Complementary Co				
	Mechatronics: Core Qualification: Elective C				
		ction: Core Qualification: Elective Compulsory			
	Naval Architecture and Ocean Engineering:				
	Ship and Offshore Technology: Core Qualifi				
	Theoretical Mechanical Engineering: Specia	lisation Simulation Technology: Elective Compuls	ory		

Course L0277: Nonlinear Str	uctural Analysis
Тур	Lecture
Hrs/wk	3
СР	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Alexander Düster
Language	EN
Cycle	WiSe
Content	1. Introduction
	2. Nonlinear phenomena
	3. Mathematical preliminaries
	4. Basic equations of continuum mechanics
	5. Spatial discretization with finite elements
	6. Solution of nonlinear systems of equations
	7. Solution of elastoplastic problems
	8. Stability problems
	9. Contact problems
Literature	[1] Alexander Düster, Nonlinear Structrual Analysis, Lecture Notes, Technische Universität Hamburg-Harburg, 2014.
	[2] Peter Wriggers, Nonlinear Finite Element Methods, Springer 2008.
	[3] Peter Wriggers, Nichtlineare Finite-Elemente-Methoden, Springer 2001.
	[4] Javier Bonet and Richard D. Wood, Nonlinear Continuum Mechanics for Finite Element Analysis, Cambridge University Press,
	2008.

Course L0279: Nonlinear Str	Course L0279: Nonlinear Structural Analysis	
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	2	
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14	
Lecturer	Prof. Alexander Düster	
Language	EN	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Courses					
Гitle			Тур	Hrs/wk	СР
Applied Tunnel Constructions (L240	17)		Lecture	2	3
ntroduction to tunnel construction	(L0707)		Lecture	1	2
Introduction to tunnel construction	(L1811)		Recitation Section (large)	1	1
Module Responsible	Prof. Jürgen Grabe				
Admission Requirements	None				
Recommended Previous	Modules from Bachelor	studies Civil and environme	ental engineering:		
Knowledge	Geotechnics I-II				
Educational Objectives	After taking part succes	ssfully, students have reach	ed the following learning results		
Professional Competence					
Knowledge	Knowledge of different tunnel construction types as well as special methods and techniques of subsoil construction.				
Skills	Basic knowledge of tunnel design as well as practical skills in structural tunnel analysis.				
Personal Competence					
Social Competence	Capacity for teamwork concerning project management and design of tunnels.				
Autonomy	Promotion of independent and creative work flow in the framework of a design exercise.				
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56				
Credit points	6				
Course achievement	Compulsory Bonus	Form	Description		
	No 5 %	Excercises			
Examination	Written exam				
Examination duration and	120 minutes				
scale					
Assignment for the	Civil Engineering: Speci	ialisation Structural Enginee	ring: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering: Compulsory				
	Civil Engineering: Speci	ialisation Coastal Engineeri	ng: Compulsory		
	Civil Engineering: Speci	ialisation Water and Traffic:	Elective Compulsory		
	Civil Engineering: Speci	ialisation Computational En	gineering: Elective Compulsory		

Course L2407: Applied Tunne	Course L2407: Applied Tunnel Constructions	
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Jürgen Grabe, Tim Babendererde	
Language	DE	
Cycle	WiSe	
Content		
Literature		

Course L0707: Introduction t	to tunnel construction		
Тур	Lecture		
Hrs/wk	1		
CP			
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14		
Lecturer	Dr. Julian Bubel		
Language	DE		
Cycle	WiSe		
Content	 Definitions Historical development in tunneling Geology for tunneling Hard rock tunneling (construction composite and machines) Tunnelung in temporarly stable soil with conventional construction methods Tunneling in soft soils (form of supports, shield types, compressed air application) Pipe jacking Tunnel Lining, tunnel supporting structures Calculation approaches for supporting structures in shield-driven tunnels 		
Literature	 Surveying for tunneling Safety requirements Construction Contract Literature and sources Vorlesung/Übung s. www.tu-harburg.de/gbt 		

Course L1811: Introduction t	Course L1811: Introduction to tunnel construction	
Тур	Recitation Section (large)	
Hrs/wk	1	
CP	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Dr. Julian Bubel	
Language	DE	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

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Courses				
Title Modern discretization methods in s		Typ Lecture	Hrs/wk 2	СР 3
Modern discretization methods in s			2	3
Module Responsible				
Admission Requirements				
Recommended Previous	Finite Element Methods			
Knowledge	Flächentragwerke			
Educational Objectives	After taking part successfully, students have rea	ched the following learning results		
Professional Competence				
Knowledge	After successful completion of this module, students can express the basic aspects of modern discretization methods in structur mechanics.			
Skills	After successful completion of this module, the students will be able to use and further improve modern discretization methods for problems in structural mechanics.			
Personal Competence				
Social Competence	Students can			
	 participate in subject-specific and interdis 	ciplinary discussions,		
	 defend their own work results in front of c 			
	 promote the scientific development of col 	leagues		
	 Furthermore, they can give and accept pr 	ofessional constructive criticism		
Autonomy	Students are able to gain knowledge of the subject area from given and other sources and apply it to new problems. Furthermo			
	they are able to structure the solution process for	-		
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	90 min			
scale				
Assignment for the	Civil Engineering: Specialisation Coastal Enginee	ering: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Er	ngineering: Elective Compulsory		
	Civil Engineering: Specialisation Structural Engir	eering: Elective Compulsory		
	Civil Engineering: Specialisation Computational	Engineering: Elective Compulsory		
	Theoretical Mechanical Engineering: Specialisati	on Simulation Technology: Elective Compulso	ry	

Тур	Lecture		
Hrs/wk	2		
CP	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	of. Bastian Oesterle		
Language	EN		
Cycle	WiSe		
Content	The course covers variational formulations, various locking phenomena and alternative formulations for finite elements an modern discretization schemes in the context of structural mechanics, like isogeometric analysis.		
	 variational formulation of finite elements, mixed variational principles geometrical and material locking effects in structural and solid mechanics hybrid-mixed and enhanced assumed strain finite element formulations, reduced integration and stabilization, DSG method u-p formulations patch test, stability, convergence linear and non-linear analyses introduction to isogeometric analysis isogeometric beam, plate and shell formulations locking effects and their avoidance in modern, smooth discretization schemes, like isogeometric analysis 		
Literature	 lecture notes and selected scientific papers O.C. Zienkiewicz, R.L. Taylor, and J.Z. Zhu: Finite Element Method: Its Basis and Fundamentals. Elsevier, 2013. J. Austin Cottrell, Thomas J. R Hughes, Yuri Bazilevs: Isogeometric Analysis: Toward Integration of CAD and FEA. Wiley, 2009 		

Course L3044: Modern discre	ourse L3044: Modern discretization methods in structural mechanics		
Тур	Recitation Section (small)		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Bastian Oesterle		
Language	EN		
Cycle	WiSe		
Content	See interlocking course		
Literature	See interlocking course		

Courses				
Title		Тур	Hrs/wk	СР
Scientific Working in Computationa	Engineering (L2764)	Project-/problem-based Learning	4	6
Module Responsible	Prof. Kay Smarsly			
Admission Requirements	None			
Recommended Previous	Basic knowledge in scientific writing. String interest in topics	s related to computing in civil engine	ering.	
Knowledge				
Educational Objectives	After taking part successfully, students have reached the fol	lowing learning results		
Professional Competence				
Personal Competence	The students will learn to apply concepts and methods of scientific working in computational engineering. In interaction with the course instructors and in collaboration with each other, the students will also learn to understand the complex process of scientific thinking, being able to accurately plan, implement and analyze scientific projects, such as prospective master theses. A project will be conducted throughout the semester, which will contribute to the grade. Since scientific writing is of particular importance in this course, a scientific paper will be developed based, which is a prerequisite for the final examination. The paper will be written based on the project conducted within this course. Project meetings in small groups, presentations, and critical discussions of scientific publications are further key activities. The students will be capable (i) of solving a scientific problem following a scientific methodology, (ii) of documenting their work effectively in the form of a paper, and (iii) of sharing their work in a presentation. The students will be able to work in a multidisciplinary team and develop communication skills necessary for problem solving.			
Autonomy	The students will be able to extend their knowledge and app	ly it to solve scientific problems by w	vorking indepe	ndently in a proje
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points				
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: B	Elective Compulsory		
	Civil Engineering: Specialisation Coastal Engineering: Electiv	e Compulsory		
	Civil Engineering: Specialisation Structural Engineering: Elec	tive Compulsory		
	Civil Engineering: Specialisation Computational Engineering	Elective Compulsory		
	Computer Science: Specialisation II: Intelligence Engineering	1: Elective Compulsory		

Course L2764: Scientific Wor	rking in Computational 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. Kay Smarsly
Language	EN
Cycle	WiSe/SoSe
Content	In the course, a scientific problem of practical relevance will first be defined, taking into account the interests of the students participating in the course. The scientific problem will then systematically be solved within the framework of a comprehensive project. The principles of scientific working will be taught based on the scientific problem defined previously. As an integral part of scientific working, fundamentals of scientific writing will be presented and applied to a scientific paper to be written during the course. Topics related to scientific writing include structuring in scientific writing (structuring the abstract, the introduction, the main part, the summary and conclusions, and the acknowledgments and references) and recommendations on effective scientific writing (principles of composition, use of English in scientific writing, useful tips, creating figures, writing in mathematics, referencing, and formal email correspondence). A final paper and a final presentation will be assembled by the students.
Literature	Smarsly, K. & Dragos, K., 2019. Scientific Writing in Engineering. Tredition, Hamburg, Germany.

Module M0969: Selected Topics in Civil Engineering

Courses				
Title		Тур	Hrs/wk	СР
Design of Composite Bridges (L309	2)	Integrated Lecture	2	3
Analysis of Offshore Structures (L1	367)	Lecture	1	1
Energy Geotechnics (L3227)		Lecture	3	3
Solid Matter Process Technology fo	r Biomass (L0052)	Lecture	2	3
Forum I - Geotechnics and Constru	ction Management (L1634)	Seminar	1	1
Forum II - Geotechnics and Constru	ction Management (L1635)	Seminar	1	1
Timber Structures (L1151)		Seminar	2	2
Innovative Timber Construction (L2	666)	Lecture	2	4
Glass Structures (L1152)		Lecture	2	2
Glass Structures (L1447)		Recitation Section (large)	1	1
Sustainable landfill design and ope	ration (L3270)	Integrated Lecture	3	3
Special Topics in Steel Design (L30	91)	Integrated Lecture	2	3
Special topics of civil engineering 1	CP (L2378)		1	1
Special topics of civil engineering 2	LP (L2379)		2	2
Special topics of civil engineering 3	LP (L2380)		3	3
Structural Design (L2789)		Seminar	2	2
Module Responsible	Prof. Frank Schmidt-Döhl			
Admission Requirements	None			
Recommended Previous	none			
Knowledge				
Educational Objectives	After taking part successfully, students have reached	d the following learning results		
Professional Competence				
Knowledge				
	 Students are able to find their way through selected special areas within civil and structural engineering. 			
	• Students are able to explain basic models and procedures in selected special areas of civil and structural engineering.			
	 Students are able to interrelate scientific and the scientific and the science of t	technical knowledge.		
Skills	 Students are able to apply basic methods in selected areas of civil and structural engineering. 			
Personal Competence				
Social Competence				
Autonomy	• Students can chose independently, in which fields they want to deepen their knowledge and skills through the election of			
	courses.			
Workload in Hours	Depends on choice of courses			
Credit points	6			
Assignment for the	Civil Engineering: Specialisation Structural Engineerin	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: El			
	Civil Engineering: Specialisation Water and Trans. En			
	civit Engineering. Specialisation Computational Engli	icening. Liective compulsory		

Course L3092: Design of Composite Bridges	
Тур	Integrated Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and	90 min
scale	
Lecturer	Prof. Marcus Rutner
Language	DE
Cycle	SoSe
Content	
Literature	

Course L1867: Analysis of Of	ifshore Structures	
Тур	Lecture	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Examination Form	Mündliche Prüfung	
Examination duration and	30 min	
scale		
	Dr. Said Fawad Mohammadi	
Language		
Cycle		
Content	Topic 1: Types of Offshore Structures, Fixed and floating structures for Oil & Gas and Offshore Wind industry	
	Topic 2: Wave Forces, Morisons equation	
	Topic 3: Irregular Seastates, Power spectrum and application of FFT	
	Topic 4: Additional Environmental Forces, wind spectra, current forces	
	Topic 5: Linear-Time-Invariant Systems, response of an LTI-system in frequency domain	
	Topic 6: Tubular Welded Connections, stress concentration factors, weld geometry	
	Topic 7: Introduction to Fracture Mechanics, criteria for fracture initiation and crack growth	
	Topic 8: Time and Frequency Domain Fatigue Analyses, rainflow counting, application of LTI-systems for frequency domain fatigue	
	Topic 9: Offshore Installation and Exam, installation of structures, pile driving, pipe laying techniques	
Literature	Chakrabarti, Handbook of Offshore Engineering, 2005	
	Sarpkaya, Wave Forces on Offshore Structures, 2010	
	Faltinsen, Sea Loads on Ships and Offshore Structures, 1998	
	Sorensen, Basic Coastal Engineering, 2006	
	Dowling, Mechanical Behavior of Materials, 2007	
	Haibach, Betriebsfestigkeit, 2006	
	Marshall, Design of Welded Tubular Connections, 1992	
	Newland, Random vibrations, spectral and wavelet analysis, 1993	

Course L3227: Energy Geote	chnics
Тур	Lecture
Hrs/wk	3
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Examination Form	Schriftliche Ausarbeitung (laut FPrO)
Examination duration and	wird zu Beginn der Lehrveranstaltung festgelegt
scale	
Lecturer	Pauline Kaminski
Language	DE/EN
Cycle	WiSe
Content	Energy geotechnics is a young field in geotechnical engineering with the aim of developing sustainable geotechnical solutions for future-oriented issues relating to the production, transport, operation, decommissioning, and waste utilisation of various energy sources. Examples of possible fields of activity in energy geotechnics include geothermal energy and thermally activated foundation components, foundations for onshore and offshore wind turbines, the decommissioning of mining facilities and the handling of waste products from fossil fuels such as tailings and the geological storage of CO2. Relevant soil mechanical processes in these applications include the thermo-hydro-mechanically coupled behaviour of soils, multiphase flow in porous media and partially saturated soils. The lecture gives an overview of various aspects of energy geotechnics and provides in-depth knowledge of the associated soil mechanical processes. In addition, CO2-scarce geotechnical applications are discussed and emission estimates as well as the optimisation of geotechnical structures according to sustainability aspects are addressed.
Literature	

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 L1634: Forum I - Geotechnics and Construction Management	
Тур	Seminar
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Examination Form	Mündliche Prüfung
Examination duration and	30 min
scale	
Lecturer	Prof. Jürgen Grabe
Language	DE
Cycle	WiSe
Content	Lectures about projects and issues with practical and scientific relevance.
Literature	

Course L1635: Forum II - Geotechnics and Construction Management	
Тур	Seminar
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Examination Form	Mündliche Prüfung
Examination duration and	30 min
scale	
Lecturer	Prof. Jürgen Grabe
Language	DE
Cycle	SoSe
Content	Lectures about projects and issues with practical and scientific relevance.
Literature	

Course L1151: Timber Structures	
Тур	Seminar
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Referat
Examination duration and	90 min
scale	
Lecturer	Prof. Torsten Faber
Language	DE
Cycle	WiSe
Content	
Literature	

Course L2666: Innovative Tir	nber Construction
Тур	Lecture
Hrs/wk	2
СР	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Examination Form	Schriftliche Ausarbeitung
Examination duration and	45 Minuten
scale	
Lecturer	Dr. Andreas Meisel
Language	DE
Cycle	WiSe
Content	
Literature	- Blass, J.: "Ingenieurholzbau"
	- Schickhofer, G.: "BSPhandbuch: Holz-Massivbauweise in Brettsperrholz"
	- Informationsdienst Holz: div. Merkblätter und Broschüren
	- Wallner-Novak M.: Brettsperrholz Bemessung, Band 1 und 2
	- Gerner M.: "Fachwerk: Entwicklung, Instandsetzung, Neubau"
	- Meisel, A.: "Historische Dachwerke: Beurteilung, realitätsnahe statische Analyse und Instandsetzung"
	- Kempe K.: "Dokumentation Holzschädlinge"
	- Huckfeldt T.: "Hausfäule- und Bauholzpilze"

Course L1152: Glass Structures		
Тур	Lecture	
Hrs/wk	2	
CP	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Examination Form	Mündliche Prüfung	
Examination duration and		
scale		
Lecturer	Marvin Matzik	
Language	DE	
Cycle	WiSe	
Content	Glass structures	
	- Introduction of the material glass (production, refinement, material characteristic)	
	- design of facades	
	- facade types	
	- static calculation of glazing	
	- static calculation of facades	
	- load bearing behavior of glazing (plate or membrane stiffness)	
	- vertical / horizontal glazing with safety-related requirements	
	- glass structures	
	- fire safety of glass facades	
	- construction physics of facades and glazing	
Literature		

Course L1447: Glass Structures	
Тур	Recitation Section (large)
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Examination Form	Mündliche Prüfung
Examination duration and	
scale	
Lecturer	Marvin Matzik
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

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

Course L3091: Special Topics in Steel Design	
Тур	Integrated Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and	90 min
scale	
Lecturer	Prof. Marcus Rutner, Nikolay Lalkovski
Language	DE
Cycle	SoSe
Content	
Literature	

ourse L2378: Special topics of civil engineering 1CP	
Тур	
Hrs/wk	1
CP	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 Lehrveranstaltung festgelegt
scale	
Lecturer	Dozenten des SD B
Language	DE
Cycle	WiSe/SoSe
Content	The course occurs only if required. The content is defined at short notice.
Literature	Die Literatur wird kurzfristig festgelegt.

Course L2379: Special topics of civil engineering 2 LP	
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 Lehrveranstaltung festgelegt
scale	
Lecturer	Dozenten des SD B
Language	DE
Cycle	WiSe/SoSe
Content	The course occurs only if required. The content is defined at short notice.
Literature	Die Literatur wird kurzfristig festgelegt.

Course L2380: Special topics of civil engineering 3 LP	
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 Lehrveranstaltung festgelegt
scale	
Lecturer	Dozenten des SD B
Language	DE
Cycle	WiSe/SoSe
Content	The course occurs only if required. The content is defined at short notice.
Literature	Die Literatur wird kurzfristig festgelegt.

Course L2789: Structural Design	
Тур	Seminar
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and	20 min
scale	
Lecturer	Dr. Jan Mittelstädt
Language	DE/EN
Cycle	SoSe
Content	
Literature	[1] Structure Systems by Heino Engel, Hantje Cantz, 3rd edition (Feb 2007), ISBN-10: 3775718761
	Form and Force, Designing Efficient, Expressive Structures by Allan, E., Zalewski, W. et al, John Wiley and
	Sons; 1st edition (Sept 2009), ISBN-10: 047017465X
	[2] Peter Rice: An Engineer Imagines, ISBN-10 : 1849944237
	[3] Konrad Wachsmann and the Grapevine Structure by C. Sumi et al., Park Books (Oct 2018), ISBN-10:
	9783038601104
	[4] Manual of Multi-Story Timber Construction by Hermann Kaufmann, Stefan Krotsch, Stefan Winter, DETAIL,
	(June 2018), ISBN-10: 3955533948
	[5] The Art of Structural Design: A Swiss Legacy by B. Billington, Princeton University Art Museum; First Edition
	edition (Mar 2003), ISBN-10: 0300097867
	[6] Structured Lineages: Learning from Japanese Structural Design by G. Nordenson et al, The Museum of
	Modern Art (Jul 2019), ISBN-10: 1633450562
	[7] The Structure: Works of Mahendra Raj by V. Mehta, R. Mehndiretta, A. Huber, Park Books (Oct 2015),
	ISBN-10: 3038600253

Courses	
Title	Typ Hrs/wk CP
Module Responsible	Dozenten des SD B
Admission Requirements	None
Recommended Previous	Subjects of the computational engineering specialisation.
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 computational engineering engineering. They ca exemplify the state of technology and application and discuss critically in the context of actual problems and general conditions science and society. The students can develop solving strategies and approaches for fundamental and practical problems in computational engineerin 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 for the project work and to justify this choice. They can explain how the methods relate to the field of work and how the context of application has to be adjusted. General findings and furth 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 f the presentation and discussion in front of a bigger group. They can lead the discussion and give a feedback on the project to the colleagues.
Autonomy	The students are capable of independently planning and documenting the work steps and procedures while considering the give deadlines. This includes the ability to accurately procure the newest scientific information. Furthermore, they can obtain feedbac from experts with regard to the progress of the work, and to accomplish results on the state of the art in science and technology.
Workload in Hours	Independent Study Time 180, Study Time in Lecture 0
Credit points	6
Course achievement	None
Examination	Study work
Examination duration and	see FSPO
scale	
Assignment for the	Civil Engineering: Specialisation Computational Engineering: Compulsory
Following Curricula	

	ing and Excavation Law				
Courses					
Title		Тур	Hrs/wk	СР	
	w in (excavation) practice (L3182)	Lecture	2	3	
	Inction (excavation) practice (L3181)	Lecture	2	3	
Module Responsible					
Admission Requirements					
	Complete modules: Geotechnics I-III				
Knowledge	After taking part successfully, students have r	accord the following learning results			
Professional Competence	After taking part successfully, students have re	eached the following learning results			
-	Students will gain knowledge of				
	• the history of civil engineering law,				
	basics of foundation and civil engineering	ng law,			
	 legal aspects of technical regulations in 	civil engineering (with case studies),			
	 the civil engineering contract, 				
	 the liability of the designer and contractor in civil engineering, 				
		• the subsoil risk and the system risk,			
	the total debt in (civil) engineering law, the (construction) conflict directs available and the construction areas.				
	 the (construction) conflict, dispute avoidance models and the construction process, the systematics of construction contract law 				
	 the systematics of construction contract law, the BGB construction contract law, 				
	 responsibilities on the construction site, 				
	 responsibilities on the construction site, remuneration and contract management, 				
	 liability for defects, 				
	public procurement law				
	Disturbed construction processes: How much money am I entitled to?				
	Correct calculation of supplements.				
Skills	Students learn to apply legal aspects in plann	ing and construction in a legally balance	d way. Students learn l	how to use legal	
	construction management aspects in practice				
	to manage the construction project optimally.				
Personal Competence					
•	Students can work in groups and support each	other in finding solutions.			
	Students can work in groups and support each other in finding solutions. Students are able to assess their own strengths and weaknesses and organize their time and learning management based on the students are able to assess their own strengths and weaknesses and organize their time and learning management based on the students are able to assess their own strengths and weaknesses and organize their time and learning management based on the students are able to assess their own strengths and weaknesses and organize their time and learning management based on the students are able to assess their own strengths and weaknesses and organize their time and learning management based on the students are able to assess are able to assess the students are able to assess are able to				
Workload in Hours	Independent Study Time 124, Study Time in Le	ecture 56			
Credit points	6				
Course achievement	None				
Examination	Oral exam				
Examination duration and	30 min				
scale					
Assignment for the	Civil Engineering: Specialisation Coastal Engine	eering: Elective Compulsory			
Following Curricula	Civil Engineering: Specialisation Geotechnical	Engineering: Elective Compulsory			
	Civil Engineering: Specialisation Structural Eng	• • •			
	Civil Engineering: Specialisation Water and Tra				
	Civil Engineering: Specialisation Computationa	I Engineering: Elective Compulsory			

Course L3182: Construction	rse L3182: Construction law BGB and VOB - law in (excavation) practice		
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Günther Schalk		
Language	DE		
Cycle	WiSe		
Content			
Literature	Literatur: - Folienskript (in der Vorlesung erhältlich) - Fuchs/Maurer/Schalk: Handbuch Tiefbaurecht		

Course L3181: Construction	urse L3181: Construction disputes from construction (excavation) practice		
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Ingo Junker		
Language	DE		
Cycle	WiSe		
Content			
Literature			

Module M2025: Finite	element modeling of structure	es		
Courses				
Title		Тур	Hrs/wk	СР
Finite element modeling of structur	es (L3046)	Lecture	2	3
Finite element modeling of structur	es (L3047)	Recitation Section (small)	2	3
Module Responsible	Prof. Bastian Oesterle			
Admission Requirements	None			
Recommended Previous Knowledge	Finite Element MethodsThin-walled structures			
Educational Objectives	After taking part successfully, students have	reached the following learning results		
Professional Competence				
Knowledge	After successful completion of this module, s	tudents can express the basic aspects of modelli	ng of structures v	with finite elements
Skills	After successful completion of this module, the students will be able to model structures with finite elements and to analys structures using appropriate computational methods.			
Personal Competence				
Social Competence	Students can			
	 participate in subject-specific and inte 	rdisciplinary discussions,		
	defend their own work results in front	of others		
	 promote the scientific development of 	colleagues		
	Furthermore, they can give and accep	t professional constructive criticism		
Autonomy	Students are able to gain knowledge of the subject area from given and other sources and apply it to new problems. Furthermore they are able to structure the solution process for problems in the area of finite element modelling of structures.			
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 elaboration of a project work (10-15 p	pages)		
scale				
Assignment for the	Civil Engineering: Specialisation Computation	al Engineering: Compulsory		
Following Curricula	Civil Engineering: Specialisation Coastal Engi	neering: Elective Compulsory		
	Civil Engineering: Specialisation Geotechnica	l Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Structural Er	ngineering: Elective Compulsory		
	Theoretical Mechanical Engineering: Specialis	sation Simulation Technology: Elective Compulso	ory	

Course L3046: Finite elemen	ourse L3046: Finite element modeling of structures		
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Bastian Oesterle		
Language	EN		
Cycle	WiSe		
Content	 Basic phenomena and aspects of the finite element modelling of structures are discussed. Besides theoretical decription of the phenomena and methods, a strong focus is on the practical use a commercial finite element software within computer-based exercises. The covered topics are: finite element modeling of trusses/beams/frames, plates subject to in-plane/out-of-plane loading and shells convergence properties of displacements and stresses singularities locking effects critical assessment, interpretation and check of results mixed-dimensional coupling of finite elements geometrically linear and non-linear, and material linear and non-linear analyses stability: bifurcation and snap-through problems dynamic problems, modal analyses 		
Literature	Vorlesungsmanuskript, Vorlesungsfolien		

Course L3047: Finite elemen	urse L3047: Finite element modeling of structures		
Тур	ecitation Section (small)		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Bastian Oesterle		
Language	EN		
Cycle	WiSe		
Content	See interlocking course		
Literature	See interlocking course		

Specialization Water and Traffic

Courses					
Title			Тур	Hrs/wk	СР
Applied Tunnel Constructions (L24	07)		Lecture	2	3
Introduction to tunnel construction			Lecture	1	2
Introduction to tunnel construction	(L1811)		Recitation Section (large) 1	1
Module Responsible	Prof. Jürgen Grabe				
Admission Requirements	None				
Recommended Previous	Modules from Bach	elor studies Civil and	environmental engineering:		
Knowledge	Geotechnics I-II				
Educational Objectives	After taking part su	After taking part successfully, students have reached the following learning results			
Professional Competence					
Knowledge	Knowledge of different tunnel construction types as well as special methods and techniques of subsoil construction.				
Skills	Basic knowledge of tunnel design as well as practical skills in structural tunnel analysis.				
Personal Competence					
Social Competence	Capacity for teamwork concerning project management and design of tunnels.				
Autonomy	Promotion of independent and creative work flow in the framework of a design exercise.				
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56				
Credit points	6				
Course achievement	Compulsory Bonus	Form	Description		
	No 5%	Excercises			
Examination	Written exam				
Examination duration and	120 minutes				
scale					
Assignment for the	Civil Engineering: S	pecialisation Structur	al Engineering: Elective Compulsory		
Following Curricula	Civil Engineering: S	pecialisation Geotech	nical Engineering: Compulsory		
	Civil Engineering: S	pecialisation Coastal	Engineering: Compulsory		
	Civil Engineering: S	pecialisation Water ar	nd Traffic: Elective Compulsory		
	Civil Engineering: S	pecialisation Computa	ational Engineering: Elective Compulsory		
	International Mana	pement and Engineeri	ng: Specialisation II. Civil Engineering: Elective	Compulsony	

Course L2407: Applied Tunnel Constructions	
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Jürgen Grabe, Tim Babendererde
Language	DE
Cycle	WiSe
Content	
Literature	

Course L0707: Introduction t	to tunnel construction		
Тур	Lecture		
Hrs/wk			
CP			
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14		
Lecturer	Dr. Julian Bubel		
Language	DE		
Cycle	WiSe		
Content	 Definitions Historical development in tunneling Geology for tunneling Hard rock tunneling (construction composite and machines) Tunnelung in temporarly stable soil with conventional construction methods Tunneling in soft soils (form of supports, shield types, compressed air application) Pipe jacking Tunnel Lining, tunnel supporting structures Calculation approaches for supporting structures in shield-driven tunnels Surveying for tunneling Safety requirements Construction Contract Literature and sources 		
Literature	 Vorlesung/Übung s. www.tu-harburg.de/gbt 		

Course L1811: Introduction to tunnel construction	
Тур	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dr. Julian Bubel
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Courses				
Title		Тур	Hrs/wk	СР
Examination of Materials, Structura	-	Lecture	3	4
Examination of Materials, Structura	I Condition and Damages (L0261)	Recitation Section (small)	1	2
Module Responsible	Prof. Frank Schmidt-Döhl			
Admission Requirements	None			
Recommended Previous	Basic knowledge about building materials or	material science, for example by the mod	dule Building Ma	terials and Buildi
Knowledge	Chemistry.			
Educational Objectives	After taking part successfully, students have read	hed the following learning results		
Professional Competence				
Knowledge	The students are able to describe the rules for trading, use and marking of construction products in Germany. They know whic methods for the testing of building material properties are usable and know the limitations and characterics of the most important testing methods.			
Skills	The students are able to responsibly discover the rules for trading and using of building products in Germany. They are able to chose suitable methods for the testing and inspection of construction products, the examination of damages an the examination of the structural conditions of buildings. They are able to conclude from symptons to the cause of damages. The are able to describe an examination in form of a test report or expert opinion.			
Personal Competence				
Social Competence	The students can describe the different roles of framework of material testing. They can describe		-	on bodies within t
Autonomy	The students are able to make the timing and the	e operation steps to learn the specialist know	ledge of a very e	xtensive field.
Workload in Hours	Independent Study Time 124, Study Time in Lect	ure 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	120 min			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Engine	eering: Elective Compulsory		
Following Curricula				
-	Civil Engineering: Specialisation Coastal Engineer			
	Civil Engineering: Specialisation Water and Traffi			
	International Management and Engineering: Spec	ialisation II. Civil Engineering: Elective Comp	oulsory	
	Materials Science and Engineering: Specialisation	Engineering Materials: Elective Compulsory		
	Materials Science: Specialisation Engineering Mat	erials: Elective Compulsory		

Course L0260: Examination of	Course L0260: Examination of Materials, Structural Condition and Damages		
Тур	Lecture		
Hrs/wk	3		
СР	4		
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42		
Lecturer	Prof. Frank Schmidt-Döhl		
Language	DE		
Cycle	WiSe		
Content	Materials testing and marking process of construction products, testing methods for building materials and structures, testing		
	reports and expert opinions, describing the condition of a structure, from symptons to the cause of damages		
Literature	Frank Schmidt-Döhl: Materialprüfung im Bauwesen. Fraunhofer irb-Verlag, Stuttgart, 2013.		

Course L0261: Examination of	ourse L0261: Examination of Materials, Structural Condition and Damages	
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	2	
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14	
Lecturer	Prof. Frank Schmidt-Döhl	
Language	DE	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

<u> </u>				
Courses				
Title Integrated Transportation Planning	-	yp oject-/problem-based Learning	Hrs/wk 4	CP 6
		oject-problem-based Learning	4	0
Module Responsible				
Admission Requirements	None			
Recommended Previous Knowledge	some knowledge of transport planning, e.g. through taking the under	ergraduate class "Transport P	lanning and T	ramic Engineerin
Educational Objectives	After taking part successfully, students have reached the following	loarning results		
-	After taking part successfully, students have reached the following	learning results		
Professional Competence	Students are able to:			
Knowledge				
	describe interdependencies between land-use/location choice	e and transportation/mobility	behaviour	
	 explain and evaluate the social, ecological and economic effective 	ects of transport and land-use	policy measu	res.
	 relate current issues in the area of integrated transport plan 	ning and formulate an opinion	on them.	
Skills	Students are able to:			
JKIIIS				
	 quantify important parameters, which influence travel demain 	nd or are influenced by it.		
	 comprehensively examine a pre-defined or self-selected top 	ic from a transportation studi	es perspectiv	e and document t
	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 ac	tivities		
	 independently plan working on a pre-defined project topic, a 		ge and use ap	opropriate means
	its execution.			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
Examination duration and	written assignment with presentation during the semester			
scale				
-	Civil Engineering: Specialisation Structural Engineering: Elective Co			
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering: Elective			
	Civil Engineering: Specialisation Coastal Engineering: Elective Comp	pulsory		
	Civil Engineering: Specialisation Water and Traffic: Compulsory			
	Logistics, Infrastructure and Mobility: Specialisation Infrastructure a Water and Environmental Engineering: Specialisation Cities: Compu		ory	

Course L1068: Integrated Tr	ansportation Planning
Тур	Project-/problem-based Learning
Hrs/wk	4
СР	6
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Lecturer	Prof. Carsten Gertz, Dr. Philine Gaffron, Jacqueline Bianca Maaß
Language	DE
Cycle	WiSe
	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)

Courses				
Title		Тур	Hrs/wk	СР
Chemistry of Drinking Water Treatr	nent (10311)	Lecture	2	1
Chemistry of Drinking Water Treatr		Recitation Section (large)	1	2
Water Resource Management (L04)		Lecture	2	2
Water Resource Management (L04)3)	Recitation Section (small)	1	1
Module Responsible	Prof. Mathias Ernst			
Admission Requirements	None			
Recommended Previous	Knowledge of water management and t	he key processes involved in water treatment.		
Knowledge				
Educational Objectives	After taking part successfully, students	have reached the following learning results		
Professional Competence				
Knowledge	Students will be able to outline key are	eas of conflict in water management, as well as th	eir mutual depend	dence for sustaina
	water supply. They will understand rel	evant economic, environmental and social factors.	Students will be	able to explain a
	outline the organisational structures of	water companies. They will be able to explain the a	ailable water trea	atment processes
	the scope of their application.			
	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
	be able to carry out chemical calculat	ions for selected treatment processes and apply g	enerally accepted	d technical rules
	standards to these processes.			
Personal Competence				
Social Competence	Working in a diverse group of specialist	s, students will be able to develop and document of	complex solutions	for the managem
	and treatment of drinking water. They	will be able to take an appropriate professional p	osition, for examp	ole representing u
	interests. They will be able to develop jo	pint solutions in teams of diverse experts and preser	t these solutions t	to others.
Autonomy	Students will be in a position to work on	a subject independently and present on this subject	-	
Autonomy	Students will be in a position to work on	a subject independency and present on this subject		
Workload in Hours	Independent Study Time 96, Study Time	e in Lecture 84		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	60 min (chemistry) + presentation			
scale				
Assignment for the	Civil Engineering: Specialisation Structu			
Following Curricula		hnical Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Water a			
	Civil Engineering: Specialisation Coasta	Engineering: Elective Compulsory		
	Chemical and Bioprocess Engineering: 1	echnical Complementary Course: Elective Compulso	ry	
	International Management and Enginee	ring: Specialisation II. Energy and Environmental Eng	jineering: Elective	Compulsory
	Process Engineering: Specialisation Env	ironmental Process Engineering: Elective Compulsor	у	
	Process Engineering: Specialisation Proc	ess Engineering: Elective Compulsory		
	Water and Environmental Engineering:	Specialisation Water: Compulsory		
	Water and Environmental Engineering:	Specialisation Environment: Elective Compulsory		

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

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

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

Course L0403: Water Resour	irse 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				
litle	Ту	p	Hrs/wk	СР
Construction Robotics (L2867)	Pro	pject-/problem-based Learning	6	6
Module Responsible	Prof. Kay Smarsly			
Admission Requirements	None			
Recommended Previous	Basics of project-oriented programming			
Knowledge				
Educational Objectives Professional Competence	After taking part successfully, students have reached the following lo	earning results		
Knowledge	Basics of robotics			
	Applications in civil engineering			
	Kinematics			
Skills	Use of specific hardware			
	Development of software routines			
	Python programming language			
	Image processing			
	Basics of localization (LIDAR, SLAM)			
Personal Competence				
Social Competence	Teamwork			
	Communication skills			
Autonomy	Independent work			
	Independent decisions			
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
Examination duration and	ca. 10 Seiten			
scale				
•	Civil Engineering: Specialisation Structural Engineering: Elective Con			
Following Curricula		•		
	Civil Engineering: Specialisation Coastal Engineering: Elective Comp			
	Civil Engineering: Specialisation Geotechnical Engineering: Elective (
	Civil Engineering: Specialisation Computational Engineering: Elective Computer Science: Specialisation II: Intelligence Engineering: Elective			
	Mechatronics: Core Qualification: Elective Compulsory	re compuisory		
	Theoretical Mechanical Engineering: Specialisation Robotics and Cor	multar Science: Elective Com	nulcon/	

Тур	Project-/problem-based Learning
Hrs/wk	6
СР	6
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84
Lecturer	Prof. Kay Smarsly, Jan Stührenberg
Language	EN
Cycle	WiSe
Content	 Introduction: Robotics in civil engineering Presentation of potential topics Programming of algorithms in Python Application of software systems: LINUX distribution, ROS, CloudCompare, Application of hardware systems: Petoi Bittle Dog, Raspberry Pi, Arduino, sensing Topics considered for robotics using the Petoi Bittle Dog: Movement Use of sensors (camera, infrared,) Data structures/data acquisition Programming Topics technically relevant to building inspection: Geodetic evaluations Image processing Localization
Literature	Bock/Linner: Construction Robotics
	Verl et al.: Soft Robotics
	Pasquale: New Laws of robotics

Courses				
litle		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 c	hemistry and biology (knowledge acquired at scho	ool).	
Knowledge				
Educational Objectives	After taking part successfully, studer	nts have reached the following learning results		
Professional Competence				
Knowledge	On completion of this module, students will be able to describe the mechanisms of biological systems. They will know the mechanisms of biological systems. They will know the mechanism of biological metabolic routes and can categorise their influence on global metabolic routes. They will be familiar with the ba analytical methods for investigating and assessing the quality of various environmental compartments.			
Skills	conditions. Students will be able to apply the th	ents will be able to categorise which metabolism neoretical principles they have learnt to exemplar erspective. They will be able to draw compariso evised and treated.	y sites and assess the re	esulting relations
Personal Competence				
Social Competence	The students are able to organize wo	orking processes within a team in a targeted way a	and based on the divisor	n of labour.
Autonomy	Students can independently exploit :	sources, acquire the particular knowledge of the s	ubject and apply it to ne	w 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	90 min			
scale	Civil Engineering: Specialisation Wat			

Course L0354: Environmenta	l Analysis
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Dorothea Rechtenbach, Dr. Henning Mangels
Language	EN
Cycle	WiSe
Content	Introduction
	Sampling in different environmental compartments, sample transportation, sample storage
	Sample preparation
	Photometry
	Wastewater analysis
	Introduction into chromatography
	Gas chromatography
	HPLC
	Mass spectrometry
	Optical emission spectrometry
	Atom absorption spectrometry Quality assurance in environmental analysis
Literature	Roger Reeve, Introduction to Environmental Analysis, John Wiley & Sons Ltd., 2002 (TUB: USD-728)
	Pradyot Patnaik, Handbook of environmental analysis: chemical pollutants in air, water, soil, and solid wastes, CRC Press, Boca Raton, 2010 (TUB: USD-716)
	Chunlong Zhang, Fundamentals of Environmental Sampling and Analysis, John Wiley & Sons Ltd., Hoboken, New Jersey, 2007 (TUB: USD-741)
	Miroslav Radojević, Vladimir N. Bashkin, Practical Environmental Analysis RSC Publ., Cambridge, 2006 (TUB: USD-720)
	Werner Funk, Vera Dammann, Gerhild Donnevert, Sarah Iannelli (Translator), Eric Iannelli (Translator), Quality Assurance in Analytical Chemistry: Applications in Environmental, Food and Materials Analysis, Biotechnology, and Medical Engineering, 2nc 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 Emissio
	Spectrometry Perkin-Elmer Corporation 1997, On-line available at: http://files.instrument.com.cn/bbs/upfile/2006291448.pdf
	Atomic absorption spectrometry: theory, design and applications, ed. by S. J. Haswell 1991 (TUB: 2727-5614)
	Royal Society of Chemistry, Atomic absorption spectometry (http://www.kau.edu.sa/Files/130002/Files/6785_AAs.pdf)

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

Courses				
Title		Тур	Hrs/wk	СР
Biological Wastewater Treatment (I		Lecture	2	2
Biological Wastewater Treatment (I		Recitation Section (large)	1	1
Advanced Wastewater Treatment (Lecture	2	2
Advanced Wastewater Treatment (Recitation Section (large)	1	1
Module Responsible				
Admission Requirements	None			
Recommended Previous	Knowledge of wastewater management a	nd the key processes involved in wastewater tre	atment.	
Knowledge				
Educational Objectives	After taking part successfully, students ha	ave reached the following learning results		
Professional Competence				
Knowledge	Students are able to outline key areas of	the full range of treatment systems in waste wa	ater management, as	s well as their mu
	dependence for sustainable water protect	tion. They can describe relevant economic, envir	onmental and social	factors.
				C 11
Skills		lain the available wastewater treatment proces	ses and the scope of	of their applicatio
	municipal and for some industrial treatme	ent plants.		
Personal Competence				
Social Competence	Social skills are not targeted in this modu	le.		
	5			
Autonomy	Students are in a position to work on a subject and to organize their work flow independently. They can also present on the			
	subject.			
Workload in Hours	Independent Study Time 96, Study Time i	in Lecture 84		
Credit points				
Course achievement	None			
Examination	Written exam			
Examination duration and				
scale				
Assignment for the	Civil Engineering: Specialisation Structure	al Engineering: Elective Compulsory		
-	Civil Engineering: Specialisation Geotech			
<u> </u>	Civil Engineering: Specialisation Coastal E			
	Civil Engineering: Specialisation Water an			
		- General Bioprocess Engineering: Elective Comp	ulsorv	
		n Water Quality and Water Engineering: Elective		
		ng: Specialisation II. Process Engineering and Bio		Compulsorv
		ng: Specialisation II. Energy and Environmental E	•••	
	• •	onmental Process Engineering: Elective Compuls		, ,
	Process Engineering: Specialisation Proce	• • •	,	
	Water and Environmental Engineering: Specialisation Free	• • • •		
		pecialisation Environment: Elective Compulsory		

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

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

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

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

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

Courses				
Courses Title		T	Hare to de	СР
Noise Protection (L1109)		Typ Lecture	Hrs/wk 2	2
Urban Infrastructures (L0874)		Project-/problem-based Learning	2	4
Module Responsible	Dr. Dorothea Rechtenbach			
Admission Requirements	None			
Recommended Previous				
Knowledge	Knowledge on Urban planning			
	Knowledge on measures for climate protection			
	General knowledge of scientific writing/working			
Educational Objectives	After taking part successfully, students have reached the followin	g learning results		
Professional Competence				
Knowledge	Students can describe urban development corridors as well as cu	irrent and future urban environr	nental probler	ns. They are able
	explain the causes of environmental problems (like noise).			
	Students can specify applications for various technical innovation	ns and explain why these contril	oute to the im	provement of urb
	life. They can, for example, derive and discuss measures for effective noise abatement.			
Skille	Chille Churchen and all he develop an offer any king for any king or future on future and future and		problems of ur	
JKIIIS	<i>Skills</i> Students are able to develop specific solutions for correcting existing or future environment-related problems development. They can define a range of conceptual and technical solutions for environmental problems for different developments. To solve specific urban environmental problems they can select technical innovations and integrate them into t			
	context.		ia incegiace ci	
Personal Competence				
-	The students can work together in international groups.			
Autonomy	Students are able to organize their work flow to prepare themselves for presentations and contributions to the discussions. The			
	can acquire appropriate knowledge by making enquiries independ	dently.		
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: Election	ve Compulsory		
	Civil Engineering: Specialisation Coastal Engineering: Elective Co			
	Civil Engineering: Specialisation Water and Traffic: Elective Comp	•		
	Environmental Engineering: Core Qualification: Elective Compulso			
	Joint European Master in Environmental Studies - Cities and Susta			
	Logistics, Infrastructure and Mobility: Specialisation Infrastructure	and Mobility: Elective Compuls	ory	
	Water and Environmental Engineering: Specialisation Environmer Water and Environmental Engineering: Specialisation Cities: Com			

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

Course L0874: Urban Infrast	urse 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.	

Courses				
Title		Тур	Hrs/wk	СР
	nergy, Soil and Food Nexus (L1229)	Seminar	2	2
Water & Wastewater Systems in a	Global Context (L0939)	Lecture	2	4
Module Responsible	Prof. Ralf Otterpohl			
Admission Requirements	None			
Recommended Previous	Basic knowledge of the global situation wi	th rising poverty, soil degradation, mig	ration to cities, lack of	water resources a
Knowledge	sanitation			
Educational Objectives	After taking part successfully, students have	reached the following learning results		
Professional Competence		· · · · · · · · · · · · · · · · · ·		
-	Students can describe the facets of the globa	al water situation. Students can iudge the	e enormous potential of t	ne implementation
	synergistic systems in Water, Soil, Food and			
Skills	Students are able to design ecological settl	ements for different geographic and soc	io-economic conditions f	or the main climat
	around the world.			
Personal Competence				
	The students are able to develop a specific topic in a team and to work out milestones according to a given plan.			
,				
Autonomy	Students are in a position to work on a subject and to organize their work flow independently. They can also present on the			
	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 includes presentations and papers. Detail			
scale	information can be found at the beginning of	the smester in the StudIP course module	e handbook.	
Assignment for the	Civil Engineering: Specialisation Water and T	raffic: Elective Compulsory		
Following Curricula	Bioprocess Engineering: Specialisation A - Ge	eneral Bioprocess Engineering: Elective C	Compulsory	
	Chemical and Bioprocess Engineering: Speci	alisation General Process Engineering: El	ective Compulsory	
	Environmental Engineering: Core Qualification	n: Elective Compulsory		
	Joint European Master in Environmental Stud	ies - Cities and Sustainability: Core Quali	fication: Compulsory	
	Process Engineering: Specialisation Environm	nental Process Engineering: Elective Com	ipulsory	
	Process Engineering: Specialisation Process	Engineering: Elective Compulsory		
	Water and Environmental Engineering: Spec	alisation Water: Elective Compulsory		
	Water and Environmental Engineering: Spec	alisation Environment: Elective Compulse	ory	
	Water and Environmental Engineering: Spec	alisation Cities: Elective Compulsory		

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

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

Courses	
Fitle	Typ Hrs/wk CP
City Planning (L1066)	Project-/problem-based Learning 4 6
Module Responsible	Prof. Carsten Gertz
Admission Requirements	None
Recommended Previous	for "Principles of Urban Planning": none
Knowledge	for "Designing Urban Streetscapes": some knowledge of transport planning, e.g. through taking the undergraduate class "Tra
	Planning and Traffic Engineering"
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are able to:
	e use technical terms of whan planning
	 use technical terms of urban planning. describe the main determinants of urban development.
	 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

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.

Courses				
Title	Тур		Hrs/wk	СР
Construction Logistics (L1163) Construction Logistics (L1164)		ture titation Section (small)	1	2
Project Development and Managem		ture	1	1
Project Development and Managen			1	1
Module Responsible	Prof. Heike Flämig			
Admission Requirements	None			
Recommended Previous	none			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the following le	earning results		
Professional Competence		-		
	Students can			
Skills Personal Competence Social Competence	 name advantages and disadvantages of internal or external co explain characteristics of products, demand and production of specific supply chains differentiate constructions logistics from other logistics system Students can carry out project life cycle assessments apply methods and instruments of construction logistics apply methods and instruments of project development and m apply methods and instruments of conflict management design supply and waste removal concepts for a construction project Students can hold presentations in and for groups 	f construction objects and th ns nanagement	eir consequer	nces for constructio
	 apply methods of conflict solving skills in group work and case 	e studies		
Autonomy	Students can • solve problems by holistic, systemic and flow oriented thinking • improve their creativity, pageticities skills, conflict, and creativity.		mothods of	moderation in ca
	 improve their creativity, negotiation skills, conflict and crise studies 	es solution skills by applying) methods of	moderation in cas
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	Two written papers with presentations			
	Civil Engineering: Specialisation Structural Engineering: Elective Com Civil Engineering: Specialisation Geotechnical Engineering: Elective C Civil Engineering: Specialisation Coastal Engineering: Elective Comput Civil Engineering: Specialisation Water and Traffic: Elective Computer International Management and Engineering: Specialisation II. Civil En International Management and Engineering: Specialisation II. Logistic Logistics, Infrastructure and Mobility: Specialisation Production and L	Compulsory ulsory ory igineering: Elective Compulso cs: Elective Compulsory		

Course L1163: Construction	Logistics
Тур	Lecture
Hrs/wk	1
СР	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Heike Flämig
Language	DE
Cycle	SoSe
Content	The lecture gives deeper insight how important logistics are as a competetive factor for construction projects and which issues are to be adressed. The following toppics are covered: • competetive factor logistics • the concept of systems, planning and coordination of logistics • the concept of systems, planning and coordination of logistics • material, equipment and reverse logistics • IT in construction logistics • elements of the planning model of construction logistics and their connections • flow oriented logistics systems for construction projects • logistics concepts for ready to use construction projects (especially procurement and waste removel logistics) • best practice examples (construction logistics Potsdamer Platz, recent case study of the region) Contents of the lecture are deepened in special exercises.
Literature	Flämig, Heike: Produktionslogistik in Stadtregionen. In: Forschungsverbund Ökologische Mobilität (Hrsg.) Forschungsbericht Bd 15.2. Wuppertal 2000. Krauss, Siri: Die Baulogistik in der schlüsselfertigen Ausführung, Bauwerk Verlag GmbH Berlin 2005. Lipsmeier, Klaus: Abfallkennzahlen für Neubauleistungen im Hochbau : Verlag Forum für Abfallwirtschaft und Altlasten, 2004. Schmidt, Norbert: Wettbewerbsfaktor Baulogistik. Neue Wertschöpfungspotenziale in der Baustoffversorgung. In: Klaus, Peter Edition Logistik. Band 6. Deutscher Verkehrs-Verlag. Hamburg 2003. Seemann, Y.F. (2007): Logistikkoordination als Organisationseinheit bei der Bauausführung Wissenschaftsverlag Mainz in Aachen, Aachen. (Mitteilungen aus dem Fachgebiet Baubetrieb und Bauwirtschaft (Hrsg. Kuhne, V.): Heft 20)

ourse L1164: Construction Logistics	
Тур	Recitation Section (small)
Hrs/wk	1
СР	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Heike Flämig
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L1161: Project Devel	ourse L1161: Project Development and Management	
Тур	Lecture	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Heike Flämig, Dr. Anton Worobei	
Language	DE	
Cycle	SoSe	
Content	Within the lecture, the main aspects of project development and management are tought:	
	 Terms and definitions of project management Advantages and disadvantages of different ways of project handling organization, information, coordination and documentation cost and fincance management in projects time- and capacity management in projects specific methods and instruments for successful team work Contents of the lecture are deepened in special exercises.	
Literature	Projektmanagement-Fachmann. Band 1 und Band 2. RKW-Verlag, Eschborn, 2004.	

Course L1162: Project Devel	irse L1162: Project Development and Management	
Тур	Project-/problem-based Learning	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Heike Flämig, Dr. Anton Worobei	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Module M0593: Building Materials and Building Preservation

Courses						
Fitle				Тур	Hrs/wk	СР
Repair of Structures (L0255)				Lecture	1	1
Mineral Building Materials (L0253)				Lecture	2	2
Technology of mineral Building Mat	erials (L0256)			Project-/problem-based Learning	1	2
Transport Processes in Building Mat	erials and Damage Processes (L	0254)		Lecture	1	1
Module Responsible	Prof. Frank Schmidt-Döhl					
Admission Requirements	None					
Recommended Previous	Basic knowledge about build	ding materials, b	uilding physics an	d building chemistry, for exan	nple by the m	nodules Principles
Knowledge	Building Materials and Buildir	ng Physics and Bu	uilding Materials an	d Building Chemistry.		
Educational Objectives	After taking part successfully	, students have r	eached the following	ng learning results		
Professional Competence						
Knowledge	manufacture of special miner able to describe the manufac	ral building mater cture, properties a	ials. They are able and fields of applic	lding materials and their function to show the characteristics of n ation of special mortars and spe s of anchor technology and desi	nineral buildin cial concretes	g materials. They
Skills	mineral mortar and to manu	facture this morta to assess possible	ar. The students ar	y of a mineral building material e able to manufacture post ins ne fundamentals of constructior	talled rebar co	onnections. They a
Personal Competence						
Social Competence		discussion they c	defend and adjust	special mortar. They present tl their results. The students are		
Autonomy	The students are able to responsibly use the resources of materials and lab equipment for their project and to investigate and to get missing components.					
Workload in Hours	Independent Study Time 110	, Study Time in Le	ecture 70			
Credit points	6					
Course achievement		ct theoretical cal work	Description and			
Examination	Written exam					
Examination duration and scale	120 min					
	Civil Engineering: Specialisat	ion Geotechnical	Engineering: Com	ulsory		
Following Curricula			• • •			
ronowing curricula	Civil Engineering: Specialisat Civil Engineering: Specialisat					
	civil Engineering: Specialisat	ion sciuctural Eng	gineering. Elective	compulsory		
	s Engineering. Specialisat	.o or accurat Eng	June of the second	cop 0.001 y		

Course L0255: Repair of Structures	
Тур	Lecture
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Frank Schmidt-Döhl
Language	DE
Cycle	SoSe
Content	Maintenance of structures, repair and strengthening, subsequent waterproofing of structures
Literature	BetonMarketing Deutschland (Hrsg.): Stahlbetonoberflächen - schützen, erhalten, instandsetzen

Course L0253: Mineral Buildi	Course L0253: Mineral Building Materials		
Тур	Lecture		
Hrs/wk	2		
СР	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Prof. Frank Schmidt-Döhl		
Language	DE		
Cycle	SoSe		
Content	Components of mineral building materials and their function, binding materials, concrete and mortar, special mortars, special concretes		
Literature	Taylor, H.F.W.: Cement Chemistry		
	Springenschmid, R.: Betontechnologie für die Praxis		

Course L0256: Technology of	Course L0256: Technology of mineral Building Materials	
Тур	Project-/problem-based Learning	
Hrs/wk	1	
СР	2	
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14	
Lecturer	Prof. Frank Schmidt-Döhl	
Language	DE	
Cycle	SoSe	
Content	Design and production of a special mineral building material	
Literature	Taylor, H.F.W.: Cement Chemistry	
	Springenschmid, R.: Betontechnologie für die Praxis	

Course L0254: Transport Processes in Building Materials and Damage Processes	
Тур	Lecture
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Frank Schmidt-Döhl
Language	DE
Cycle	SoSe
Content	Transport Processes in Building Materials and Damage Processes
Literature	Blaich, J.: Bauschäden, Analyse und Vermeidung

Courses				
Title		Тур	Hrs/wk	СР
Structural Dynamics (L1202)		Lecture	2	2
Structural Dynamics (L1203)		Recitation Section (large)	2	2
Fracture mechanics and fatigue in	steel structures (L0564)	Lecture	1	1
Fracture mechanics and fatigue in	steel structures (L0565)	Recitation Section (large)	1	1
Module Responsible	Prof. Bastian Oesterle			
Admission Requirements	None			
Recommended Previous	Knowledge of linear structural analysis	of statically determinate and indeterminate struct	ures; Mechanics	I/II, Mathematics
Knowledge	Differential equations I			
Educational Objectives	After taking part successfully, students h	ave reached the following learning results		
Professional Competence				
Knowledge	After successful completion of this mode respective methods.	ule, the student can explain the basic aspects of c	dynamic effects o	n structures and
Skills	After successful completion of this mo dynamics loading using the appropriate o	odule, the students will be able to predict the res computational approaches and methods.	sponse of mater	ial and structures
Personal Competence				
Social Competence	Students can			
	 participate in subject-specific and 	interdisciplinary discussions		
	 defend their own work results in fr 			
	 promote the scientific development 			
		ccept professional constructive criticism		
	·			
Autonomy		he subject area from given and other sources and a		oblems. Furthermo
	they are able to structure the solution pro	ocess for problems in the area of Structural Analysis		
Workload in Hours	Independent Study Time 96, Study Time	in Lecture 84		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	150 min			
scale				
Assignment for the	Civil Engineering: Specialisation Structura	al Engineering: Compulsory		
		nical Engineering: Elective Compulsory		
Following Curricula				
Following Curricula		Engineering: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Coastal I			
Following Curricula		nd Traffic: Elective Compulsory		

Course L1202: Structural Dy	namics
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Bastian Oesterle
Language	DE
Cycle	SoSe
Content	 mechanical background of dynamics harmonic vibrations, damped and undamped free and forced vibrations frequency and time domain modelling aspects principle of d'Alembert systems with multiple degrees of freedom consistent and lumped mass matrices finite elements for dynamics problems impact problems eigenvalue problems and modal analysis direct time integration schemes, transient analyses
Literature	 Vorlesungsmanuskript Clough, R.W., Penzien, J.: Dynamics of Structures. 2. Aufl., McGraw-Hill, New York, 1993.

Course L1203: Structural Dynamics	
Тур	Recitation Section (large)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Bastian Oesterle
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Тур	Lecture
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dr. Jürgen Priebe
Language	DE
Cycle	SoSe
Content	 basics of fatigue stress and fatigue resistance and determination of fatigue strength,
	determination and use of S-N-curves and classification of notch effects,
	set up of determination of fatigue strength under dynamic load using the accumulation formula by Palmgren-Miner,
	set up of determination of fatigue strength in different examples,
	 basics of construction and design regarding the problem of material fatigue,
	basics of linear elastic fracture mechanics under static and dynamic load,
	determination of lifetime of steel construction based on linear elastic fracture mechanics in different examples.
Literature	Seeßelberg, C.; Kranbahnen - Bemessung und konstruktive Gestaltung; 3. Auflage; Bauwerk-Verlag; Berlin 2009
	Kuhlmann, Dürr, Günther; Kranbahnen und Betriebsfestigkeit; in Stahlbau Kalender 2003; Verlag Ernst & Sohn; Berlin 2003
	Deutscher Stahlbau-Verband (Hrsg.); Stahlbau Handbuch Band 1 Teil B; 3. Auflage; Stahlbau-Verlagsgesellschaft; Köln 199
	Petersen, C.; Stahlbau; 3. überarb. und erw. Auflage; Vieweg-Verlag; Braunschweig 1993
	 DIN V ENV 1993-1-1: Eurocode 3; Bemessung und Konstruktion von Stahlbauwerken; Teil 1-1: Allgemeine Bemessungsre- Bemessungsregeln für den Hochbau; 1993
	• DIN V ENV 1993-6: Eurocode 3; Bemessung und Konstruktion von Stahlbauwerken; Teil 6: Kranbahnen; 2001
	• DIN-Fachbericht 126. Richtlinie zur Anwendung von DIN V ENV 1993-6; Nationales Anwendungsdokument (NAD); Berlin 20

Course L0565: Fracture mechanics and fatigue in steel structures	
Тур	Recitation Section (large)
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dr. Jürgen Priebe
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M0982: Trans			
Courses			
Title	Тур	Hrs/wk	СР
Fransportation Modelling (L1180)	Project-/problem-based Learn	ng 4	6
Module Responsible	Prof. Carsten Gertz		
Admission Requirements	None		
Recommended Previous	some knowledge of transport planning, e.g. through taking the undergraduate class "Transp	ort 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. 		
Personal Competence			
Social Competence	Students are able to independently develop and document solutions.		
Autonomy	Students are able to:		
	 independently organise, manage and solve set tasks. 		
	 independently prepare written reports. 		
	and the second		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56		
Credit points	6		
Course achievement	None		
Examination	Written elaboration		
Examination duration and	written assignment with presentation during the semester		
scale			
Assignment for the	Civil Engineering: Specialisation Water and Traffic: Compulsory		
Following Curricula	Logistics, Infrastructure and Mobility: Specialisation Infrastructure and Mobility: Elective Com	pulsory	
	Water and Environmental Engineering: Specialisation Cities: Elective Compulsory		

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

Module M0827: Mode	ling in Water Management			
Courses				
Title		Тур	Hrs/wk	СР
Groundwater Modeling using Modfl	ow (L0543)	Lecture	1	1
Groundwater Modeling using Modfl		Recitation Section (small)	2	2
Modeling of Water Supply Network		Project-/problem-based Learning	2	3
Module Responsible	-			
Admission Requirements				
Recommended Previous	Groundwater			
Knowledge	• groundwater hydraulics and transport of sub	ostances		
	Pipe Systems			
	Knowledge on urban water infrastructures	s, in particular drinking water systemsand ι	ırban drainag	e systems includin
	special structures			
	 Hydraulics of drinking water supply systems 	and sewer systems		
	Basic knowledge on water management			
Educational Objectives	After taking part successfully, students have reach	ed the following learning results		
Professional Competence				
Knowledge	The students are able to describe the modelling of	groundwater flow and transport as well as urb	oan water infr	astructures. They ca
	carry out systems analyses and can detect technic	cal and conceptual weak points within the sys	tems in case	studies. Besides the
	are able to analyse interdependencies of hydraulic	and toxic phenomena in soil and water.		
Skills	The students are able to construct and apply scie			
	and can compare or assess different solutions for		oftware produ	cts. The students ar
	able to use different software solutions (e.g. EPANI	ET, EPA-SWMM).		
Personal Competence				
Social Competence	Wird nicht vermittelt.			
Autonomy	Wird nicht vermittelt.			
	Independent Study Time 110, Study Time in Lectur	re 70		
Credit points Course achievement				
Examination				
Examination duration and	30 min			
scale	50 mm			
	Civil Engineering: Specialisation Structural Enginee	ering: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering	5 1 5		
	Civil Engineering: Specialisation Coastal Engineering	5 1 5		
	Civil Engineering: Specialisation Water and Traffic:			
	Civil Engineering: Specialisation Computational En			
	Water and Environmental Engineering: Specialisati			
	Water and Environmental Engineering: Specialisati	ion Cities: Elective Compulsory		
	Water and Environmental Engineering: Specialisati	ion Water: Elective Compulsory		

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

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

Course L0875: Modeling of V	Vater 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.

Courses				
Title		Тур	Hrs/wk	СР
Modelling of Flow in Rivers and Est		Lecture	3	4
	ring / Integrated Flood Protection (L0961)	Project-/problem-based Learnir	g 2	2
Module Responsible				
Admission Requirements				
	Fundamentals of Hydromechanics, Hydraulics,	Hydrology and Hydraulic Engineering; Hyd	draulic Engineer	ring I and Hydrau
Knowledge	Engineering II			
Educational Objectives	After taking part successfully, students have rea	ched the following learning results		
Professional Competence				
Knowledge	Students are able to define in detail the basic processes that are related to the modelling of flows in hydraulic engineering Resides, they can describe the basic processes of numerical medaling and actual numerical medals for the simulation of flows a			
Besides, they can describe the basic aspects of numerical modelling and actual numerical models for the simulatio waves. They can also depict the concepts of nature oriented hydraulic engineering.		nulation of nows a		
	waves. They can also depict the concepts of hat	are oriented hydraulic engineering.		
Skills Students are able to apply hydrodynamic-numerical models to practical hydraulic engineering tasks. Furthermo		ore, the students		
	able to set up flood-risk management concepts and are able to apply basic concepts of renaturation to practical problems.			
Personal Competence				
	The students are able to deploy their gained kn	owledge in applied problems of the practical	natura bacad b	vdraulic opginoori
Social Competence	Additionaly, they will be able to work in team wit		nature-based n	yuraulic engineeri
Autonomy	The students will be able to independently exten	•		
Autonomy	The students will be able to independently exten	in their knowledge and apply it to new problem	115.	
Workload in Hours	Independent Study Time 110, Study Time in Lect	ture 70		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	The duration of the examination is 150 min. T	he examination includes tasks with respect	to the general	understanding of
scale	lecture contents and calculations tasks.			
Assignment for the	Civil Engineering: Specialisation Water and Traff	c: Compulsory		
Following Curricula	Environmental Engineering: Core Qualification: E	lective Compulsory		
	Joint European Master in Environmental Studies	- Cities and Sustainability: Core Qualification:	Compulsory	
	Water and Environmental Engineering: Specialisa	ation Water: Compulsory		
	Water and Environmental Engineering: Specialisa	ation Environment: Compulsory		
	Water and Environmental Engineering: Specialisa			

Course L0810: Modelling of F	Flow in Rivers and Estuaries
Тур	Lecture
Hrs/wk	
СР	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Edgar Nehlsen, Prof. Peter Fröhle
Language	EN
Cycle	SoSe
Content	Introduction to numerical flow modelling
	 Processes affecting tht flow Examples and applications of numerical models Procedure of numerical modelling Model concept Basic equations of hydrodynamics Saint-Venant equations Euler Equations Navier-Stokes equations Reynolds-averaged Navier-Stokes equations Shallow water equations
	Solving schemes Numerical discretization Solution algorithms Convergence
Literature	Vorlesungsskript
	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 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

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

Courses				
Title		Тур	Hrs/wk	СР
Harbour Engineering (L0809)		Lecture	2	2
Harbour Engineering (L1414)		Project-/problem-based Learning	1	2
Port Planning and Port Construction	n (L0378)	Lecture	2	2
Module Responsible	Prof. Peter Fröhle			
Admission Requirements	None			
Recommended Previous	Basics of coastal engineering			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the fol	lowing learning results		
Professional Competence				
Knowledge	The students are able to define in details and to choose design approaches for the functional design of a port and apply then			
design tasks. They can design the fundamental elements of a port.				
<i></i>				
Skills	The students are able to select and apply appropriate approaches for the functional design of ports.			
Personal Competence				
Social Competence	The students are able to deploy their gained knowledge in	applied problems such as the funct	tional design	of ports. Addition
	they will be able to work in team with engineers of other dis	ciplines.		
Autonomy	The students will be able to independently extend their know	vledge and apply it to new problems		
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	The duration of the examination is 150 min. The examina	tion includes tasks with respect to	the general u	understanding of
scale	lecture contents and calculations tasks.			
Assignment for the	Civil Engineering: Specialisation Structural Engineering: Elec	tive Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering: I	Elective Compulsory		
	Civil Engineering: Specialisation Coastal Engineering: Comp	llsory		
	Civil Engineering: Specialisation Water and Traffic: Elective	Compulsory		
	International Management and Engineering: Specialisation I	Civil Engineering: Elective Compute		

ourse L0809: Harbour Engin	
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
Cycle	SoSe
Content	 Fundamentals of harbor engineering Maritime transportation and waterways engineering Ships Elements of harbors Harbor approaches and water-side harbor areas Terminal design and handling of cargo Quay-walls and piers Equipment of harbors Sluices and other special constructions Connection to inland transportation / inland waterway transportation Protection of harbors Breakwaters and Jetties Wave protection of harbors Fishery and other small harbors
Literature	Brinkmann, B.: Seehäfen, Springer 2005

Course L1414: Harbour Engi	urse L1414: Harbour 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	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

lent Study Time 32, Study Time in Lecture 28 indt anning and implementation of major projects
anning and implementation of major projects
anning and implementation of major projects
anning and implementation of major projects
arket analysis and traffic relations anning process and plan rt planning in urban neighborhood evelopment of the logistics center "Port of Hamburg" in the metropolis uays and waterfront structure eccial planning Law Harbor - securing of a flexible use of the port mensioning of quays bod protection structures rt of Hamburg - Infrastructure and development eparation of areas our formation in front of shore structures

Courses				
Courses		_		
Title Water and Environment (L2754)		Typ	Hrs/wk 3	СР 3
Water and Environment (L2753)		Project-/problem-based Learning Lecture	3	3
Module Responsible	Prof. Nima Shokri			-
Admission Requirements				
Recommended Previous	Basic knowledge in water and environmental research, Hydrol	ogy		
Knowledge				
Educational Objectives	After taking part successfully, students have reached the follo	wing 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 too and techniques relevant to water and environmental research at different scales. This will provide the students with an exceller opportunity to improve their skills on multiple fronts which will be useful in their future career.			
Personal Competence				
Social Competence	Developing teamwork and problem solving skills through Rese	arch-Based Teaching approaches	will be at the c	ore of this module
Autonomy	The students will be involved in writing individual reports willingness to work independently and responsibly.	and presentation. This will contri	bute to the s	students' ability a
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 Co	mpulsory		
	Environmental Engineering: Specialisation Environment and Cl	imate: Elective Compulsory		
	Water and Environmental Engineering: Specialisation Cities: El	ective Compulsory		
	Water and Environmental Engineering: Specialisation Water: E	lective Compulsory		
	Water and Environmental Engineering: Specialisation Environm	ent: Compulsory		

Course L2754: Water and En	vironment
Тур	Project-/problem-based Learning
Hrs/wk	3
CP	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

Courses					
Title		Тур	Hrs/wk	СР	
Smart Monitoring (L2762)		Integrated Lecture	2	2	
Smart Monitoring (L2763)		Recitation Section (small)	2	4	
Module Responsible	Prof. Kay Smarsly				
Admission Requirements	None				
Recommended Previous	Basic knowledge or interest in object-oriented modeli	ng, programming, and sensor technolo	ogies are helpful	. Interest in mod	
Knowledge	research and teaching areas, such as Internet of Thin	gs, Industry 4.0 and cyber-physical sys	stems, as well as	s the will to dee	
	skills of scientific working, are required. Basic knowledge	ge in scientific writing and good English	skills.		
Educational Objectives	After taking part successfully, students have reached t	a following learning regults			
	After taking part successfully, students have reached t	le following learning results			
Professional Competence	The students will become familiar with the principle	and practices of smart monitoring	The students wil	II ha abla ta da	
Kilowiedge	The students will become familiar with the principles decentralized smart systems to be applied for com				
	environment. In addition, the students will learn to des				
	analysis techniques, modern software design concepts	• • •			
	also part of this module, which will be conducted thro				
	students will design smart monitoring systems that inte	-	÷	• •	
	Specific focus will be put on the application of machi				
	real-world (built or natural) systems, such as bridges o	r slopes, or on scaled lab structures for	validation purpo	ses. The outcom	
	every group will be documented in a paper. All student	s of this module will "automatically" pa	articipate with the	eir smart monito	
	system in the annual "Smart Monitoring" competition.	The written papers and oral examinatio	ns form the final	grades. The mo	
	will be taught in English. Limited enrollment.				
Skille	The students will gain insights into operating state-of-	beart smart sensor systems used for	monitoring a wi	de range of phys	
JKIIIS	processes relevant to engineering, such as environm				
	devising monitoring strategies of physical processes				
	implement the strategies in smart wireless sensor nod				
	be able to document the findings of their projects in sh		- 9	,,,	
D					
Personal Competence					
Social Competence	The students will be able to work in groups, share par	ts of the work for their projects, and de	evelop communic	cation skills, tow	
	achieving the common project goals.				
Autonomy	The students will be able to gain a solid basis on app	roaching and solving problems in eng	ineering, as well	as on documen	
	results, through their involvement in their monitoring g	roup projects.			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56				
Credit points		,			
Course achievement					
	Written elaboration				
Examination duration and	10 pages of work with 15-minute oral presentation				
scale					
Assignment for the	Civil Engineering: Specialisation Water and Traffic: Elec	tive Compulsory			
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineer	ing: Elective Compulsory			
	Civil Engineering: Specialisation Coastal Engineering: E	lective 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 Environmen				
	Environmental Engineering: Specialisation Water Quality		pulsory		
	Mechatronics: Technical Complementary Course: Election	ve Compulsory			
	Mechatronics: Core Qualification: Elective Compulsory				
	Theoretical Mechanical Engineering: Specialisation Rob		ompulsory		
	Water and Environmental Engineering: Specialisation C				
	Water and Environmental Engineering: Specialisation E				
	Water and Environmental Engineering: Specialisation V				

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

Course L2763: Smart Monitor	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
Literature	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. The course contents couples different fields, such as signal processing, sensing technologies, data analytics, environmental engineering, civil engineering, artificial intelligence, database systems, and many more. The basics will be taught in this course. However, specific literature that covers all these topics does not exist. Instead, literature will be referenced in the lectures, all of which are papers that are freely available online.

Courses						
itle				Тур	Hrs/wk	СР
Vaste management (L3261)				Project-/problem-based Learning	3	3
nternational waste concepts (L325				Lecture	2	2
nternational waste concepts (L326	-			Recitation Section (small)	1	1
Module Responsible	Prof. Kerstin Kuchta					
Admission Requirements	None					
Recommended Previous	Basics in process eng	lineering				
Knowledge						
Educational Objectives	After taking part succ	essfully, students ha	ive reached the following	ng learning results		
Professional Competence						
Knowledge	The students are abl	e to describe waste	as a resource as well a	as advanced technologies for re	ecycling and re	ecovery of resou
	from waste in detail.	This covers collection	n, transport, treatment	and disposal in national and inte	ernational con	texts.
C1.111					0	
SKIIIS				with respect to the national or c		
	They can evaluate th	e ecological impact a	and the technical effort	of different technologies and ma	anagement sy	stems.
Personal Competence						
Social Competence	Students can work t	ogether as a team o	of 2-5 persons, particin	pate in subject-specific and inte	erdisciplinary	discussions. dev
	cooperated solutions and defend their own work results in front of others and promote the scientific development of colleage					
	Furthermore, they ca	n give and accept pr	ofessional constructive	criticisms.		
	-					
Autonomy		ndently gain additio	nal knowledge of the	subject area and apply it in so	olving the give	en course tasks
	projects.					
Workload in Hours	Independent Study T	ime 96. Study Time i	n Lecture 84			
Credit points						
Course achievement		Form	Description			
course acmevement	Yes 20 %	Written elaboration				
Examination	Presentation					
Examination duration and	PowerPoint presentat	ion (10-15 minutes)				
scale	· · · · · · · · · · · · · · · · · · ·					
Assignment for the	Civil Engineering: Spe	ecialisation Water an	d Traffic: Elective Com	pulsory		
Following Curricula				ocess Engineering: Elective Com	pulsory	
3		• • •		Engineering: Elective Compulso		
		• • •				
	Chemical and Bioprocess Engineering: Specialisation Chemical Process Engineering: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation Chemical and Bio process Engineering: Elective Compulsory					
			re Qualification: Electiv			
			Energy and Resources			
	-	•		newable Energy: Elective Compu	ilsory	
	-	-		eering: Elective Compulsory	,	
				5		
	Water and Environme	ental Engineering: Sp	ecialisation Cities: Elec	tive Compulsory		

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

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

Course L3260: International	waste concepts
Тур	Recitation Section (small)
Hrs/wk	1
CP	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

Courses					
Title		Тур	Hrs/wk	СР	
Applied Surface Hydrology (L0289)		Lecture	2	2	
Applied Surface Hydrology (L1412)		Project-/problem-based Learning	1	2	
nteraction Water - Environment in	1	Project-/problem-based Learning	1	2	
Module Responsible					
Admission Requirements	None				
Recommended Previous	Fundamentals of Hydromechanics and	Hydraulic Engineering: Hydraulic Engineering I and Hydra	ulic Engineeri	ng II	
Knowledge					
Educational Objectives	After taking part successfully, students	have reached the following learning results			
Professional Competence					
Knowledge	The students are able to define the basic concepts of hydrology and water management. They are able to describe and quar				
	the relevant processes of the hydrologi	ical water cycle. Besides, the students know the main as	pects of rainfa	ll-run-off-models	
	are able to theoretically derive establis	hed reservoir / storage models and a unit-hydrograph.			
Chille	a The students are able to use the basis budgelegical concents and expressions and are able to the retically derive establish				
SKIIIS	s The students are able to use the basic hydrological concepts and approaches and are able to theoretically derive establish reservoir / storage models or a unit-hydrograph as the basis for rainfall-run-off-models. The student are able to explain the ba				
	concepts of measurements of hydrological and hydrodynamic values in nature and are able to perform, analyze and statistica				
	assess these measurements. Furthermore, they are able to apply a hydrological model to basic hydrological problems.				
	assess these measurements. Furthermo	ore, they are able to apply a hydrological model to basic	nyurulugical pi	oblems.	
Personal Competence					
Social Competence	The students are able to deploy their g	ained knowledge in applied problems of the hydrology ar	nd water mana	gement. Additior	
	they will be able to work in team with e	ngineers of other disciplines.			
Autonomy	The students will be able to independer	ntly extend their knowledge and apply it to new problems	5		
	Independent Study Time 124, Study Tir	ne in Lecture 56			
Credit points					
Course achievement	None				
Examination	Written exam				
Examination duration and	The duration of the examination is 90 n	nin. The examination includes tasks with respect to the g	eneral underst	anding of the lec	
scale	contents and calculations tasks.				
Assignment for the	Civil Engineering: Specialisation Compu	tational Engineering: Elective Compulsory			
Following Curricula	Civil Engineering: Specialisation Water	and Traffic: Compulsory			
	Environmental Engineering: Core Qualit	fication: Elective Compulsory			
	Joint European Master in Environmental Studies - Cities and Sustainability: Core Qualification: Compulsory				
	Water and Environmental Engineering:	Specialisation Cities: Elective Compulsory			
	1				
	Water and Environmental Engineering:	Specialisation Environment: Elective Compulsory			

Course L0289: Applied Surfa	ce Hydrology
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Peter Fröhle
Language	DE/EN
Cycle	SoSe
Content	Basics of hydrology:
	 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	rse L1412: Applied Surface Hydrology		
Тур	Project-/problem-based Learning		
Hrs/wk	1		
CP	2		
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14		
Lecturer	Prof. Peter Fröhle		
Language	DE/EN		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Course L0295: Interaction 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	-

Courses						
Title		Тур	Hrs/wk	СР		
Modeling Processes in Vadose Zone	(L2735)	Recitation Section (small)	2	2		
/adose Zone Hydrology (L2732)		Lecture	2	2		
/adose Zone Hydrology (L2733)		Recitation Section (large)	2	2		
Module Responsible	Prof. Nima Shokri					
Admission Requirements	None					
Recommended Previous	Basic knowledge in water and soil					
Knowledge						
	Comfortable with math and physics, critic	cal thinking, creative problem solving				
	Analytic skills					
Educational Objectives	After taking part successfully, students h	ave reached the following learning results				
Professional Competence						
Knowledge	The students will learn about soil cha	racterization (solid and liquid phase), the energ	y state of soil w	ater, the soil wa		
	characteristic curve, flow in saturated and unsaturated soil as well as about solute transport in soil					
Skills	Students will work on practical examples modelling transport processes in soil using different quantitative tools includi					
	computer simulations and analytical tools. This will help them to apply knowledge in order to solve problems and tasks.					
Personal Competence						
	The module aims at raising awareness	and enthusiasm for new knowledge related to a	water soil and er	ovironment This		
Social competence	e The module aims at raising awareness and enthusiasm for new knowledge related to water, soil and environment. This v positively contribute to shape their work and life environment.					
	positively contribute to shape their work	and me environment.				
Autonomy	The students will be involved in many problem solving exercises. This will contribute toward their willingness to wor					
	independently and responsibly.					
	Independent Study Time 96, Study Time	IN LECTURE 84				
· · · · ·	6 None					
	Written elaboration					
Examination duration and	Report and Presentation					
scale						
Assignment for the	Civil Engineering: Specialisation Compute					
	Civil Engineering: Specialisation Water ar	nα Traffic: Elective Compulsory				
Following Curricula						
Following Curricula	Environmental Engineering: Core Qualific Water and Environmental Engineering: Sp					

Course L2735: Modeling Proc	cesses 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	urse 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		

Courses					
Title		Тур	Hrs/wk	СР	
Rural Development and Resources	Oriented Sanitation for different Climate Zones (L0942)	Seminar	2	3	
Rural Development and Resources	Oriented Sanitation for different Climate Zones (L0941)	Lecture	2	3	
Module Responsible	Prof. Ralf Otterpohl				
Admission Requirements	None				
Recommended Previous	Basic knowledge of the global situation with rising povert	y, soil degradation, lack of w	vater resources and sanit	ation	
Knowledge					
Educational Objectives	After taking part successfully, students have reached the	following learning results			
Professional Competence					
Knowledge	Students can describe resources oriented wastewater s	ystems mainly based on so	urce control in detail. Th	ney can comment o	
	techniques designed for reuse of water, nutrients and so	l conditioners.			
	Students are able to discuss a wide range of proven appr	oaches in Rural Developmer	t from and for many regi	ons of the world	
	students are use to discuss a wide range or proven appr		it normania for many regi	ons of the world.	
Skills	Students are able to design low-tech/low-cost sanitation	n, rural water supply, rain	water harvesting system	is, measures for t	
	rehabilitation of top soil quality combined with food and water security. Students can consult on the basics of soil building through				
	"Holisitc Planned Grazing" as developed by Allan Savory.				
Personal Competence					
-	The students are able to develop a specific topic in a tea	n and to work out milestone	s according to a given pl	an	
beendr competence			s according to a given pr		
Autonomy	Students are in a position to work on a subject and to	organize their work flow in	ndependently. They can	also present on th	
	subject.				
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56				
Credit points	6				
Course achievement	None				
Examination	Subject theoretical and practical work				
Examination duration and	During the course of the semester, the students work to	wards mile stones. The wor	k includes presentations	and papers. Detail	
scale	information will be provided at the beginning of the smea	ter.			
Assignment for the	Civil Engineering: Specialisation Water and Traffic: Electiv	ve Compulsory			
Following Curricula	Bioprocess Engineering: Specialisation A - General Biopro	cess Engineering: Elective C	Compulsory		
	Chemical and Bioprocess Engineering: Specialisation Ger	eral Process Engineering: El	ective Compulsory		
	Environmental Engineering: Specialisation Environment a	nd Climate: Elective Compu	lsory		
	Environmental Engineering: Specialisation Water Quality	and Water Engineering: Elec	tive Compulsory		
	International Management and Engineering: Specialisation	n II. Energy and Environmen	tal Engineering: Elective	Compulsory	
	Process Engineering: Specialisation Environmental Proces	ss Engineering: Elective Com	pulsory		
	Process Engineering: Specialisation Process Engineering:	Elective Compulsory			
	Water and Environmental Engineering: Specialisation Wa	ter: Elective Compulsory			
	Water and Environmental Engineering: Specialisation Env	vironment: Elective Compuls	ory		
	Water and Environmental Engineering: Specialisation Citi				

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

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

Courses				
Title		Тур	Hrs/wk	СР
Process Modelling of Wastewater T	reatment (L0522)	Project-/problem-based Learning	2	3
Process Modeling in Drinking Wate	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 drin	nking water and waste water treatment.		
Knowledge				
Educational Objectives	After taking part successfully, students have reach	ed the following learning results		
Professional Competence				
Knowledge	Students are able to explain selected processes of	of drinking water and waste water treatment i	n detail. They	, are able to expla
	basics as well as possibilities and limitations of dyr	namic modeling.		
Chille	Students are able to use the most important feat	ures Modelica offers. They are able to transpo	se selected -	rocossos in drinki
JKIIIS				
	water and waste water treatment into a mathematical model in Modelica with respect to equilibrium, kinetics and mass ba They are able to set up and apply models and assess their possibilities and limitations.			
	They are able to set up and apply models and asse	ess their possibilities and inflitations.		
Deveenal Competence				
Personal Competence				!
Social Competence	Students are able to solve problems and document solutions in a group with members of different technical background. They a			
	able to give appropriate feedback and can work co	instructively with reedback concerning their wo	JEK.	
Autonomy	Students are able to define a problem, gain the required knowledge and set up a model.			
Werklood in Hours	Independent Study Time 124, Study Time in Lestry	xo 56		
Credit points	Independent Study Time 124, Study Time in Lectur	16.20		
Course achievement				
Examination				
Examination duration and				
scale	50 mm			
	Civil Engineering: Specialisation Water and Traffic:	Elective Compulsory		
Following Curricula	Chemical and Bioprocess Engineering: Technical C			
ronowing curricula	Environmental Engineering: Specialisation Water Q	1 , 1 ,	lsorv	
	Process Engineering: Specialisation Environmental			
	Process Engineering: Specialisation Process Engine			
	Water and Environmental Engineering: Specialisati			
	Water and Environmental Engineering: Specialisati			
	Water and Environmental Engineering: Specialisati			

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

	rete Structures	ة 				
Courses						
Fitle			Тур	Hrs/wk	СР	
Concrete Structures (L0579)			Seminar	1	1	
Structural Concrete Members (L05)	77)		Lecture	2	3	
Structural Concrete Members (L05	78)		Recitation Section (large)	2	2	
Module Responsible	NN					
Admission Requirements	None					
Recommended Previous	Basics of structural a	analysis, conception an	d dimensioning of structural concrete			
Knowledge						
	Modules: Reinforced	Concrete Structures I+	-II, Structural Analysis I+II, Mechanics I+II			
	After taking part suc	cessfully, students hav	e reached the following learning results			
Professional Competence						
Knowledge			ral engineering, especially in the field of buildin			
	the knowledge for th	he knowledge for the conception and design of concrete buildings and structural members that are often used.				
Skills	The students are able to apply procedures of the conception and dimensioning to to practical problems of structural engineering.					
511115	They are capable to draft concrete buildings and to design them for general action effects and to plan their of execution. Moreover, they can make design and construction sketches and draw up technical descriptions.					
					a chen accumig a	
	execution. Horeover	, they can make design	rand construction sketches and draw up teenin	icul descriptions.		
Personal Competence						
Social Competence	The students are able to obtain results of high quality in teamwork.					
Autonomy	The students are abl	le to carry out complex	conception and dimensioning tasks of structure	es under the quidan	co of tutors	
hatohomy	The statents are us	The students are able to carry out complex conception and dimensioning tasks of structures under the guidance of tutors.				
	Independent Study T	Fime 110, Study Time in	n Lecture 70			
Workload in Hours						
Workload in Hours Credit points						
	Compulsory Bonus	Form	Description			
Credit points Course achievement	Compulsory Bonus No None	Form Presentation	Description Es werden 2 Referate ausgegeben			
Credit points Course achievement Examination	Compulsory Bonus No None Written exam		•			
Credit points Course achievement	Compulsory Bonus No None Written exam		•			
Credit points Course achievement Examination	Compulsory Bonus No None Written exam		•			
Credit points Course achievement Examination Examination duration and scale	Compulsory Bonus No None Written exam 120 minutes	Presentation	•			
Credit points Course achievement Examination Examination duration and scale Assignment for the	Compulsory Bonus No None Written exam 120 minutes Civil Engineering: Sp	Presentation	Es werden 2 Referate ausgegeben			
Credit points Course achievement Examination Examination duration and scale Assignment for the	Compulsory Bonus No None Written exam 120 minutes Civil Engineering: Sp Civil Engineering: Sp	Presentation pecialisation Structural l pecialisation Geotechnic	Es werden 2 Referate ausgegeben			
Credit points Course achievement Examination Examination duration and scale Assignment for the	Compulsory Bonus No None Written exam 120 minutes Civil Engineering: Sp Civil Engineering: Sp Civil Engineering: Sp Civil Engineering: Sp	Presentation pecialisation Structural pecialisation Geotechnic pecialisation Coastal En	Es werden 2 Referate ausgegeben			
Credit points Course achievement Examination Examination duration and scale Assignment for the	Compulsory Bonus No None Written exam 120 minutes Civil Engineering: Sp Civil Engineering: Sp Civil Engineering: Sp Civil Engineering: Sp	Presentation pecialisation Structural pecialisation Geotechnic pecialisation Coastal En- pecialisation Water and	Es werden 2 Referate ausgegeben Engineering: Compulsory cal Engineering: Elective Compulsory gineering: Elective Compulsory			

Course L0579: Concrete Stru	ictures
Тур	Seminar
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	NN
Language	DE
Cycle	WiSe
Content	With help of a project teamwork the subjects of the course "Concrete Structures" is practiced, discussed and presented.
Literature	- Projektbezogene Unterlagen werden abgegeben.

 Phocas, Marios C.: Hochhäuser : Tragwerk und Konstruktion, Stuttgart, Teubner, 2005 Deutscher Ausschuss für Stahlbeton: Heft 600: Erläuterungen zu DIN EN 1992-1-1, Beuth Verlag, Berlin 2012 Deutscher Ausschuss für Stahlbeton: Heft 240: Hilfsmittel zur Berechnung der Schnittgrößen und Formänderungen von Stahlbetontragwerken, Verlag Ernst & Sohn, Berlin 1978 Stiglat, K., Wippel, H.: Massive Platten - Ausgewählte Kapitel der Schnittkraftermittlung und Bemessung, Betonkalend 1992, Teil I, 287-366, Verlag Ernst & Sohn, Berlin 1992 Stiglat/Wippel: Platten. Verlag Ernst & Sohn, Berlin, 1973 	ourse L0577: Structural Co	
cp 3 Workload in Hours Independent Study Time 62, Study Time in Lecture 28 Lecturer NN Language DE Cycle WiSe Content • skyscrapers: structural elements • actions on structrues • bracing systems • design orf slabs (line and point supported plates and floor slabs) • membranes and deep beams • folded plates and shells • truss models • reinforced and prestressed members Vorlesungsunterlagen können im STUDiP heruntergeladen werden • Zilch K., Zehetmaier G.: Bemessung im konstruktiven Ingenieurbau. Springer, Heidelberg 2010 • König, G., Liphardt S.: Hochhäuser aus Stahlbeton, Betonkalender 2003, Teil II, Seite 1-69, Verlag Ernst & Sohn, Berlin 2002 • Phocas, Marios C.: Hochhäuser in Stablbeton: Heft 600: Erläuterungen zu DIN EN 1992-1-1, Beuth Verlag, Berlin 2012 • Deutscher Ausschuss für Stahlbeton: Heft 600: Erläuterungen zu DIN EN 1992-1-1, Beuth Verlag, Berlin 2012 • Deutscher Ausschuss für Stahlbeton: Heft 600: Erläuterungen zu DIN EN 1992-1-1, Beuth Verlag, Berlin 2012 • Deutscher Ausschuss für Stahlbeton: Heft Sohn, Berlin 1978 • Stiglat, K., Wippel, H.: Massive Platten - Ausgewählte Kapitel der Schnittkraftermittlung und Bemessung, Betonkalend 1992, Teil 1, 287-366, Verlag Ernst & Sohn, Berlin 1973		
Workload in Hours Independent Study Time 62, Study Time in Lecture 28 Lecturer NN Language DE Cycle WiSe Content eskyscrapers: structural elements eactions on structrues ebracing systems edesign off slabs (line and point supported plates and floor slabs) emembranes and deep beams efolded plates and shells etruss models ereinforced and prestressed members Literature Vorlesungsunterlagen können im STUDIP heruntergeladen werden Zlich K., Zehetmaier G.: Bemessung im konstruktiven Ingenieurbau. Springer, Heidelberg 2010 (König, G., Liphardt S.: Hochhäuser aus Stahlbeton, Betonkalender 2003, Teil II, Seite 1-69, Verlag Ernst & Sohn, Berlin 200 ePhocas, Marios C.: Hochhäuser : Tragwerk und Konstruktion, Stuttgart, Teubner, 2005 veluscher Ausschuss für Stahlbeton: Heft 240: Hilfsmittel zur Berechnung der Schnittgrößen und Formänderungen v stahlbetontragwerken, Verlag Ernst & Sohn, Berlin 1978 Stiglat, K., Wippel, H.: Massive Platten - Ausgewählte Kapitel der Schnittkraftermittlung und Bemessung, Betonkalend 1992, Teil I, 287-366, Verlag Ernst & Sohn, Berlin 1973		
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Language DE Cycle WiSe Content • skyscrapers: structural elements • actions on structrues • bracing systems • design orf slabs (line and point supported plates and floor slabs) • membranes and deep beams • folded plates and shells • truss models • reinforced and prestressed members Literature Vorlesungsunterlagen können im STUDIP heruntergeladen werden • Zilch K., Zehetmaier G.: Bemessung im konstruktiven Ingenieurbau. Springer, Heidelberg 2010 • König, G., Liphardt S.: Hochhäuser aus Stahlbeton, Betonkalender 2003, Teil II, Seite 1-69, Verlag Ernst & Sohn, Berlin 2000 • Phocas, Marios C.: Hochhäuser : Tragwerk und Konstruktion, Stuttgart, Teubner, 2005 • Deutscher Ausschuss für Stahlbeton: Heft 600: Erläuterungen zu DIN EN 1992-1-1, Beuth Verlag, Berlin 2012 • Deutscher Ausschuss für Stahlbeton: Heft 200: Hilfsmittel zur Berechnung der Schnittgrößen und Formänderungen v Stahlbetontragwerken, Verlag Ernst & Sohn, Berlin 1978 • Stiglat, K., Wippel, H.: Massive Platten - Ausgewählte Kapitel der Schnittkraftermittlung und Bemessung, Betonkalender 1992, Teil I, 287-366, Verlag Ernst & Sohn, Berlin 1992 • Stiglat/Wippel: Platten. Verlag Ernst & Sohn, Berlin 1992		
Cycle WiSe Content • skyscrapers: structural elements • actions on structures • bracing systems • design orf slabs (line and point supported plates and floor slabs) • membranes and deep beams • folded plates and shells • truss models • truss models • reinforced and prestressed members Literature Vorlesungsunterlagen können im STUDiP heruntergeladen werden • Zilch K., Zehetmaier G.: Bemessung im konstruktiven Ingenieurbau. Springer, Heidelberg 2010 • König, G., Liphardt S.: Hochhäuser aus Stahlbeton, Betonkalender 2003, Teil II, Seite 1-69, Verlag Ernst & Sohn, Berlin 200 • Phocas, Marios C.: Hochhäuser : Tragwerk und Konstruktion, Stuttgart, Teubner, 2005 • Deutscher Ausschuss für Stahlbeton: Heft 600: Erläuterungen zu DIN EN 1992-1-1, Beuth Verlag, Berlin 2012 • Deutscher Ausschuss für Stahlbeton: Heft 600: Hilfsmittel zur Berechnung der Schnittgrößen und Formänderungen v Stahlbetontragwerken, Verlag Ernst & Sohn, Berlin 1978 • Stiglat, K., Wippel, H.: Massive Platten - Ausgewählte Kapitel der Schnittkraftermittlung und Bemessung, Betonkalend 1992, Teil I, 287-366, Verlag Ernst & Sohn, Berlin 1992 • Stiglat/Wippel: Platten. Verlag Ernst & Sohn, Berlin 1992		
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Literature Vorlesungsunterlagen können im STUDiP heruntergeladen werden Zilch K., Zehetmaier G.: Bemessung im konstruktiven Ingenieurbau. Springer, Heidelberg 2010 König, G., Liphardt S.: Hochhäuser aus Stahlbeton, Betonkalender 2003, Teil II, Seite 1-69, Verlag Ernst & Sohn, Berlin 2000 Phocas, Marios C.: Hochhäuser : Tragwerk und Konstruktion, Stuttgart, Teubner, 2005 Deutscher Ausschuss für Stahlbeton: Heft 600: Erläuterungen zu DIN EN 1992-1-1, Beuth Verlag, Berlin 2012 Deutscher Ausschuss für Stahlbeton: Heft 240: Hilfsmittel zur Berechnung der Schnittgrößen und Formänderungen v Stahlbetontragwerken, Verlag Ernst & Sohn, Berlin 1978 Stiglat, K., Wippel, H.: Massive Platten - Ausgewählte Kapitel der Schnittkraftermittlung und Bemessung, Betonkalend 1992, Teil I, 287-366, Verlag Ernst & Sohn, Berlin 1992 Stiglat/Wippel: Platten. Verlag Ernst & Sohn, Berlin 1973	Content	 actions on structrues bracing systems design orf slabs (line and point supported plates and floor slabs) membranes and deep beams folded plates and shells truss models
1998	Literature	 Zilch K., Zehetmaier G.: Bemessung im konstruktiven Ingenieurbau. Springer, Heidelberg 2010 König, G., Liphardt S.: Hochhäuser aus Stahlbeton, Betonkalender 2003, Teil II, Seite 1-69, Verlag Ernst & Sohn, Berlin 2003 Phocas, Marios C.: Hochhäuser : Tragwerk und Konstruktion, Stuttgart, Teubner, 2005 Deutscher Ausschuss für Stahlbeton: Heft 600: Erläuterungen zu DIN EN 1992-1-1, Beuth Verlag, Berlin 2012 Deutscher Ausschuss für Stahlbeton: Heft 240: Hilfsmittel zur Berechnung der Schnittgrößen und Formänderungen vor Stahlbetontragwerken, Verlag Ernst & Sohn, Berlin 1978 Stiglat, K., Wippel, H.: Massive Platten - Ausgewählte Kapitel der Schnittkraftermittlung und Bemessung, Betonkalende 1992, Teil I, 287-366, Verlag Ernst & Sohn, Berlin 1992 Stiglat/Wippel: Platten. Verlag Ernst & Sohn, Berlin,1973 Schlaich J.; Schäfer K.: Konstruieren im Stahlbetonbau. Betonkalender 1998, Teil II, S. 721ff, Verlag Ernst & Sohn, Berlin,

Course L0578: Structural Concrete Members	
Тур	Recitation Section (large)
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	NN
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Courses				
Title		Тур	Hrs/wk	СР
Steel and Composite Structures (L1		Lecture	2	2
Steel and Composite Structures (L1 Steel Bridges (L1097)	205)	Recitation Section (large) Lecture	2	2 2
-	Prof. Marcus Rutner	Lecture	2	2
Module Responsible Admission Requirements	None			
Recommended Previous	Basics of steel construction (i.e. Steel Structures I and			
Knowledge	basics of steel construction (i.e. steel structures i an			
Educational Objectives	After taking part successfully, students have reached	the following learning results		
	Arter taking part successionly, students have reached	the following learning results		
Professional Competence	After successful completition, students can			
Knowledge	Alter succession completition, students can			
	 describe the phenomenon of local buckling 			
	 explain warping torsion 			
	 illustrate the behaviour of composite structure 	S		
	 specify the principles in design of composite st 	tructures		
	sketch the contructions of steel and composite	bridges		
Skills	After successful participation students are able to			
	- shark stiffened and unstiffened plated structure			
	check stiffened and unstiffened plated structure			
	 recognize and verify warping tosion in strucure 	25		
	design composite structures			
	 design bridges and o perform the detailing 			
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 96, Study Time in Lecture 8	4		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	180 min			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Engineering	ng: Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engine	ering: Elective Compulsory		
-	Civil Engineering: Specialisation Coastal Engineering:			
	Civil Engineering: Specialisation Water and Traffic: El			
	Civil Engineering: Specialisation Computational Engin			
	International Management and Engineering: Specialis		oulsory	

Course L1204: Steel and Composite Structures		
Тур	Lecture	
Hrs/wk		
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Marcus Rutner	
Language	DE	
Cycle	WiSe	
Content	 Local-buckling of plated structures Warping torsion Composite-girders, -columns, -slabs, -bridges Principles in composite constructions Bridge-design and -construction 	
Literature	Petersen, C.: Stahlbau, 4.Auflage 2013, Springer-Vieweg Verlag Minnert, J. Wagenknecht, G.: Verbundbau-Praxis - Berechnung und Konstruktion nach Eurocode 4, 2.Auflage 2013, Bauwerk Beuth Verlag	

Course L1205: Steel and Con	ourse L1205: Steel and Composite Structures	
Тур	Recitation Section (large)	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Marcus Rutner	
Language	DE	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L1097: Steel Bridges		
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Yves Freundt	
Language		
Cycle		
Content	Lecture Contents ,Steel Bridge Construction' DrIng. Jörg Ahlgrimm	
	- From tendering and contracting to completion - the development of a steel bridge	
	- Contents of a bridge static - structural details, examples of analysis in detail:	
	-> effective width in regard to the longitudinal stiffeners	
	-> Bearing point, bearing stiffener	
	-> Crossbeam breakthrough, crossbeam reinforcement	
	-> Analysis of the Rib-to-Floorbeam (RF) connection (web-tooth of the floorbeam between trapezoidal shaped Ribs)	
	- Steel grades, -designation, testing methods and approval certificates	
	- Nondestructive weld inspecting	
	- Corrosion protection	
	- Bridge bearing - types, format, function, dimensioning, installation	
	- Expansion Joints	
	- Oscillation of bridge hangers and cables - oscillation damper	
	- Opening bridges- Detailed reviews to different assembling procedures and - implements	
	- Selective damage events	
	Requirements: Basic knowledge in the calculation, dimensioning, and construction of structural elements and joints of constructional steelwork	
Literature		
	Herbert Schmidt, Ulrich Schulte, Rainer Zwätz, Lothar Bär: Ausführung von Stahlbauten	
	Petersen, Christian: Stahlbau, Abschnitt Brückenbau	
	 Ahlgrimm, J., Lohrer, I.: Erneuerung der Eisenbahnüberführung in Fulda-Horas über die Fulda, Stahlbau 74 (2005), Heft 2, S. 114 	

Courses				
Title		Тур	Hrs/wk	СР
Water Protection and Wastewater	5	Lecture	3	3
Water Protection and Wastewater		Project Seminar	3	3
Module Responsible				
Admission Requirements	None			
Recommended Previous	 Basic knowledge in water management; 			
Knowledge	 Good knowledge in urban drainage; 			
	Good knowledge of wastewater treatment	techniques;		
	 Good knowledge of pollutants (e.g. COD, B 	OD, TS, N, P) and their properties;		
Educational Objectives	After taking part successfully, students have reac	hed the following learning results		
Professional Competence				
	The students can describe the basic principles of	the regulatory framework related to the	e international and Eu	uropean water secto
5	They can explain limnological processes, substa			
	problems related to water protection, such as e	cosystem service and wastewater trea	atment with a special	l focus on innovativ
	solutions, remediation measures as well as conce	ptual approaches.		
Skille	Students can accurately assess current problems	and situations in a country specific or	local context. They	can suggest concre
SKIIIS	actions to contribute to the planning of tomorr		-	
	administrative and legislative solutions to solve th		they can suggest a	ppropriate teenniet
Personal Competence				
Social Competence	e The students can work together in international groups.			
Autonomy	Students are able to organize their work flow to	prepare presentations and discussions.	. They can acquire ap	opropriate knowledg
	by making enquiries independently.			
Workload in Hours	Independent Study Time 96, Study Time in Lectur	e 84		
Credit points				
Course achievement				
Examination				
	Term paper plus presentation			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Engine	ering: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Eng	ineering: Elective Compulsory		
	Civil Engineering: Specialisation Coastal Engineer	ing: Elective Compulsory		
	Civil Engineering: Specialisation Water and Traffic	:: Elective Compulsory		
	Environmental Engineering: Specialisation Water	Quality and Water Engineering: Elective	e Compulsory	
	International Management and Engineering: Spec	ialisation II. Civil Engineering: Elective (Compulsory	
	Water and Environmental Engineering: Specialisa	tion Cities: Elective Compulsory		
	Water and Environmental Engineering: Specialisa			
	Water and Environmental Engineering: Specialisat	tion Environment: Compulsory		

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

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

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Independent Study Time 96, Study Time in Lecture 84 6			
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Course L0375: Numerical Methods in Geotechnics		
Тур	ecture	
Hrs/wk	3	
СР	3	
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42	
Lecturer	Dr. Hans Mathäus Stanford	
Language	DE	
Cycle	WiSe	
Content	Topics:	
	 Introduction to numerical soil mechanics Introduction to numerical mathematics Finite Element Method (analysis procedures, algorithms) Finite Element Method (application in geotechnical engineering) 	
Literature	 Wriggers P. (2001): Nichtlineare Finite-Elemente-Methoden. Springer Wriggers P. (2008): Nonlinear Finite Element Methods. Springer Deutsche Gesellschaft für Geotechnik e.V. (Hrsg., 2014): Empfehlungen des Arbeitskreises "Numerik in der Geotechnik". Ernst & Sohn 	

Course L0497: Advanced Fou	Indation Engineering	
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	rof. Jürgen Grabe	
Language	DE	
Cycle	WiSe	
Content	 Vertical drains Piles Ground improvement (Deep Compaction, Soil mixing) Vibration driving Jet grouting Slurry wall Deep excavation 	
Literature	 EAK (2002): Empfehlungen für Küstenschutzbauwerke EAU (2004): Empfehlungen des Arbeitsausschusses Uferbauwerke EAB (1988): Empfehlungen des Arbeitskreises Baugruben Grundbau-Taschenbuch, Teil 1-3, (1997), Ernst & Sohn Verlag 	

Course L0498: Advanced Fou	urse L0498: Advanced Foundation Engineering	
Тур	Recitation Section (large)	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Jürgen Grabe	
Language	DE	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

	ging Trends in Environmen			
Courses				
Title		Тур	Hrs/wk	СР
Environmental Research Trends (L2	2752)	Seminar	2	2
Microplastics in Environment (L275	0)	Lecture	2	2
Scientific Communication and Meth	ods (L2751)	Lecture	1	2
Module Responsible	Prof. Nima Shokri			
Admission Requirements	None			
Recommended Previous	Basic knowledge on water, soil and en	vironmental research.		
Knowledge				
Educational Objectives	After taking part successfully, students	s have reached the following learning results		
Professional Competence				
Knowledge	The students will be exposed to up-to-	date research topics focused on soil, water and	d climate related challen	iges with a particu
	focus on the effects of microplastics i	in environment. Data analysis, data measurem	ent, curation and prese	ntation will be ot
	skills that the students will develop in	this module.		
	s Students' research skills will be improved in this module. How to prepare and deliver an effective presentation, how to write a abstract, research paper and proposal will be discussed in this module. Moreover, through Research-Based Learning approache the students will be exposed to current research trends in environmental engineering.			
Personal Competence				
Social Competence	Developing teamwork and problem sol	ving skills through Research-Based Teaching ap	proaches will be at the o	core of this modul
Autonomy		ting individual reports and presentation. This	will contribute to the	students' ability a
	willingness to work independently and	responsibly.		
Workload in Hours	Independent Study Time 110, Study Ti	me 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	Environmental Engineering: Specialisa	tion Environment and Climate: Elective Compuls	sory	
	Water and Environmental Engineering	Specialisation Cities: Elective Compulsory		
	Water and Environmental Engineering	Specialisation Environment: Elective Compulso		
	·····	. Specialisation Environment. Elective compaise	/i y	

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

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

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

Courses	
Title	Typ Hrs/wk CP
Module Responsible	Dozenten des SD B
Admission Requirements	None
Recommended Previous Knowledge	Subjects of the Water Management and Waste specialisation.
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 management and waste. They can exempli the state of technology and application and discuss critically in the context of actual problems and general conditions of scien and society. The students can develop solving strategies and approaches for fundamental and practical problems in the field of wat management and waste. They may apply theory based procedures and integrate safety-related, ecological, ethical, and econom view points of science and society. Scientific work techniques that are used can be described and critically reviewed.
Skills	The students are able to independently select methods or planning approaches for the project work and to justify their choic They can explain how these methods or approaches relate to solutions in the field of work and how the context of application h to be adjusted. General findings and further developments may essentially be outlined.
Personal Competence	
Social Competence	The students are able to condense the relevance and the structure of the project work, the work steps and the sub-problems f the presentation and discussion in front of a bigger group. They can lead the discussion and give a feedback on the project to the colleagues.
Autonomy	The students are capable of independently planning and documenting the work steps and procedures while considering the give deadlines. This includes the ability to accurately procure the newest scientific information. Furthermore, they can obtain feedbac from experts with regard to the progress of the work, and to accomplish results on the state of the art in science and technology.
Workload in Hours	Independent Study Time 180, Study Time in Lecture 0
Credit points	6
Course achievement	None
Examination	Study work
Examination duration and scale	See FSPO
Assignment for the Following Curricula	Civil Engineering: Specialisation Water and Traffic: Compulsory

Module M0969: Selected Topics in Civil Engineering

Courses				
Title		Тур	Hrs/wk	СР
Design of Composite Bridges (L3092)		Integrated Lecture	2	3
Analysis of Offshore Structures (L1867)		Lecture	1	1
Energy Geotechnics (L3227)		Lecture	3	3
Solid Matter Process Technology fo	r Biomass (L0052)	Lecture	2	3
Forum I - Geotechnics and Constru	ction Management (L1634)	Seminar	1	1
Forum II - Geotechnics and Constru	ction Management (L1635)	Seminar	1	1
Timber Structures (L1151)		Seminar	2	2
Innovative Timber Construction (L2	666)	Lecture	2	4
Glass Structures (L1152)		Lecture	2	2
Glass Structures (L1447)		Recitation Section (large)	1	1
Sustainable landfill design and ope	ration (L3270)	Integrated Lecture	3	3
Special Topics in Steel Design (L30	91)	Integrated Lecture	2	3
Special topics of civil engineering	CP (L2378)		1	1
Special topics of civil engineering 2	2 LP (L2379)		2	2
Special topics of civil engineering 3	3 LP (L2380)		3	3
Structural Design (L2789)		Seminar	2	2
Module Responsible	Prof. Frank Schmidt-Döhl			
Admission Requirements	None			
Recommended Previous	none			
Knowledge				
Educational Objectives	After taking part successfully, students have reached	d the following learning results		
Professional Competence				
Knowledge				
	 Students are able to find their way through selected special areas within civil and structural engineering. 			
	 Students are able to explain basic models and procedures in selected special areas of civil and structural engineering. 			
	Students are able to interrelate scientific and	technical knowledge.		
Skills	• Students are able to apply basic methods in selected areas of civil and structural engineering.			
Personal Competence				
Social Competence				
Autonomy				
	 Students can chose independently, in which fields they want to deepen their knowledge and skills through the election of courses. 			
Workload in Hours	Depends on choice of courses			
Credit points	6			
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: E			
	Civil Engineering: Specialisation Computational Engin			
	eren Engineering. Specialisation computational Engli	icening. Licenive compulsory		

Course L3092: Design of Con	Course L3092: Design of Composite Bridges	
Тур	Integrated Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Examination Form	Klausur	
Examination duration and	90 min	
scale		
Lecturer	Prof. Marcus Rutner	
Language	DE	
Cycle	SoSe	
Content		
Literature		

Course L1867: Analysis of Of	fshore Structures
Тур	Lecture
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Examination Form	Mündliche Prüfung
Examination duration and	30 min
scale	Dr. Said Fawad Mohammadi
Language	
Cycle	
	Topic 1: Types of Offshore Structures, Fixed and floating structures for Oil & Gas and Offshore Wind industry
	Topic 2: Wave Forces, Morisons equation
	Topic 3: Irregular Seastates, Power spectrum and application of FFT
	Topic 4: Additional Environmental Forces, wind spectra, current forces
	Topic 5: Linear-Time-Invariant Systems, response of an LTI-system in frequency domain
	Topic 6: Tubular Welded Connections, stress concentration factors, weld geometry
	Topic 7: Introduction to Fracture Mechanics, criteria for fracture initiation and crack growth
	Topic 8: Time and Frequency Domain Fatigue Analyses, rainflow counting, application of LTI-systems for frequency domain fatigue
	Topic 9: Offshore Installation and Exam, installation of structures, pile driving, pipe laying techniques
Literature	Chakrabarti, Handbook of Offshore Engineering, 2005
	Sarpkaya, Wave Forces on Offshore Structures, 2010
	Faltinsen, Sea Loads on Ships and Offshore Structures, 1998
	Sorensen, Basic Coastal Engineering, 2006
	Dowling, Mechanical Behavior of Materials, 2007
	Haibach, Betriebsfestigkeit, 2006
	Marshall, Design of Welded Tubular Connections, 1992
	Newland, Random vibrations, spectral and wavelet analysis, 1993

Course L3227: Energy Geotechnics		
Тур	Lecture	
Hrs/wk	3	
СР	3	
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42	
Examination Form	Schriftliche Ausarbeitung (laut FPrO)	
Examination duration and	wird zu Beginn der Lehrveranstaltung festgelegt	
scale		
Lecturer	Pauline Kaminski	
Language	DE/EN	
Cycle	WiSe	
Content	Energy geotechnics is a young field in geotechnical engineering with the aim of developing sustainable geotechnical solutions for future-oriented issues relating to the production, transport, operation, decommissioning, and waste utilisation of various energy sources. Examples of possible fields of activity in energy geotechnics include geothermal energy and thermally activated foundation components, foundations for onshore and offshore wind turbines, the decommissioning of mining facilities and the handling of waste products from fossil fuels such as tailings and the geological storage of CO2. Relevant soil mechanical processes in these applications include the thermo-hydro-mechanically coupled behaviour of soils, multiphase flow in porous media and partially saturated soils. The lecture gives an overview of various aspects of energy geotechnics and provides in-depth knowledge of the associated soil mechanical processes. In addition, CO2-scarce geotechnical applications are discussed and emission estimates as well as the optimisation of geotechnical structures according to sustainability aspects are addressed.	
Literature		

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

Course L1634: Forum I - Geotechnics and Construction Management	
Тур	Seminar
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Examination Form	Mündliche Prüfung
Examination duration and	30 min
scale	
Lecturer	Prof. Jürgen Grabe
Language	DE
Cycle	WiSe
Content	Lectures about projects and issues with practical and scientific relevance.
Literature	

Course L1635: Forum II - Geotechnics and Construction Management	
Тур	Seminar
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Examination Form	Mündliche Prüfung
Examination duration and	30 min
scale	
Lecturer	Prof. Jürgen Grabe
Language	DE
Cycle	SoSe
Content	Lectures about projects and issues with practical and scientific relevance.
Literature	

Course L1151: Timber Structures	
Тур	Seminar
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Referat
Examination duration and	90 min
scale	
Lecturer	Prof. Torsten Faber
Language	DE
Cycle	WiSe
Content	
Literature	

Course L2666: Innovative Timber Construction		
Тур	Lecture	
Hrs/wk	2	
СР	4	
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28	
Examination Form	Schriftliche Ausarbeitung	
Examination duration and	45 Minuten	
scale		
Lecturer	Dr. Andreas Meisel	
Language	DE	
Cycle	WiSe	
Content		
Literature	- Blass, J.: "Ingenieurholzbau"	
	- Schickhofer, G.: "BSPhandbuch: Holz-Massivbauweise in Brettsperrholz"	
	- Informationsdienst Holz: div. Merkblätter und Broschüren	
	- Wallner-Novak M.: Brettsperrholz Bemessung, Band 1 und 2	
	- Gerner M.: "Fachwerk: Entwicklung, Instandsetzung, Neubau"	
	- Meisel, A.: "Historische Dachwerke: Beurteilung, realitätsnahe statische Analyse und Instandsetzung"	
	- Kempe K.: "Dokumentation Holzschädlinge"	
	- Huckfeldt T.: "Hausfäule- und Bauholzpilze"	

Course L1152: Glass Structures		
Тур	Lecture	
Hrs/wk		
СР		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Examination Form	Mündliche Prüfung	
Examination duration and		
scale		
Lecturer	Marvin Matzik	
Language	DE	
Cycle	WiSe	
Content	Glass structures	
	- Introduction of the material glass (production, refinement, material characteristic)	
	- design of facades	
	- facade types	
	- static calculation of glazing	
	- static calculation of facades	
	- load bearing behavior of glazing (plate or membrane stiffness)	
	- vertical / horizontal glazing with safety-related requirements	
	- glass structures	
	- fire safety of glass facades	
	- construction physics of facades and glazing	
Literature		

Course L1447: Glass Structures	
Тур	Recitation Section (large)
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Examination Form	Mündliche Prüfung
Examination duration and	
scale	
Lecturer	Marvin Matzik
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

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

Course L3091: Special Topics in Steel Design	
Тур	Integrated Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and	90 min
scale	
Lecturer	Prof. Marcus Rutner, Nikolay Lalkovski
Language	DE
Cycle	SoSe
Content	
Literature	

Course L2378: Special topics of civil engineering 1CP		
Тур		
Hrs/wk	1	
CP	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 Lehrveranstaltung festgelegt	
scale		
Lecturer	Dozenten des SD B	
Language	DE	
Cycle	WiSe/SoSe	
Content	The course occurs only if required. The content is defined at short notice.	
Literature	Die Literatur wird kurzfristig festgelegt.	

Course L2379: Special topics	of civil engineering 2 LP
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 Lehrveranstaltung festgelegt
scale	
Lecturer	Dozenten des SD B
Language	DE
Cycle	WiSe/SoSe
Content	The course occurs only if required. The content is defined at short notice.
Literature	Die Literatur wird kurzfristig festgelegt.

Course L2380: Special topics of civil engineering 3 LP	
Тур	
Hrs/wk	3
CP	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 Lehrveranstaltung festgelegt
scale	
Lecturer	Dozenten des SD B
Language	DE
Cycle	WiSe/SoSe
Content	The course occurs only if required. The content is defined at short notice.
Literature	Die Literatur wird kurzfristig festgelegt.

Course L2789: Structural Design		
Тур	Seminar	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Examination Form	Mündliche Prüfung	
Examination duration and	20 min	
scale		
Lecturer	Dr. Jan Mittelstädt	
Language	DE/EN	
Cycle	SoSe	
Content		
Literature	[1] Structure Systems by Heino Engel, Hantje Cantz, 3rd edition (Feb 2007), ISBN-10: 3775718761	
	Form and Force, Designing Efficient, Expressive Structures by Allan, E., Zalewski, W. et al, John Wiley and	
	Sons; 1st edition (Sept 2009), ISBN-10: 047017465X	
	[2] Peter Rice: An Engineer Imagines, ISBN-10 : 1849944237	
	[3] Konrad Wachsmann and the Grapevine Structure by C. Sumi et al., Park Books (Oct 2018), ISBN-10:	
	9783038601104	
	[4] Manual of Multi-Story Timber Construction by Hermann Kaufmann, Stefan Krotsch, Stefan Winter, DETAIL,	
	(June 2018), ISBN-10: 3955533948	
	[5] The Art of Structural Design: A Swiss Legacy by B. Billington, Princeton University Art Museum; First Edition	
	edition (Mar 2003), ISBN-10: 0300097867	
	[6] Structured Lineages: Learning from Japanese Structural Design by G. Nordenson et al, The Museum of	
	Modern Art (Jul 2019), ISBN-10: 1633450562	
	[7] The Structure: Works of Mahendra Raj by V. Mehta, R. Mehndiretta, A. Huber, Park Books (Oct 2015),	
	ISBN-10: 3038600253	

	Тур	Hrs/wk	СР
	Lecture	2	3
			2
Draf Mathias Errat	Practical Course	T	1
	adde of the core processes involved in water, das	and steam treat	ment
basic knowledge of water chemistry. Knowle	age of the core processes involved in water, gas	and steam treat	nent
After taking part successfully, students have	e reached the following learning results		
The taking part succession, statenes have			
the different driving forces behind existing	membrane separation processes. Students wi	Il be able to nar	ne materials used
membrane filtration and their advantages and disadvantages. Students will be able to explain the key differences in the us membranes in water, other liquid media, gases and in liquid/gas mixtures.		erences in the use	
Students will be able to prepare mathematical equations for material transport in porous and solution-diffusion membranes an calculate key parameters in the membrane separation process. They will be able to handle technical membrane processes usin available boundary data and provide recommendations for the sequence of different treatment processes. Through their ow experiments, students will be able to classify the separation efficiency, filtration characteristics and application of different membrane materials. Students will be able to characterise the formation of the fouling layer in different waters and apply technical measures to control this.			
within their group on laboratory experiments Students will be in a position to solve hom	s to be undertaken jointly and present these to one work on the topic of membrane technology in	thers.	
	Lecture 56		
30 mm			
Bioprocess Engineering: Specialisation A - Ge	eneral Bioprocess Engineering: Elective Compuls		
Chemical and Bioprocess Engineering: Speci	ialisation Chemical Process Engineering: Elective	Compulsory	
Chemical and Bioprocess Engineering: Speci	ialisation General Process Engineering: Elective C	Compulsory	
Chemical and Bioprocess Engineering: Techr	nical Complementary Course: Elective Compulsor	У	
Environmental Engineering: Specialisation W	Vater Quality and Water Engineering: Elective Co	mpulsory	
Process Engineering: Specialisation Process			
Process Engineering: Specialisation Process Process Engineering: Specialisation Environm	mental Process Engineering: Elective Compulsory		
Process Engineering: Specialisation Process Process Engineering: Specialisation Environm Water and Environmental Engineering: Speci	mental Process Engineering: Elective Compulsory		
	After taking part successfully, students have Students will be able to rank the technical a the different driving forces behind existing membrane filtration and their advantages i membranes in water, other liquid media, ga Students will be able to prepare mathemat calculate key parameters in the membrane available boundary data and provide recor experiments, students will be able to cla membrane materials. Students will be able to cla measures to control this. Students will be able to work in diverse tea within their group on laboratory experiment Students will be in a position to solve hom finding creative solutions to technical questi Independent Study Time 124, Study Time in 6 None Written exam 90 min Civil Engineering: Specialisation Water and T Bioprocess Engineering: Specialisation A - G Bioprocess Engineering: Specialisation B - In Chemical and Bioprocess Engineering: Spec	Lecture Recitation Section (small) Practical Course Prof. Mathias Ernst None Basic knowledge of water chemistry. Knowledge of the core processes involved in water, gas After taking part successfully, students have reached the following learning results Students will be able to rank the technical applications of industrially important membrane [the different driving forces behind existing membrane separation processes. Students will be able to prepare mathematical equations for material transport in procus a calculate key parameters in the membrane separation process. They will be able to handle available boundary data and provide recommendations for the sequence of different tree experiments, students will be able to characterise the formation of the fouling layer measures to control this. Students will be able to work in diverse teams on tasks in the field of membrane technology if finding creative solutions to technical questions. Independent Study Time 124, Study Time in Lecture 56 6 None Written exam 90 min Civil Engineering: Specialisation Water and Traffic: Elective Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compuls Supervise Sengineering: Specialisation Representing: Elective Compuls Chemical and Bioprocess Engineering: Specialisation Chemical Process Engineering: Elective Compuls Chemical and Bioprocess Engineering: Specialisation General Process Engineering: Elective Compuls Chemical and Bioprocess Engineering: Specialisation Chemical Process Engineering: Elective Compuls Chemical and Bioprocess Engineering: Specialisation General Process Engineering: Elective Compuls Chemical and Bioprocess Engineering: Specialisation Chemical Process Engineering: Elective Compuls Chemical and Bioprocess Engineering: Specialisation Chemical Process Engineering: Elective Compuls Chemical and Bioprocess Engineering: Specialisation Chemical Process Engineering: Elective Compuls Chemical and Bioprocess Engineering: Specialisation Chemical Process Engineering: Elective C	Lecture 2 Recitation Section (small) 1 Prof. Mathias Ernst 1 None 2 Basic knowledge of water chemistry. Knowledge of the core processes involved in water, gas and steam treater After taking part successfully, students have reached the following learning results Students will be able to rank the technical applications of industrially important membrane processes. They will be able to rank the technical applications of industrially important membrane processes. Students will be able to nark their advantages and disadvantages. Students will be able to explain the key differ membrane filtration and their advantages and disadvantages. Students will be able to explain the key differ membranes in water, other liquid media, gases and in liquid/gas mixtures. Students will be able to prepare mathematical equations for material transport in porous and solution-diffu calculate key parameters in the membrane separation process. They will be able to handle technical memb available boundary data and provide recommendations for the sequence of different treatment processer experiments, students will be able to classify the separation efficiency, filtration characteristics and ap membrane materials. Students will be able to characterise the formation of the fouling layer in different water measures to control this. Students will be able to work in diverse teams on tasks in the field of membrane technology. They will be able within their group on laboratory experiments to be undertaken jointly and present these to others. Students will be in a position to solve homework on the topic of membrane technology independently. T

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

ourse L0400: Membrane Technology	
Тур	Recitation Section (small)
Hrs/wk	1
CP	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

/p oject-/problem-based Learning tection learning results ter Cycle hent of needs for action adaptation measures :alculation approaches, meth	Hrs/wk 4	CP 6
learning results ter Cycle nent of needs for action adaptation measures	nods, numerica	ıl models, plannin
learning results ter Cycle nent of needs for action adaptation measures	nods, numerica	ıl models, plannir
learning results ter Cycle nent of needs for action adaptation measures	nods, numerica	ıl models, plannir
ter Cycle nent of needs for action adaptation measures	iods, numerica	ıl models, plannir
nent of needs for action adaptation measures	iods, numerica	ıl models, plannir
adaptation measures	oods, numerica	ıl models, plannir
tion and subsequent discussion	on. The work o	n the complex ta
Compulsory mpulsory sory e: Elective Compulsory	_	_
	ation and subsequent discussion pulsory e Compulsory ompulsory ilsory te: Elective Compulsory ve Compulsory : Elective Compulsory ve Compulsory	e Compulsory ompulsory Ilsory te: Elective Compulsory ve Compulsory : Elective Compulsory

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

Courses	
Title Adaptation to climate change in hyd	draulic engineering (L2291) Typ Hrs/wk CP Project-/problem-based Learning 4 6
Module Responsible	Prof. Peter Fröhle
Admission Requirements	
Recommended Previous Knowledge	 Hydrology, Hydraulic Engineering Hydromechanic, Hydraulics Fundamentals of Coastal Engineering, Coastal- and Flood Protection Hydrological Systems
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence <i>Knowledge</i> <i>Skills</i>	 Climate protection and climate adaptation Insights into climate change and its regional characteristics - fundamentals, climate modelling / climate models Impacts of climate change on the components of the regional hydrological cycle Fundamentals of analysis of climate data Consequences of the impact of the climate change Measures for climate adaptation Assessment, prioritization and communication of adaptation measures Fundamentals of the analysis of hydrometeorological and hydrological data Critical thinking: analysis of processes and relations, assessment of needs for action Creative thinking: inclusion of restrictions, application of calculation approaches, methods, numerical models, planni methods Consideration of complex tasks
Personal Competence Social Competence Autonomy	 Working in heterogenous groups Working with different scientific / non-scientific disciplines Self reflection Application oriented use of knowledge and skills
	Autonomous work on complex tasks
	Independent Study Time 124, Study Time in Lecture 56
Credit points	
Course achievement	
	Written elaboration Preparation of a written report and a presentation of a complex task.
Assignment for the	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory
	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory
	Civil Engineering: Specialisation Water and Traffic: Elective Compulsory
	Water and Environmental Engineering: Specialisation Cities: Elective Compulsory Water and Environmental Engineering: Specialisation Environment: Elective Compulsory
	WALE AND LUXUUMUEURA ENGINEEURA SUEURISAUUL ENVIRONNEUL' EIECHVE COMOUSOLV

Course L2291: Adaptation to	o 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.

ourses				
tle	Тур	Hrs/wk	СР	
onstruction law BGB and VOB - law in (excavation) practice (L3182)	Lecture	2	3	
onstruction disputes from construction (excavation) practice (L3181)	Lecture	2	3	
Module Responsible Prof. Jürgen Grabe				
Admission Requirements None				
Recommended Previous Complete modules: Geotechnics I-III Knowledge				
Educational Objectives After taking part successfully, students have reached th	e following learning results			
Professional Competence	e following learning results			
Knowledge Students will gain knowledge of				
• the history of civil engineering law,				
 basics of foundation and civil engineering law, 				
 legal aspects of technical regulations in civil engineering 	neering (with case studies),			
 the civil engineering contract, 				
 the liability of the designer and contractor in civil 	engineering,			
• the subsoil risk and the system risk,				
 the total debt in (civil) engineering law, the (construction) conflict, dispute avoidance models and the construction process, the systematics of construction contract law. 				
 responsibilities on the construction site, 				
 remuneration and contract management, 				
liability for defects,				
public procurement law				
Disturbed construction processes: How much more	ney am I entitled to?			
Correct calculation of supplements.				
Skills Students learn to apply legal aspects in planning and c	onstruction in a legally balanc	ed way. Students learn l	now to use legal a	
construction management aspects in practice (planning				
to manage the construction project optimally.				
Personal Competence	finding colutions			
Social Competence Students can work in groups and support each other in t	inuing solutions.			
Autonomy Students are able to assess their own strengths and wea	aknesses and organize their tir	me and learning manage	ment based on th	
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 Coastal Engineering: Ele				
Following Curricula Civil Engineering: Specialisation Geotechnical Engineering	5 1 ,			
Civil Engineering: Specialisation Structural Engineering:				
Civil Engineering: Specialisation Water and Traffic: Elect Civil Engineering: Specialisation Computational Enginee				

Course L3182: Construction	urse L3182: Construction law BGB and VOB - law in (excavation) practice		
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Günther Schalk		
Language	DE		
Cycle	WiSe		
Content			
Literature			
	- Folienskript (in der Vorlesung erhältlich) - Fuchs/Maurer/Schalk: Handbuch Tiefbaurecht		

Course L3181: Construction	urse L3181: Construction disputes from construction (excavation) practice		
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Ingo Junker		
Language	DE		
Cycle	WiSe		
Content			
Literature			

Courses				
Title		Тур	Hrs/wk	СР
Scientific Working in Computationa	Engineering (L2764)	Project-/problem-based Learning	4	6
Module Responsible	Prof. Kay Smarsly			
Admission Requirements	None			
Recommended Previous	Basic knowledge in scientific writing. String interest in to	pics related to computing in civil engine	ering.	
Knowledge				
Educational Objectives	After taking part successfully, students have reached th	e following learning results		
Professional Competence				
<i>Skills</i> Personal Competence	course instructors and in collaboration with each other, thinking, being able to accurately plan, implement and will be conducted throughout the semester, which will of this course, a scientific paper will be developed based, based on the project conducted within this course. Pr scientific publications are further key activities. The students will be capable (i) of solving a scientific p effectively in the form of a paper, and (iii) of sharing the	analyze scientific projects, such as pro ontribute to the grade. Since scientific wi which is a prerequisite for the final exan oject meetings in small groups, present problem following a scientific methodolo	spective mast riting is of part nination. The p rations, and cr	ter theses. A proje ticular importance paper will be writt ritical discussions
•	The students will be able to work in a multidisciplinary to	eam and develop communication skills no	ecessary for p	roblem solving.
Autonomy	The students will be able to extend their knowledge and	apply it to solve scientific problems by w	vorking indepe	endently in a proje
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: Elect	ive Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering	ng: Elective Compulsory		
	Civil Engineering: Specialisation Coastal Engineering: Ele	ective Compulsory		
	Civil Engineering: Specialisation Structural Engineering:	Elective Compulsory		
	Civil Engineering: Specialisation Computational Enginee	ing: Elective Compulsory		
	Computer Science: Specialisation II: Intelligence Engine	ering: Elective Compulsory		

Course L2764: Scientific Wor	rking in Computational 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. Kay Smarsly
Language	EN
Cycle	WiSe/SoSe
Content	In the course, a scientific problem of practical relevance will first be defined, taking into account the interests of the students participating in the course. The scientific problem will then systematically be solved within the framework of a comprehensive project. The principles of scientific working will be taught based on the scientific problem defined previously. As an integral part of scientific working, fundamentals of scientific writing will be presented and applied to a scientific paper to be written during the course. Topics related to scientific writing include structuring in scientific writing (structuring the abstract, the introduction, the main part, the summary and conclusions, and the acknowledgments and references) and recommendations on effective scientific writing (principles of composition, use of English in scientific writing, useful tips, creating figures, writing in mathematics, referencing, and formal email correspondence). A final paper and a final presentation will be assembled by the students.
Literature	Smarsly, K. & Dragos, K., 2019. Scientific Writing in Engineering. Tredition, Hamburg, Germany.

Module M2033: Subs					
Courses					
Title		Тур	Hrs/wk	СР	
Modeling of Subsurface Processes	L2731)	Recitation Section (sr	mall) 3	3	
Subsurface Solute Transport (L272		Lecture	2	2	
Subsurface Solute Transport (L272	3)	Recitation Section (la	irge) 1	1	
Module Responsible	Prof. Nima Shokri				
Admission Requirements	None				
Recommended Previous	Basic Mathematics, Hydrology				
Knowledge					
Educational Objectives	After taking part successfully, students h	ave reached the following learning results			
Professional Competence					
	Upon completion of this module, the s	tudents will understand the mechanisms co	ontrolling solute trans	port in soil and natu	
	• •		Ū.		
	porous media and will be able to work with the equations that govern the fate and transport of solutes in porous media. Analytical numerical and experimental tools and techniques will be used in this module.				
	······································				
Skills	In addition to the physical insights, the students will be exposed to analytical, experimental and numerical tools and techniques in				
	this module. This provides them with an excellent opportunity to improve their skills on multiple fronts which will be useful in the				
	future career.				
Personal Competence					
Social Competence	Teamwork & problem solving				
Autonomy	The students will be involved in writing individual reports and presentation. This will contribute to the students' ability an				
	willingness to work independently and re	esponsibly.			
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				
scale					
Assignment for the	Civil Engineering: Specialisation Structure	al Engineering: Elective Compulsory			
Following Curricula	Civil Engineering: Specialisation Geotech				
3	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory				
	Civil Engineering: Specialisation Coasta Engineering: Elective Compulsory				
	Civil Engineering: Specialisation Computational Engineering: Elective Compulsory				
	Chemical and Bioprocess Engineering: Technical Complementary Course: Elective Compulsory				
	Environmental Engineering: Core Qualific		,		
		ronmental Process Engineering: Elective Con	npulsory		
	Process Engineering: Specialisation Proce				
	Water and Environmental Engineering: S				
		pectanoution match. compulsory			

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	Dr. Milad Aminzadeh
Language	EN
Cycle	WiSe
Content	Basic usage and background of chosen computer software to calculate flow and transport in the saturated and unsaturated zone and to analyze field data like pumping test data
Literature	

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

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

Courses				
Title		Тур	Hrs/wk	СР
Waste and Environmental Chemist	-	Practical Course	2	2
Biological Waste Treatment (L0318		Project-/problem-based Learning	3	4
Module Responsible				
Admission Requirements	None			
	chemical and biological basics			
Knowledge				
Educational Objectives	After taking part successfully, students have reach	ned the following learning results		
Professional Competence				
Knowledge	The module aims possess knowledge concerning t design and layout of anaerobic and aerobic waste plants for biological waste treatment plants and ex	treatment plants in detail, describe different te		
Skills	The students are able to discuss the compilation o control measurements. The students can rechercl and plan additional tests. They are capable of refle	né and evaluate literature and date connected		
Personal Competence				
	Students can participate in subject-specific and ir	nterdisciplinary discussions, develop cooperate	ed solutions a	nd defend their
	work results in front of others and promote the accept professional constructive criticism.	scientific development in front of colleagues.	. Furthermore	e, they can give
Autonomy	Students can independently tap knowledge from are capable, in consultation with supervisors as we steps on this basis. Furthermore, they can define potential social, economic and cultural impact.	ell as in the interim presentation, to assess the	ir learning lev	vel and define fur
Workload in Hours	Independent Study Time 110, Study Time in Lectu	re 70		
Credit points				
Course achievement	Compulsory Bonus Form	Description		
course demovement	Yes None Subject theoretical an	d		
	practical work			
Examination	Presentation			
Examination duration and	Elaboration and Presentation (15-25 minutes in gro	pups)		
scale				
Assignment for the	Civil Engineering: Specialisation Coastal Engineering	ng: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engi	neering: Elective Compulsory		
	Civil Engineering: Specialisation Structural Engineer	ering: Elective Compulsory		
	Civil Engineering: Specialisation Water and Traffic:	Elective Compulsory		
	Bioprocess Engineering: Specialisation A - General	Bioprocess Engineering: Elective Compulsory		
	Chemical and Bioprocess Engineering: Specialisati	on General Process Engineering: Elective Comp	oulsory	
	Chemical and Bioprocess Engineering: Specialisati	on Bioprocess Engineering: Elective Compulsor	У	
	Chemical and Bioprocess Engineering: Specialisati	on Chemical Process Engineering: Elective Com	npulsory	
	Chemical and Bioprocess Engineering: Specialisati	on Chemical and Bio process Engineering: Elec	tive Compuls	ory
	Environmental Engineering: Core Qualification: Co	mpulsory		
	International Management and Engineering: Speci	alisation II. Renewable Energy: Elective Compu	lsory	
	Process Engineering: Specialisation Environmental	Process Engineering: Elective Compulsory		
	Water and Environmental Engineering: Specialisat			
	Water and Environmental Engineering: Specialisat			

Course L0328: Waste and En	vironmental Chemistry
Тур	Practical Course
Hrs/wk	2
CP	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 Was	ste Treatment
Тур	Project-/problem-based Learning
Hrs/wk	3
СР	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Kerstin Kuchta
Language	EN
Cycle	WiSe
Content	 Introduction biological basics determination process specific material characterization aerobic degradation (Composting, stabilization) anaerobic degradation (Biogas production, fermentation) Technical layout and process design Flue gas treatment Plant design practical phase
Literature	

Courses				
Title Planning of waste treatment plants	(1 2 2 6 7)	Typ Project-/problem-based Learning	Hrs/wk 3	СР 3
Recycling technologies and therma		Lecture	2	2
Recycling technologies and therma		Recitation Section (small)	1	1
Module Responsible				
Admission Requirements				
Recommended Previous				
Knowledge	 Basics of thermo dynamics 			
	 Basics of fluid dynamics 			
	 fluid dynamics chemistry 			
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence	After taking part successfully, statents have reached			
	The students can name, describe current issue and p	roblems in the field of waste treatment (r	ochonical ch	omical and there
Knowledge	and contemplate them in the context of their field.	Toblems in the field of waste treatment (in	iechanicai, ch	
	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	waste technologi
	Compostion, particle sizes, transportation and dosing	of wastes are described as important unit o	perations .	
	Students will be able to design and design waste trea	tment technology equipment.		
Skills	The students are able to select suitable processes for	the treatment of wastes or raw material w	ith respect to	their characteris
Skills	and the process aims. They can evaluate the efforts a			
	and the process and. They can evaluate the choics a		uny reasible e	
Personal Competence				
Social Competence	Students can			
	 respectfully work together as a team and discussion 	se technical tasks		
	 participate in subject-specific and interdisciplina 			
	 develop cooperated solutions 			
	 promote the scientific development and accept 	professional constructive criticism.		
	hh.			
Autonomy	Students can independently tap knowledge of the	subject area and transform it to new	questions. Th	ney are capable
	consultation with supervisors, to assess their learning			
	targets for new application-or research-oriented duties	s in accordance with the potential social, ec	conomic and c	ultural 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: Ele	ctive Compulsory		
Following Curricula	Bioprocess Engineering: Specialisation A - General Bio	process Engineering: Elective Compulsory		
-	Chemical and Bioprocess Engineering: Specialisation (General Process Engineering: Elective Comp	oulsory	
	Chemical and Bioprocess Engineering: Specialisation E	Bioprocess Engineering: Elective Compulsor	у	
	Chemical and Bioprocess Engineering: Specialisation C	Chemical Process Engineering: Elective Con	npulsory	
	Chemical and Bioprocess Engineering: Specialisation C	Chemical and Bio process Engineering: Elec	tive Compulso	ory
	Environmental Engineering: Specialisation Energy and	Resources: Elective Compulsory		
	International Management and Engineering: Specialisa	tion II. Renewable Energy: Elective Compu	lsory	
	Renewable Energies: Specialisation Bioenergy System	s: Elective Compulsory		
	Process Engineering: Specialisation Chemical Process	Engineering: Elective Compulsory		
	Process Engineering: Specialisation Process Engineering	ng: Elective Compulsory		
	Process Engineering: Specialisation Environmental Pro	cess Engineering: Elective Compulsory		
	Water and Environmental Engineering: Specialisation			
	Water and Environmental Engineering: Specialisation	Cities: Elective Compulsory		

Course L3267: Planning of w	aste 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 tec	hnologies and thermal waste treatment
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Kerstin Kuchta
Language	EN
Cycle	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	hnologies 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

	Thesis
Madula M 002: Masta	u Thosia
Module M-002: Maste	
Courses	
Гitle	Typ Hrs/wk CP
Module Responsible	Professoren der TUHH
Admission Requirements	According to General Regulations §21 (1):
	At least 60 credit points have to be achieved in study programme. The examinations board decides on exceptions.
Recommended Previous	
Knowledge	
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	• The students can use specialized knowledge (facts, theories, and methods) of their subject competently on specializ
	issues.
	• The students can explain in depth the relevant approaches and terminologies in one or more areas of their subje
	describing current developments and taking up a critical position on them.
	• The students can place a research task in their subject area in its context and describe and critically assess the state
	research.
Skills	The students are able:
	To select, apply and, if necessary, develop further methods that are suitable for solving the specialized problem in questive
	• To apply knowledge they have acquired and methods they have learnt in the course of their studies to complex and
	incompletely defined problems in a solution-oriented way.
	 To develop new scientific findings in their subject area and subject them to a critical assessment.
Personal Competence	
Social Competence	Students can
···· , ···	
	Both in writing and orally outline a scientific issue for an expert audience accurately, understandably and in a structure
	Way.
	 Deal with issues competently in an expert discussion and answer them in a manner that is appropriate to the addresse while upholding their own assessments and viewpoints convincingly.
Autonomy	Students are able:
Autonomy	
	 To structure a project of their own in work packages and to work them off accordingly.
	• To work their way in depth into a largely unknown subject and to access the information required for them to do so.
	 To apply the techniques of scientific work comprehensively in research of their own.
Workload in Hours	Independent Study Time 900, Study Time in Lecture 0
Credit points	30
Course achievement	None
Examination	
Examination duration and	According to General Regulations
scale	Civil Engineering: Thesis: Computern:
Following Curricula	Civil Engineering: Thesis: Compulsory Bioprocess Engineering: Thesis: Compulsory
ronowing curricula	Chemical and Bioprocess Engineering: Thesis: Compulsory
	Chemical and Bioprocess Engineering: Thesis: Compulsory
	Computer Science: Thesis: Compulsory
	Data Science: Thesis: Compulsory
	Electrical Engineering: Thesis: Compulsory
	Energy Systems: Thesis: Compulsory
	Environmental Engineering: Thesis: Compulsory
	Aircraft Systems Engineering: Thesis: Compulsory
	Global Innovation Management: Thesis: Compulsory
	Computer Science in Engineering: Thesis: Compulsory
	Information and Communication Systems: Thesis: Compulsory Interdisciplinary Mathematics: Thesis: Compulsory
	International Production Management: Thesis: Compulsory
	International Management and Engineering: Thesis: Compulsory
	Joint European Master in Environmental Studies - Cities and Sustainability: Thesis: Compulsory
	Logistics, Infrastructure and Mobility: Thesis: Compulsory

Aeronautics: Thesis: Compulsory
Materials Science and Engineering: Thesis: Compulsory
Materials Science: Thesis: Compulsory
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
Ship and Offshore Technology: Thesis: Compulsory
Theoretical Mechanical Engineering: Thesis: Compulsory
Process Engineering: Thesis: Compulsory
Water and Environmental Engineering: Thesis: Compulsory
Certification in Engineering & Advisory in Aviation: Thesis: Compulsory