Karlsruhe Institute of Technology

Module Handbook
Civil Engineering (M.Sc.)

Summer Term 2016
Long version
Date: 23.03.2016

Department of Civil Engineering, Geo- and Environmental Sciences

KIT - University of the State of Baden-Wuerttemberg and
National Research Center of the Helmholtz Association

www.kit.edu

Publisher:

Department of Civil Engineering, Geo- and Environmental Sciences
Karlsruhe Institute of Technology (KIT)
76128 Karlsruhe
www.bgu.kit.edu

Photographer: Martin Fenchel

Contact: ulf.mohrlok@kit.edu

For informational use only. For legally binding information please refer to the german version of the handbook.

Preface

The module handbook is the document in which important additional information about the studies is described. The general rules from the examination regulation and its several statutes for amendment and the structure of the programme are specified by the curriculum (chap. 1). Also, substantial issues of the course of studies (chap. 2) and changes (chap. 3) are described in detail. The main function of the Module Handbook is the compilation of the module descriptions (chap. 4).
In addition to the module handbook information about the execution of the single courses is collected within the course catalogue (on-line). Information about the examinations is provided by the self-service function for students. This information is also announced by postings and webpages of the institutes.

Table of Contents

1 Degree programme

In the section "Degree Programme" rules in addition to the examination regulation (ER/SPO) and the amendments to this, if existing, are declared.

1.1 Objectives of the master degree programme

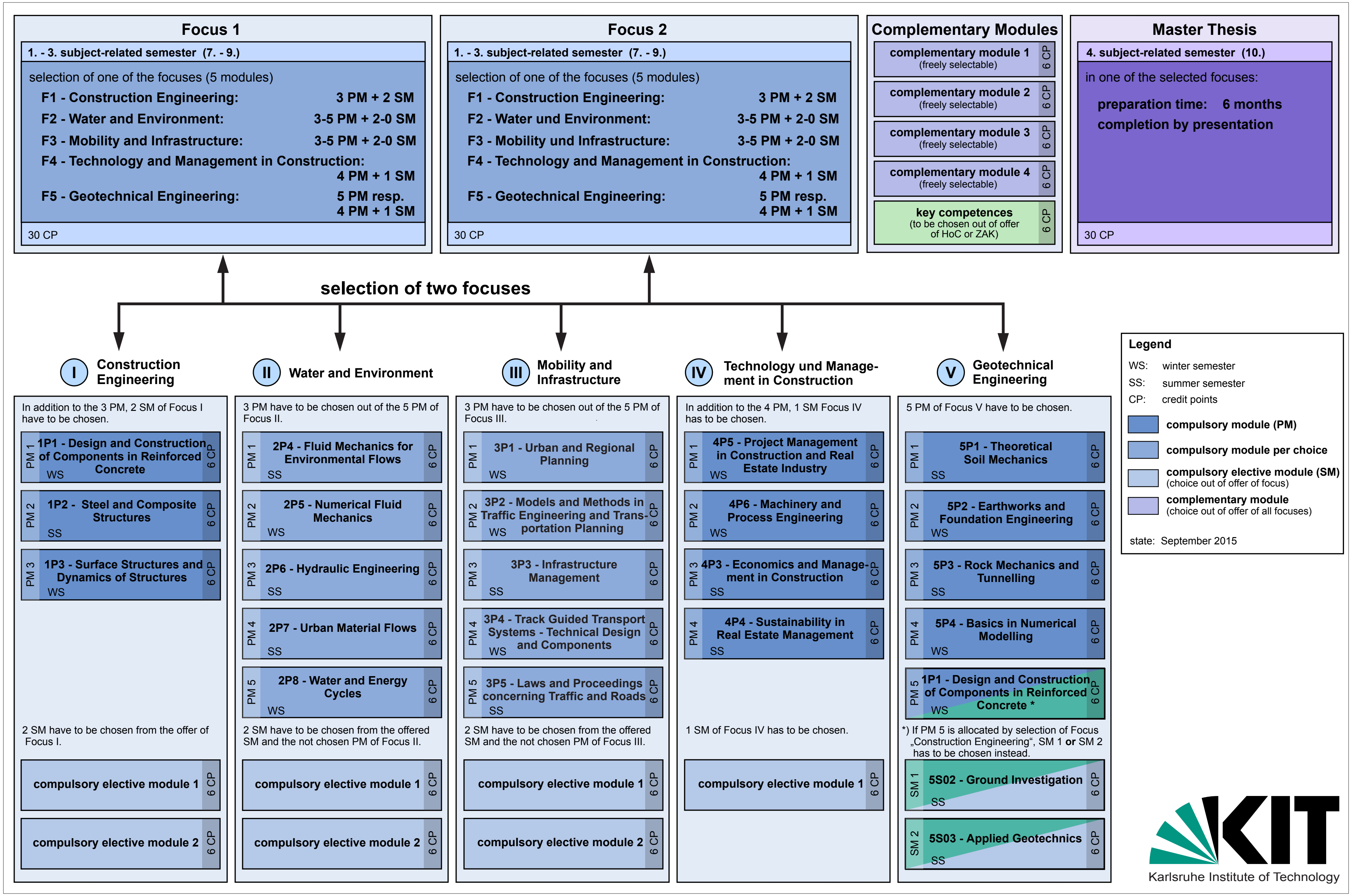
The graduates of the master degree programme Civil Engineering at Karlsruhe Institute of Technology (KIT) augmented and deepened their scientific qualifications in at least two of the five study focuses obtained in the bachelor degree programme.
They have learned to apply self-reliantly their scientific sound and interdisciplinary knowledge and methods (system analysis, measurement technology, modelling, management) also across disciplines and to evaluate their significance and scope for the solution of complex scientific and societal problems. They can develop innovative problem solutions beyond the application of established structurally engineered and scientific rules, and to enter new fields of engineering and to develop overall economic and socially acceptable solutions for the increasing complexity of these problems.
The graduates have the capability to work interdisciplinarily, to present technically complex issues understandably and to perform convincingly which made them also prepared very well for executive functions - also in an interdisciplinary team.

1.2 Structure of the master degree programme

The master degree programme Civil Engineering comprises 120 credit points (CP). It is structured in a **Focus Study** (60 CP), a **Complementary Study** (30 CP) and the preparation of the **Master Thesis** (30 CP) (s. diagram next page). The subject-related focuses

I Construction Engineering
II Water and Environment
III Mobility and Infrastructure
IV Technology and Management in Construction
V Geotechnical Engineering

represent the different of characteristics of the professional profile. They are structured differently regarding the assigned compulsory and compulsory elective modules. All modules in the master degree programme are integrated into these subject-related focuses (s. Tab. 1 - 5) as described in the following sections and they comprise 6 CP.


Focus 1
1. - 3. subject-related semester (7. - 9.)
selection of one of the focuses (5 modules)
F1 - Construction Engineering: 3 PM + 2 SM
F2 - Water and Environment: 3-5 PM + 2-0 SM
F3 - Mobility and Infrastructure: 3-5 PM + 2-0 SM
F4 - Technology and Management in Construction: 4 PM + 1 SM
F5 - Geotechnical Engineering: 5 PM resp. 4 PM + 1 SM
30 CP
Focus 2
1. - 3. subject-related semester (7. - 9.)
selection of one of the focuses (5 modules)
F1 - Construction Engineering: 3 PM + 2 SM
F2 - Water und Environment: 3-5 PM + 2-0 SM
F3 - Mobility und Infrastructure: 3-5 PM + 2-0 SM
F4 - Technology and Management in Construction: 4 PM + 1 SM
F5 - Geotechnical Engineering: 5 PM resp. 4 PM + 1 SM
30 CP
Complementary Modules
complementary module 1 (freely selectable) 6 CP
complementary module 2 (freely selectable) 6 CP
complementary module 3 (freely selectable) 6 CP
complementary module 4 (freely selectable) 6 CP
key competences (to be chosen out of offer of HoC or ZAK) 6 CP
Master Thesis
4. subject-related semester (10.)
in one of the selected focuses:
preparation time: 6 months
completion by presentation
30 CP
selection of two focuses
I Construction Engineering
In addition to the 3 PM, 2 SM of Focus I have to be chosen.
PM 1 1P1 - Design and Construction of Components in Reinforced Concrete WS 6 CP
PM 2 1P2 - Steel and Composite Structures SS 6 CP
PM 3 1P3 - Surface Structures and Dynamics of Structures WS 6 CP
2 SM have to be chosen from the offer of Focus I.
compulsory elective module 1 6 CP
compulsory elective module 2 6 CP
II Water and Environment
3 PM have to be chosen out of the 5 PM of Focus II.
PM 1 2P4 - Fluid Mechanics for Environmental Flows SS 6 CP
PM 2 2P5 - Numerical Fluid Mechanics WS 6 CP
PM 3 2P6 - Hydraulic Engineering SS 6 CP
PM 4 2P7 - Urban Material Flows SS 6 CP
PM 5 2P8 - Water and Energy Cycles WS 6 CP
2 SM have to be chosen from the offered SM and the not chosen PM of Focus II.
compulsory elective module 1 6 CP
compulsory elective module 2 6 CP
III Mobility and Infrastructure
3 PM have to be chosen out of the 5 PM of Focus III.
PM 1 3P1 - Urban and Regional Planning WS 6 CP
PM 2 3P2 - Models and Methods in Traffic Engineering and Transportation Planning WS 6 CP
PM 3 3P3 - Infrastructure Management SS 6 CP
PM 4 3P4 - Track Guided Transport Systems - Technical Design and Components WS 6 CP
PM 5 3P5 - Laws and Proceedings concerning Traffic and Roads SS 6 CP
2 SM have to be chosen from the offered SM and the not chosen PM of Focus III.
compulsory elective module 1 6 CP
compulsory elective module 2 6 CP
IV Technology und Management in Construction
In addition to the 4 PM, 1 SM Focus IV has to be chosen.
PM 1 4P5 - Project Management in Construction and Real Estate Industry WS 6 CP
PM 2 4P6 - Machinery and Process Engineering WS 6 CP
PM 3 4P3 - Economics and Management in Construction SS 6 CP
PM 4 4P4 - Sustainability in Real Estate Management SS 6 CP
1 SM of Focus IV has to be chosen.
compulsory elective module 1 6 CP
V Geotechnical Engineering
5 PM of Focus V have to be chosen.
PM 1 5P1 - Theoretical Soil Mechanics SS 6 CP
PM 2 5P2 - Earthworks and Foundation Engineering WS 6 CP
PM 3 5P3 - Rock Mechanics and Tunnelling SS 6 CP
PM 4 5P4 - Basics in Numerical Modelling WS 6 CP
PM 5 1P1 - Design and Construction of Components in Reinforced Concrete * WS 6 CP
*) If PM 5 is allocated by selection of Focus „Construction Engineering“, SM 1 or SM 2 has to be chosen instead.
SM 1 5S02 - Ground Investigation SS 6 CP
SM 2 5S03 - Applied Geotechnics SS 6 CP
Legend
WS: winter semester
SS: summer semester
CP: credit points
compulsory module (PM)
compulsory module per choice
compulsory elective module (SM) (choice out of offer of focus)
complementary module (choice out of offer of all focuses)
state: September 2015
Karlsruhe Institute of Technology

1.3 Study Focus I ”Construction Engineering”

All modules offered in the focus ”Construction Engineering” are included in Table 1. This table also provides information in which semester the accompanying lectures take place and how the learning control is carried out.

Three compulsory modules are predetermined for this focus:

- Design and Construction of Components in Reinforced Concrete (1P1)
- Steel and Composite Structures (1P2)
- Surface Structures and Dynamics of Structures (1P3)

In addition, two compulsory elective modules have to be chosen from the offer of this focus (Tab. 1).

For the compulsory module 1P2 (Steel and Composite Structures) the attendance of the compulsory elective module 1S14 (Non-linear Analysis of Beam Structures) in advance is recommended.

For the registration to the modules 1S10, 1S11 and 1S13 the registration to module 1S12 (Timber Structures) is recommended.

Three student research projects have to be conducted. The respective work load of these student research projects is 80 hours. One of the three student research projects can be replaced by a seminar presentation (20 min. presentation time). Student research projects have to be prepared close to the examinations. The respective module is completed by the passed project and the successful examination. At least two student research projects are to be related to the five modules determined for the focus.

As part of several lectures numerous field trips are offered. It is recommended to attend at least one field trip.

Table 1: Study Focus Construction Engineering

Tab. 1: Modules in Focus I, Construction Engineering

module (bauiM)	module name	course	type	semester *) SWS WS	semester *) SWS SS	LC	CP LC	CP module
1P1	Design and Construction of Components in Reinforced Concrete	Design and Construction of Components in Reinforced Concrete	L/E	2/2		wE	6	6
1P2	Steel and Composite Structures	Steel and Composite Structures	L/E		2/2	wE	6	6
1P3	Surface Structures and Dynamics of Structures	Surface Structures	L	2		wE	3	6
		Dynamics of Structures	L	2		wE	3	
sum compulsory modules				**8**	**4**			**18**
1S01	Bracing and Stability in Reinforced Concrete	Bracing and Stability in Reinforced Concrete	L/E		2/2	wE	6	6
1S02	Basics of Prestressed Concrete	Basics of Prestressed Concrete	L/E		2/2	wE	6	6
1S03	Solid Construction Bridges	Solid Construction Bridges	L/E	2/2		wE	6	6
1S04	Applied Dynamics of Structures [1])	Applied Dynamics of Structures	L/E		1/1	oE	6	6
		Earthquake Engineering	L/E	1/1				
1S05	Anchorage in Concrete [1])	Anchorage in Concrete I	L/E		1/1	oE	6	6
		Anchorage in Concrete II	L/E	1/1				
1S06	Material Science, Welding and Fatigue	Material Science, Welding and Fatigue	L/E		3/1	wE	6	6
1S07	Construction of Steel and Composite Bridges	Construction of Steel and Composite Bridges	L/E		2/2	wE	6	6
1S08	Hollow Section Structures	Hollow Section Structures	L/E	2/2		oE	6	6
1S09	Glass, Plastic and Cable Structures	Glass, Plastic and Cable Structures	L/E	3/1		oE	6	6
1S10	Structures in Steel and Timber	Supporting Steel Structures	L/E	1/1		oE	6	6
		Supporting Timber Structures	L/E	2				
1S11	Preservation of Steel and Timber Structures	Preservation of Steel Structures	L	2		wE	6	6
		Preservation of Timber Structures	L/E	2				
1S12	Timber Structures	Timber Structures	L/E		2/2	wE	6	6
1S13	Timber and Wood-based Materials	Timber and Wood-based Materials	L/E		2/2	oE	6	6
1S14	Non-linear Analysis of Beam Structures	Non-linear Analysis of Beam Structures	L/E	2/2		wE	6	6

Tab. 1 (cont.): Modules in Focus I, Construction Engineering

module (bauiM)	module name	course	type	semester *) SWS WS	semester *) SWS SS	LC	CP LC	CP module
1S15	Computational Analysis of Structures	Computational Analysis of Structures	L/E		2/2	oE	6	6
1S16	FE-Applications in Practical Engineering	FE-Applications in Practical Engineering	L/E		2/2	oE	6	6
1S17	Shell Structures and Stability of Structures	Shell Structures	L/E		1/1	oE	6	6
		Stability of Structures	L/E		1/1			
1S18	Numerical Methods in Structural Analysis	Numerical Methods in Structural Analysis	L/E	2/2		oE	6	6
1S19	Non-linear Analysis of Surface Structures	Non-linear Analysis of Surface Structures	L/E	2/2		oE	6	6
1S20	Basics of Finite Elements	Basics of Finite Elements	L/E	2/2		oE	6	6
1S21	Fracture and Damage Mechanics	Fracture and Damage Mechanics	L/E	2/2		oE	6	6
1S22	Material Models in Solid Mechanics	Material Models in Solid Mechanics	L/E		2/2	oE	6	6
1S24	Concrete Construction Technology	Concrete Technology	L/E	3		oE	6	6
		Deformation and Fracture Processes	L	1				
1S25	Durability and Service Life Design	Corrosion Processes and Life Time	L/E	3		oE	6	6
		Analytic Methods	L	1				
1S26	Building Preservation of Concrete and Masonry Constructions	Protection, Rehabilitation and Reinforcement of Concrete and Masonry Constructions	L/E		2/1	oE	6	6
		Building Analysis	L		1			
1S27	Building Physics I	Applied Building Physics	L	2		oE	3	6
		Building Technology	L	2		oE	3	
1S28	Building Physics II	Practical Noise Control	L		2	wE	3	6
		Practical Fire Protection	L		2	oE	3	
1S29	Materials Testing and Measuring Techniques	Measuring Techniques in Civil Engineering	L/E	1/1		oE	6	6
		Materials Testing in the Field of Concrete	L	2				
1S32	Continuum Mechanics of Heterogeneous Solids [2, 3])	Continuum Mechanics	L	2		oE	6	6
		Micromechanics of Heterogeneous Solids	L		2			
1S35	Contact Mechanics - Fundamentals and Basics	Contact Mechanics - Fundamentals and Basics	L/E		2/2	oE	6	6

Tab. 1 (cont.): Modules in Focus I, Construction Engineering								
module (bauiM)	**module name**	**course**	**type**	**semester *) SWS**		**LC**	**CP LC**	**CP module**
				WS	**SS**			
1S36	Contact Mechanics - Computational algorithms in a geometrically exact form	Contact Mechanics - Computational algorithms in a geometrically exact form	L/E	2/2		oE	6	6
1S37	Finite Elements in Solid Mechanics	Finite Elements in Solid Mechanics	L/E		2/2	oE	6	6
1S38	Numerical Structural Dynamics	Numerical Structural Dynamics	L/E		2/2	oE	6	6
1S39	Tank Construction	Tank Construction	L/E	3/1		oE EoT	6	6
1S40	Modeling in Solid Mechanics	Modeling in Solid Mechanics	L/E		2/2	oE	6	6
sum compulsory elective modules				**70**	**70**			**210**

explanations to Table 1:

1PX = Focus I, compulsory module
1SXX = Focus I, compulsory elective module
CP = credit point (1 SWS = 1,5 CP)
LC = learning control
wE = written examination
oE = oral examination
EoT = examination of other type

L = lecture
L/E = lecture and exercise separate or integrated

*) The master's degree study can be started in winter (WS) and summer semester (SS) as well.

[1]) Starting this module in summer semester (SS) is recommended.

[2]) Starting this module in winter semester (WS) is recommended.

[3]) Module must not be selected together with module 5P4 (Focus V).

1.4 Study Focus II ”Water and Environment”

All modules offered in the focus ”Water and Environment” are included in Table 2. This table also provides information in which semester the accompanying lectures take place and how the learning control is carried out.

In this focus five compulsory modules are predetermined:

- Fluid Mechanics for Environmental Flows (2P4)
- Numerical Fluid Mechanics (2P5)
- Hydraulic Engineering (2P6)
- Urban Material Flows (2P7)
- Water and Energy Cycles (2P8)

At least three out of these compulsory modules has to be chosen. In case of choosing less than five compulsory modules the respective number of missing modules has to be chosen from the offer of this focus (Tab. 2).

Table 2: Study Focus Water and Environment

Tab. 2: Modules in Focus II, Water and Environment

module (bauiM)	module name	course	type	semester *) SWS WS	semester *) SWS SS	LC	CP LC	CP module
2P4	Fluid Mechanics for Environmental Flows **)	Fluid Mechanics for Environmental Flows	V/Ü		2/2	wE	6	6
2P5	Numerical Fluid Mechanics**)	Numerical Fluid Mechanics I	V/Ü	2/2		wE	6	6
2P6	Hydraulic Engineering **)	Multiphase Flow in Hydraulic Engineering	V/Ü		1/1	wE	6	6
		Design of Hydraulic Structures	V/Ü		1/1			
2P7	Urban Material Flows **)	Urban Material Flows	V/Ü		2/2	wE	6	6
2P8	Water and Energy Cycles **)	Water and Energy Cycles in Hydrological Systems: Processes, Predictions and Management	V/Ü	2/2		wE	6	6
sum compulsory modules **) **) 3 compulsory modules have to be chosen, in total 18 CP.				**8**	**12**			**30**
2S01	Water Resources and River Basin Management	Water Resources and River Basin Management	L/E		4	EoT	6	6
2S02	Thermodynamics in Environmental Systems	Thermodynamics in Environmental Systems	L/E	4		EoT	6	6
2S03	Dynamics of Water and Mass Transport in Watersheds 3)	Dynamics of Water and Mass Transport in Watersheds	L/E		4	EoT	6	6
2S04	Data Analysis and Environmental Monitoring 3)	Data Analysis and Environmental Monitoring	L/E		4	EoT	6	6
2S05	Experimental Hydrology and Process Monitoring in Environmental Systems 3)	Experimental Hydrology and Process Monitoring in Environmental Systems	E		4	EoT	6	6
2S06	Aquatic Ecosystems	Aquatic Ecosystems	L/E	2/1		EoT	6	6
2S07	Environmental Communication	Environmental Communication	S	2		EoT	6	6
2S08	Groundwater Management 1)	Groundwater Management	L/E		2	oE	3	6
		Numerical Groundwater Modelling	Pj	2		EoT	3	
2S09	Studies of Development Projects in Water Resources Management 3)	Studies of Development Projects in Water Resources Management	L	4		EoT	6	6
2S10	Practical Use of Numerical Methods in Fluid Mechanics3)	Practical Use of Numerical Methods in Fluid Mechanics	L/E	2/2		wE	6	6
2S11	Hydro Power Engineering	Hydro Power Engineering	L/E		4	oE	6	6
2S12	Waterway Engineering	Waterway Engineering	L/E		4	oE	6	6

Tab. 2 (cont.): Modules in Focus II, Water and Environment								
module (bauiM)	**module name**	**course**	**type**	**semester *) SWS**		**LC**	**CP LC**	**CP module**
				WS	**SS**			
2S13	River Dynamics	Morphodynamics	L/E		2	oE	6	6
		Flow Behaviour	L/E		2			
2S15	Experimental Techniques I: Small Scale Experiments [1, 3])	Experimental Methods	L/E		1/2	oE	4,5	6
		Hydraulic Engineering Project	Pj	1		EoT	1,5	
2S16	Interaction Flow - Building Structure	Interaction Flow - Building Structure	L/E	1/1		oE	3	6
		Building and Environmental Aerodynamics	L/E	1/1		oE	3	
2S17	Technical Hydraulics	Steady and Unsteady-state Operation of Hydraulic Systems	L/E		2/2	wE	6	6
2S18	Experimental Techniques II: Measurement Techniques [2])	Flow Measuring Technique	L/E	1/1		oE	3	6
		Signal Processing in Fluid Mechanics	L/E		1/1	oE	3	
2S19	Environmental Fluid Mechanics	Environmental Fluid Mechanics	L/E	3/1		wE	6	6
2S21	Advanced Computational Fluid Dynamics	Parallel Programming Techniques for Engineering Problems	L/E		1/1	wE	3	6
		Numerical Fluid Mechanics II	L/E		1/1	oE	3	
2S24	Water Treatment Technologies	Process Technologies in Storm Water Treatment	L/E		2	EoT	3	6
		Process Technologies in Water Supply and Wastewater Disposal	L/E		2	oE	3	
2S25	Urban Water Management [3])	Urban Water Management	L/E	4		oE	6	6
2S26	Water Quality of Surface Water and Groundwater [3])	Seminar Water Quality	S		2	EoT	3	6
		Field Training Water Quality	P		2	EoT	3	
2S28	Water Supply and Sanitation Systems and Plants [3])	Water Treatment	L/E		2	oE	3	6
		Water Distribution	L/E	2		oE	3	
2S29	Industrial Water Management [1])	Cleaner Production – Closing the Loop	L/E		2	oE	6	6
		Appropriate Technologies	L/E	2				

Tab. 2 (cont.): Modules in Focus II, Water and Environment								
module (bauiM)	**module name**	**course**	**type**	**semester *) SWS WS**	**semester *) SWS SS**	**LC**	**CP LC**	**CP module**
2S30	River Basin Modelling [1])	Mass Fluxes in River Basins	L		2	oE	3	6
		Modelling Mass Fluxes in River Basins	E	2		EoT	3	
2S32	Analysis of Turbulent Flows [1])	Fluid Mechanics of Turbulent Flows	L		2	oE	6	6
		Modelling of Turbulent Flows - RANS and LES	L	2				
sum compulsory elective modules **) **) At least 2 modules of compulsory elective modules and not already chosen compulsory modules have to be chosen, in total at least 12 CP.				**43**	**61**			**156**

explanations to Table 2:

2PX =	Focus II, compulsory module	L =	lecture
2SXX =	Focus II, compulsory elective module	E =	exercise
CP =	credit point (1 SWS = 1,5 CP)	L/E =	lecture and exercise separate or integrated
LC =	learning control	S =	seminar
wE =	written examination	P =	practical training
oE =	oral examination	Pj =	study project
EoT =	examination of other type		

*) The master's degree study can be started in winter (WS) and summer semester (SS) as well.

[1]) Starting this module in summer semester (SS) is recommended.

[2]) Starting this module in winter semester (WS) is recommended.

[3]) Module will not be offered any more or not any more in this form as from winter term 2016/17

1.5 Study Focus III ”Mobility and Infrastructure”

All modules offered in the focus ”Mobility and Infrastructure” are included in Table 3. This table also provides information in which semester the accompanying lectures take place and how the learning control is carried out.

In this focus five compulsory modules are predetermined:

- Urban and Regional Planning (3P1)
- Models and Methods in Traffic Engineering and Transportation Planning (3P2)
- Infrastructure Management (3P3)
- Track Guided Transport Systems – Technical Design and Components (3P4)
- Laws and Proceedings concerning Traffic and Roads (3P5)

At least three out of these compulsory modules has to be chosen. In case of choosing less than five compulsory modules the respective number of missing modules has to be chosen from the offer of this focus (Tab. 3).

Students selecting the focus ”Mobility and Infrastructure” are recommended to attend one field trip of several days' duration. Normally, this takes place annually in the week following the Whitsun holidays.

Table 3: Study Focus Mobility and Infrastructure

Tab. 3: Modules in Focus III, Mobility and Infrastructure

module (bauiM)	**module name**	**course**	**type**	**semester *) SWS WS**	**SS**	**LC**	**CP LC**	**CP module**
3P1	Urban and Regional Planning **)	Urban Planning	L/E	1/1		oE	6	6
		Regional Planning	L	2				
3P2	Models and Methods in Traffic Engineering and Transportation Planning **)	Methods and Models in Transportation Planning	L/E	1/1		oE	6	6
		Traffic Engineering	L/E	1/1				
3P3	Infrastructure Management**)	Design and Construction of Highways	L/E		2	oE	6	6
		Operation and Maintenance of Highways	L		2			
3P4	Track Guided Transport Systems - Technical Design and Components **)	Track Guided Transport Systems - Technical Design and Components	L/E	3/1		wE	6	6
3P5	Laws and Proceedings concerning Traffic and Roads **)	Laws concerning Traffic and Roads	L		2	oE	3	6
		Environmental Impact Assessment	L		1	oE	1,5	
		Assessment and Evaluation Techniques	L		1	oE	1,5	
sum compulsory modules **) **) 3 compulsory modules have to be chosen, in total 18 CP.				**12**	**8**			**30**
3S01	Urban Renewal	Urban Management	L/E		1/1	oE	6	6
		History of Urban Planning and the Built Environment	L		1			
		Building Theory	L		1			
3S02	Space and Infrastructure	Logistics, Supply and Disposal	L/E		1/1	oE	6	6
		Fundamentals of Geographic Information Systems for Modelling and Planning	L		2			
3S03	Traffic Management und Simulation Methods	Traffic Management and Transport Telematics	L/E		1/1	oE	6	6
		Traffic Flow Simulation	L/E		1/1			
3S04	Planning of Transportation Systems	Characteristics of Transportation Systems	L		2	oE	6	6
		Strategic Transport Planning	L		2			
3S05	Highway Design	IT-based Road Design	L/E	2		oE	6	6
		Highway Design Project Study	L/E	2				

Tab. 3 (cont.): Modules in Focus III, Mobility and Infrastructure

module (bauiM)	module name	course	type	semester *) SWS WS	SS	LC	CP LC	CP module
3S06	Road Construction	Practical Laboratory Training in Road Construction	L/E	2		oE	6	6
		Pavement Structural De-sign and Failure Analysis	L	2				
3S09	Project Integrated Planning [1])	Project Integrated Planning	Pj	4		oE	6	6
3S11	Intermodality in Long-distance, Freight and Air Transport	Freight Transport	L/E		1/1	oE	3	6
		Long-distance and Air Traffic	L	2		oE	3	
3S12	Road Safety	Safety Management in Highway Engineering	L/E	2		oE	6	6
		Seminar in Highway Engineering	S	2				
3S13	Special Topics in Highway Engineering	Technical and Economic Management Tools in Highway Engineering	L		2	oE	3	6
		Simulations and Analysis Methods in Highway Engineering	L		1	oE	3	
		Special Topics in Highway Engineering	L		1			
3S14	Dimensioning and Construction of Railway Lines	Infrastructure Dimensioning and Railway Traffic	L/E		1/1	oE	6	6
		Infrastructure Equipment of Railway Tracks	L		1			
		Construction and Mainten-ance of Track Infrastructure	L		1			
3S15	Economics, Law and Environmental Aspects in Railway Transportation	Environmental Aspects of Guided Transport Systems	L	2		oE	6	6
		Economic Efficiency of Guided Transport Systems	L	1				
		Law Aspects of Guided Transport Systems	L	1				
3S16	Traffic Infrastructure [2])	Determination of Demand, Timetable Construction and Alignment	L/E		1/2	oE	6	6
		Standard Valuation in Public Transport. Using an Example	E	1				
3S17	City Transport Facilities	City Transport Facilities	L/E	4		oE	6	6
3S18	Track Guided Transport Systems - Operation and Capacity	Operation	L		2	oE	6	6
		Operation Systems and Track Guided Infrastructure Capacity	L		2			

Tab. 3 (cont.): Modules in Focus III, Mobility and Infrastructure

module (bauiM)	module name	course	type	semester *) SWS WS	SWS SS	LC	CP LC	CP module
3S19	Track Guided Transport Systems - Management, Facilities and Vehicles of Public Transport	Facilities and Rolling Stock	L/E		1/1	oE	6	6
		Management in Public Transport	L		2			
3S20	Analysis and Evolution of Mobility	Transportation Data Analysis	L/E	2		oE	6	6
		Mobility Services and new Forms of Mobility	L/E		2			
3S21	Special Topics in Transportation	Tendering, Planning and Financing in Public Transport	L		2	oE	3	6
		Seminar in Transportation #)	S	2	2	EoT	3	
sum compulsory elective modules **) **) At least 2 modules of compulsory elective modules and not already chosen compulsory modules have to be chosen, in total at least 12 CP.				**31**	**43**			**108**

explanations to Table 3:

3PX = Focus III, compulsory module
3SXX = Focus III, compulsory elective module
CP = credit point (1 SWS = 1,5 CP)
LC = learning control
wE = written examination
oE = oral examination
EoT = examination of other type

L = lecture
E = exercise
L/E = lecture and exercise separate or integrated
S = seminar
Pj = study project

*) The master's degree study can be started in winter (WS) and summer semester (SS) as well.

#) Course is offered every semester.

[1]) Taking this module in the 1st semester is <u>not</u> recommended.

[2]) Starting this module in summer semester (SS) is recommended.

1.6 Study Focus IV ”Technology and Management in Construction”

All modules offered in the focus ”Technology and Management in Construction” are included in Table 4. This table also provides information in which semester the accompanying lectures take place and how the learning control is carried out.

In this focus four compulsory modules are predetermined:

- Economics and Management in Construction (4P3)
- Sustainability in Real Estate Management (4P4)
- Project Management in Construction and Real Estate Industry (4P5)
- Machinery and Process Engineering (4P6)

In addition, one compulsory elective module has to be chosen from the offer of this focus (Tab. 4).

Further, the preparation of two student research projects in the fields of process planning (work load 120 hours) and construction time planning or calculation (work load 40 hours) are obligatory in this focus. These will be attested by a colloquium.

Selected this focus only those can be admitted to the master thesis who got attested both student research projects in addition to the passed modules in the required extent of minimum 42 LP (s.a.). The earliest date for starting the thesis project is therefore the third subject-related semester in the master programme.

Beside numerous field trips as part of several lectures a one day field trip takes place annually at the beginning of the winter term. The attendance at this fall field trip is obligatory for students selected focus IV.

Furthermore, a ”large” field trip of several days’ duration is offered also annually in the week following the Whitsun holidays. All students planning to prepare their master thesis in this focus shall attend this once.

Table 4: Study Focus Technology and Management in Construction

Tab. 4: Modules in Focus IV, Technology and Management in Construction

module (bauiM)	module name	course	type	semester *) SWS WS	SWS SS	LC	CP LC	CP module
4P3	Economics and Management in Construction	Cost Estimation	L/E		1/1	wE	6	6
		Building Laws	L		2			
4P4	Sustainability in Real Estate Management	Sustainability in Real Estate Management	L/E		1/1	wE	6	6
		Real Estate Life Cycle Management	L		1			
		Facility and Real Estate Management II	L		1			
4P5	Project Management in Construction and Real Estate Industry	Project Management in Construction and Real Estate Industry	L/E	3/1		wE	6	6
4P6	Machinery and Process Engineering	Mechanical engineering basics	L	2		wE	6	6
		Construction Machinery and Mechanical Process Engineering	L	2				
sum compulsory modules				**8**	**8**			**24**
4S01	Business and Human Resource Management	Business and Human Resources	L/E		2/1	oE	6	6
		Site Management	L		1			
4S06	Environmentally-friendly Recycling and Disassembly of Buildings	Project Studies	L/E		1/1	oE	6	6
		Disassembly Process Engineering	L/E		1/1			
4S07	Upgrading of Existing Buildings and Energetic Refurbishment	Upgrading of Existing Buildings	L/E	2/1		oE, EoT	6	6
		Energetic Refurbishment	L	1				
4S08	Real Estate Management	Controlling in Real Estate Management	L	1		oE	6	6
		Public Real Estate Management and Public Private Partnership	L	1				
		Project Development	L	1				
		Corporate Real Estate Management and Human Resources in Real Estate	L	1				
4S09	Lean Construction	Lean Construction	L/E	2/2		oE EoT	6	6

Tab. 4 (cont.): Modules in Focus IV, Technology and Management in Construction

module (bauiM)	module name	course	type	semester *) SWS WS	SS	LC	CP LC	CP module
4S10	Advanced Studies in Construction Engineering	Tunnel Construction and Blasting Engineering	L	2		oE	6	6
		Operation Methods for Foundation and Marine Construction	L	1				
		Operation Methods for Earthmoving	L	1				
4S12	Decommissioning of Nuclear Facilities	Removal and Decontamination of Nuclear Facilities	L/E	1/1		oE	6	6
		New Development and Optimization of Decommissioning Machine Technology	L/E	1/1				
4S13	Facility Management in Hospitals and Hospital Management	Facility Management in Hospitals	L/E	3		EoT	4,5	6
		Hospital Management	L	1		oE	1,5	
4S15	Turnkey Construction	Turnkey Construction I - Processes and Methods	L		1	oE	6	6
		Turnkey Construction II - Trades and Technology	L/E		1/1			
		Claim Management	L		1			
4S16	Building Information Modelling	Building Information Modelling	L/E		4	EoT	6	6
sum compulsory modules				**24**	**16**			**60**

explanations to Table 4:

4PX = Focus IV, compulsory module
4SXX = Focus IV, compulsory elective module
CP = credit point (1 SWS = 1,5 CP)
LC = learning control
wE = written examination
oE = oral examination
EoT = examination of other type

L = lecture
L/E = lecture and exercise separate or integrated

*) The master's degree study can be started in winter (WS) and summer semester (SS) as well.

1.7 Study Focus V ”Geotechnical Engineering”

All modules offered in the focus ”Geotechnical Engineering” are included in Table 5. This table also provides information in which semester the accompanying lectures take place and how the learning control is carried out.

In this focus five compulsory modules are predetermined:

- Theoretical Soil Mechanics (5P1)
- Earthworks and Foundation Engineering (5P2)
- Rock Mechanics and Tunnelling (5P3)
- Basics in Numerical Modelling (5P4)
- Design and Construction of Components in Reinforced Concrete (1P1)

In case that the compulsory module Design and Construction of Components in Reinforced Concrete (1P1) is already allocated by the selection of Construction Engineering as second focus one of the compulsory elective modules 5S02 and 5S03 has to be chosen instead.

Starting the study in the winter term it is recommended to attend the compulsory module Basics in Numerical Modelling (5P4) in advance to the compulsory module Theoretical Soil Mechanics (5P1) if the basics in mathematics and continuum mechanics are not obtained otherwise. Generally, the study can be started with 5P2, 5P4 and 1P1 in winter term and likewise with 5P1, 5P3 and eventually 5S02 or 5S03 in summer term.

A few compulsory elective modules are depending in content and difficulty on compulsory modules, so that the compliance of an order is recommended. These are:

- Special Issues of Soil Mechanics (5S01) following Theoretical Soil Mechanics (5P1)
- Applied Geotechnics (5S03) following Earthworks and Foundation Engineering (5P2)
- Ground Water and Earth Dams (5S04) following Earthworks and Foundation Engineering (5P2)
- Rock Engineering and Underground Construction (5S05) following Rock Mechanics and Tunnelling (5P3)
- Numerical Modelling in Geotechnics (5S06) following Basics in Numerical Modelling (5P4)
- Coupled Geomechanical Processes (5S10) following Rock Mechanics and Tunnelling (5P3)

The attendance of the annual Whitsun field trips is recommended at least once during the master programme.

Appropriate courses of the bachelor and master programmes Applied Geosciences and Geophysics can be taken also in the Complementary Study in agreement with the mentor. At maximum the extent has to be the same as the credit points taken from the IBF offer. The examination regulations has to be clarified with the respective lecturer in time.

Additional courses from these programmes can be taken as additional accomplishments.

Table 5: Study Focus Geotechnical Engineering

Tab. 5: Modules in Focus V, Geotechnical Engineering

module (bauiM)	module name	course	type	semester *) SWS WS	semester *) SWS SS	LC	CP LC	CP module
5P1	Theoretical Soil Mechanics	Theoretical Soil Mechanics	L/E		4	wE	6	6
5P2	Earthworks and Foundation Engineering	Foundation Types	L/E	2		wE	6	6
		Basics in Earthworks and Embankment Dams	L/E	2				
5P3	Rock Mechanics and Tunnelling	Basics in Rock Mechanics	L/E		2	wE	6	6
		Basics in Tunnel Construction	L/E		2			
5P4	Basics in Numerical Modelling [1])	Continuum Mechanics	L	2		oE	6	6
		Numerics in Geotechnics	L	2				
1P1	Design and Construction of Components in Reinforced Concrete **)	Design and Construction of Components in Reinforced Concrete	L/E	2/2		wE	6	6
sum compulsory modules **) Since module 1P1 is already taken by combination with Focus I "Construction Engineering", module 5S02 or 5S03 has to be taken instead.				**12**	**8**			**30**
5S01	Special Issues of Soil Mechanics	Unsaturated, Viscous and Cyclic Soil Behaviour - Theory and Element Tests	L/E	2		oE	6	6
		Soil Dynamics	L/E	2				
5S02	Ground Investigation **)	Soil Mechanical Laboratory Exercises	E		2	oE	6	6
		Geomechanical Field Exercise	E		2			
5S03	Applied Geotechnics **)	Foundations and Retaining Structures	L/E		2	wE	6	6
		Special Foundation Engineering and Design	L/E		2			
5S04	Ground Water and Earth Dams	Geotechnical Ground Water Problems	L/E		2	oE	6	6
		Embankment Dams (Advanced)	L/E		2			
5S05	Rock Engineering and Underground Construction	Aboveground Rock Engineering	L/E	2		wE	6	6
		Tunnel Construction in Soils and in Existence	L/E	2				

Tab. 5 (cont.): Modules in Focus V, Geotechnical Engineering								
module (bauiM)	**module name**	**course**	**type**	**semester *)**	**SWS**	**LC**	**CP LC**	**CP module**
				WS	**SS**			
5S06	Numerical Modelling in Geotechnics	Exercises in Numerical Modelling	E		2	oE	6	6
		FEM Applications in Geotechnical Modelling	L		2			
5S07	Geotechnical Testing and Measuring Technology	Rock Testing	L	1		oE	6	6
		Testing in Dam and Wastefill Engineering	L	1				
		Geotechnical Measuring Technology	L/E	2				
5S08	Special Underground Engineering	Ground Improvement, Grouting and Soil Freezing	L/E		2	oE	3	6
		Anchoring, Piling and Slurry Wall Technology	L/E		2	oE	3	
5S09	Environmental Geotechnics	Landfills	L/E	2		oE	3	6
		Brownfield Sites - Investigation, Evaluation, Rehabilitation	L	2		oE	3	
5S10	Coupled Geomechanical Processes	Special Issues in Rock Mechanics	L/E	2		oE	6	6
		Coupled Phenomena in Geomechanics	L/E	2				
sum compulsory elective modules				**20**	**20**			**60**

explanations to Table 5:

5PX =	Focus V, compulsory module	L =	lecture
5SXX =	Focus V, compulsory elective module	E =	exercise
CP =	credit point (1 SWS = 1,5 CP)	L/E =	lecture and exercise separate or integrated
LC =	learning control		
wE =	written examination		
oE =	oral examination		

*) The master's degree study can be started in winter (WS) and summer semester (SS) as well.

[1]) Module must not be selected together with module 1P32 (Focus I).

1.8 Module selection, mentoring

Starting with the selection of two study focuses every student has to compile an individual curriculum. By selection of the two focuses the respective **compulsory modules** are determined (s. Tab. 1 - 5). According to the predefined number of compulsory modules the necessary number of **compulsory elective modules** have to be taken from the list of the respective selected focus in order to take modules in amount of 30 CP within the respective focus. For the Complementary Study four **compulsory or compulsory elective modules** from all focuses of the master degree programme Civil Engineering, if not already selected, or from any related one have to be chosen freely.
The module **Key Competences** is composed by the student herself or himself respectively with an extent of 6 CP from the respective offering of the KIT House of Competence (HoC) or the Centre for Cultural and General Studies (ZAK). In special cases the examination committee can accept further suitable courses as key competences which are not included in the offers of HoC and ZAK as mentioned above. The module Key Competences is completed without grade. After consultation with the lecturer a grade can be reported but is not included in the general grade.
The selection of the focuses with the respective modules and the modules in the complementory study (complementary modules) has to be accompanied and confirmed in the forms for module selection (http://www.ibs.kit.edu/1061.php) by a **mentor** (professor) chosen by the student. The Mentor has to be professor of the Department Civil Engineering, Geo and Environmental Sciences and to be involved in one of the selected focuses.
The forms for module selection have to be submitted the "Studierendenservice" (students' service) and are posted by this into Campus Management System. The students have access to that via the self-service function for students. There, they can register to the examinations within the selected modules and view the individual curriculum any time.

1.9 Crediting of external accomplishments

The acceptance of external accomplishments is to be made by the acceptance form (http://www.ibs.kit.edu/download/Formblatt_Master_Anerkennung.pdf) of the examination committee (http://www.ibs.kit.edu/1049.php).
If the accomplishments are identical with modules from the curriculum this is confirmed on the form by the respective lecturer.
If the accomplishments are not identical with modules from the curriculum the mentor will include them into the personal curriculum. He also defines the name of the respective modules.
Usually, modules in extent of 12 CP at maximum can be credited as complementary modules in this way. Additional credit points get lapsed.
The form for acceptance has to be submitted to the examination committee which transfers it to the "Studierendenservice" (students' service).

1.10 Begin and completion of a module

Every module and every examination is allowed to be credited only once. The binding decision whether a module is chosen is made by the student at the time of signing in for the corresponding examination, also partial examination. After attendance of the examination, especially of a partial examination, a module cannot be replaced by another one any more. In case of cancellation of an examination, e.g. cancellation in time, the respective module is not considered as started.
The module is **completed**, if the general examination of the module has been passed (grade min. 4.0). In case that the module examination consists of several partial examinations, it holds: The module is completed if all partial examinations are passed (grade min. 4.0) so that the minimum requirement of credits of this module have been met.

1.11 Admittance, preparation and completion of the master thesis

Normally, the **Master Thesis** has to be prepared in semester 4 in one of the selected focuses. The topic of the master thesis has to be assigned by a **professor** of the Department of Civil Engineering, Geo- and Environmental Sciences. The wishes of the students shall be respected when formulating the topic. In case that the master thesis shall be prepared outside of KIT the "Merkblatt - Externe Abschlussarbeiten" (http://www.haa.kit.edu/downloads/KIT_ALLGEMEIN_Merkblatt_Externe_Abschlussarbeiten.pdf) has to be considered.
Those are admitted to the master thesis who has passed successfully modules of extent of minimum 42 CP within the master programme Civil Engineering. Obtained results in the module Key Competences cannot be counted for this purpose. Students selected Focus IV, Technology and Management in Construction, have to get attested the

two student research projects additionally (s.a.). The **application for admittance** has to be made three months after passing the last module examination at latest. Otherwise, the master thesis will be graded as ”not sufficient” (grade 5.0). The **admittance** to the master thesis is carried out after approval of the prerequisites to be provided by the programme coordinator. The registration for the master thesis is made at the "Studierendenservice" (students' service).
The **duration of preparation** is six months. The master thesis can be written in English. The master thesis has to be completed by a **presentation** that is considered in the grading within one month after **submission**. It is very much recommended to have gained already all technical and soft skills required for the preparation of the topic of the master thesis before beginning the thesis project.

1.12 Additional accomplishments

An **additional accomplishments** is a voluntarily taken examination, which is not considered in the overall grade but is listed in the transcript of records. It is mandatory to declare an additional accomplishment as such at the time of registration for the examination. It cannot be booked as compulsory or compulsory elective module subsequently. The results of three modules at least 6 CP at maximum each are included in the master degree certificate as additional modules on application by the student. In total, additional accomplishments can be taken in extent of 20 CP at maximum.

2 Useful tips and information

Module Handbook

The **module handbook** is the relevant document in which the structure of the programme is described and therefore it provides assistance for the orientation during the study. It describes the modules belonging to the programme and contains information about:

- the structure of the modules
- the extent (in CP),
- the dependencies of the modules,
- the learning outcomes,
- the assessment and examinations.

Each module consists of one or more interrelated courses, which are completed by one or more **examinations**. The extent of each module is characterized by 6 credit points (CP), which will be credited after the successful completion of the module. The module handbook provides the necessary information that the students can customize content and time schedule of the interdisciplinary study according to personal needs, interest and job perspective.
In addition to the module handbook the **course catalogue** and the individual announcements of the institutes provide important information. These are updated every semester concerning variable course details (e.g. time and location of the course) as well as short-term modifications.

Individual curriculum, mentoring

The choices offered within the degree programme requires that every student has to compile an individual curriculum. This is to be agreed by a **mentor**. The mentor has to be professor of the Department of Civil Engineering, Geo- and Environmental Sciences and to be involved in the selected study focuses.
For the selection of the profile and the respective modules the forms for module selection available on the web page of the examination board, `http://www.ibs.kit.edu/1061.php`, have to be filled in. They have to be signed by the student and the mentor and to be submitted via the programme coordinator to the "Studierendenservice" (students' service).
The selection of the modules shall be transferred to the data base of the "Studierendenservice" (students' service) in sufficient time to the registration for examinations in the first semester so that the administration of the examinations (registration, cancellation, crediting results, etc.) can be carried out smoothly. The individual curriculum can be viewed any time via the self-service function for students, `https://campus.studium.kit.edu`.
The selection of the modules have to be made with care. On the one hand, the assignment of the modules to the respective part of the programme, Focus Study or Complementary Study respectively, will be transferred to the master degree certificate. On the other hand, changes of the module selection has to be agreed by the selected mentor and should be limited to exceptional cases, e.g. if a compulsory elective module is not offered at short notice. As far as the respective module is not yet begun, changes of the module selection are generally possible.

General or partial examinations

The module examination can be taken as a general examination or as several partial examinations. If the module examination is offered as a **general examination**, the entire content of the module will be reviewed in a single examination. If the module examination consists of **partial examinations**, the content of each course will be reviewed in corresponding partial examinations.
The registration for the examinations takes place online via the self-service function for students.The following functions can be accessed via `https://campus.studium.kit.edu`:

- Sign in and sign off examinations
- Retrieve examination results
- Print transcript of records

Repeating examinations

Principally, a failed examination can be repeated once, latest by the end of the examination period of the next but one semester to this examination. If failing a written repeat examination an oral repeat examination can be taken that will be evaluated independently. The overall grade of the repeat examination is determined by arithmetic average of the written examination and the oral repeat examination.
If the **repeat examination** (including an oral repeat examination) will be failed as well, the **examination claim** is lost. A potential request for a **second repetition** has to be made without delay after loosing the examination claim. Requests for a second repetition of an examination require the approval of the examination board. A counselling interview is mandatory.
In addition, every student has the opportunity to take immediately an additional oral examination after the attendance at the first written examination after the announcement of the results.
Further information is available in the examination regulation (ER/SPO) and from the master examination committee or the "Fachschaft" (student council).

Verification of internship in construction

In order to get accepted to examinations within the master degree programme, in particular to the first examination, an **internship in construction** of at least eight weeks has to be confirmed. The registration for this confirmation is done via the self-service function for students. This confirmation will be approved by the ”Praktikumsamt”. It is strongly recommended to obtain this confirmation in advance to the submission of module selection to the "Studierendenservice" (students' service), because it is a condition for transferring the module selection to the data base, there.

Changes in module offer

The offer of modules changes in the course of the semesters. Modules can be discontinued or added or the module examination may change. If possible, such changes are announced in the module handbook with sufficient time in advance, at latest at the beginning of the semester as from they are valid. Usually, it is valid that students started a module (s. selection and completion of a module) can complete this in that form as started. The respective examinations are provided onwards over a certain time period usually at least one semester after time of change. In general, a consultation with the examiner is recommended in such a case.

Further information

More detailed information about the legal and general conditions of the programme can be found in the examination regulation of the programme (as of 8.9.2009), and in the statutes for amendment of the examination regulation (as of 19.3.2012 und 28.3.2014 (Art. 34)):
`http://www.sle.kit.edu/imstudium/master-bauingenieurwesen.php`.

Contact persons

Dean of Study Affairs:

Prof. Dr. Peter Vortisch
Institute for Transport Studies, Bldg. 10.30, R. 305
consultation: on appointment
Phone: 0721/608-42255
Email: peter.vortisch@kit.edu

Programme Coordination:

PD Dr. Ulf Mohrlok
Department of Civil Engineering, Geo and Environmental Sciences, Bldg. 10.81, R. 329
consultation: on appointment
Phone: 0721/608-46517
Email: ulf.mohrlok@kit.edu

Master Examination Board:

Prof. Dr.-Ing. habil. Werner Wagner (chairperson)
Dipl.-Ing. Marc Fina (person in charge)
Institute for Structural Analysis, Bldg. 10.50, R. 205
consultation: Mo 14.00 – 15.00 h
Phone: 0721/608-42282
Email: marc.fina@kit.edu
Web: http://www.ibs.kit.edu/1049.php

Students' Advisory Service:

Dr.-Ing. Harald Schneider
Institute for Technology and Management in Construction, Bldg. 50.31, R. 008 (ground floor)
consultation: on appointment
Phone: 0721/608-43881
Email: harald.schneider@kit.edu

Fachschaft:

Students in Civil Engineering
Bldg. 10.81 (Altes Bauing. Geb.), R. 317.1 (3rd floor)
consultation: s. http://www.fs-bau.kit.edu
Phone: 0721/608-43895
Email: FSBau@lists.uni-karlsruhe.de
Web: http://www.fs-bau.kit.edu

Abbreviations

LP/CP	Credit Points	Leistungspunkte
LV	course	Lehrveranstaltung
P	practical training	Praktikum
Pj	project	Projekt
S	summer term	Sommersemester
Sem.	semester/term	Semester
ER/SPO	examination regulations	Studien- und Prüfungsordnung
KC/SQ	key competences	Schlüsselqualifikationen
HpW/SWS	contact hour per week	Semesterwochenstunde
E/Ü	excercise course	Übung
L/V	lecture	Vorlesung
W	winter term	Wintersemester

3 Actual Changes

Important changes are pointed out in this section in order to provide a better orientation. Although this process was done with great care, other/minor changes may exist.

not any more offered modules as of summer term 2016:

Turbulent Flows [bauiM2S20-NS1]

newly offered modules as of summer term 2016:

Modeling in Solid Mechanics [bauiM1S40-MODFEST]
Analysis of Turbulent Flows [bauiM2S32-NS3]
Building Information Modeling (BIM) [bauiM4S16-]

not any more or not any more in this form offered modules as of winter term 2016/17:

Dynamics of Water and Mass Transport in Watersheds [bauiM2S03-HY3]
Data Analysis and Environmental Monitoring [bauiM2S04-HY4]
Experimental Hydrology and Process Monitoring in Environmental Systems [bauiM2S05-HY5]
Studies of Development Projects in Water Resources Management [bauiM2S09-WB1]
Practical Use of Numerical Methods in Fluid Mechanics [bauiM2S10-WB2]
Experimental Techniques I: Small Scale Experiments [bauiM2S15-SM1]
Urban Water Management [bauiM2S25-SW2]
Water Quality of Surface Water and Groundwater [bauiM2S26-SW3]
Water Supply and Sanitation Systems and Plants [bauiM2S27-SW4]

changes of courses assigned to modules as of summer term 2016:

Space and Infrastructure [bauiM3S02-PLRAUMINF]:
LV Fundamentals of Geographic Information Systems for Modelling and Planning (6072201), 2 SWS, new

changed examinations and term papers in the modules as of summer term 2016:

Waterway Engineering [bauiM2S12-WB4]:
Student research project Waterway Engineering, attested, as examination prerequisite is new.

River Dynamics [bauiM2S13-WB5]:
Student research project Flow Behavior, attested, as examination prerequisite is new.

Environmental Fluid Mechanics [bauiM2S19-SM5]:
Module examination ”Environmental Fluid Mechanics”, graded, consists of a written examination.

Building Information Modeling (BIM) [bauiM4S16-]:
Module examination ”Building Information Modeling”, graded, consists of an examination of other type.

4 Modules

4.1 Modules Study Focus 1: Construction Engineering

Module: Design and Construction of Components in Reinforced Concrete [bauiM1P1-BEMISTB]

Coordination: L. Stempniewski
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Construction Engineering, Focus Geotechnical Engineering

ECTS Credits	Cycle	Duration
6	Every 2nd term, Winter Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6211701	Design and Construction of Components in Reinforced Concrete (p. 245)	L/E	2/2	W	6	L. Stempniewski

Learning Control / Examinations
graded:
examination Design and Construction of Components in Reinforced Concrete, written, 90 min., accord. ER/SPO § 4 par. 2 no. 1
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
courses Basics of Reinforced Concrete I+II (6200601, 6200615)

Qualification Goals
Based on the module “Basics in Reinforced Concrete” and cross-cutting modules such as “Structural Analyses” the students can recognise complex subjects of reinforced concrete and apply their methods. They can assign given problems to the respective design problems, conduct these subsequently and apply the current standards. Furthermore, the students can interpretate the results of a design and evaluate them with respect to their correctness and profitability.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up, examination preparation:	120 h
total:	180 h

Content

- Design and Construction of Components
- Design for Bending and Torsion
- Punching
- Discontinuities
- Truss Analogy
- Foundations

Remarks
Literature:
lecture notes

Module: Steel and Composite Structures [bauiM1P2-STAHLBAU]

Coordination: T. Ummenhofer
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Construction Engineering

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6212801	Steel and Composite Structures (p. 377)	L/E	2/2	S	6	T. Ummenhofer

Learning Control / Examinations
graded:
examination Steel and Composite Structures, written, 90 min., accord. ER/SPO § 4 par. 2 no. 1
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
course Basics in steel structures (6200504)

Qualification Goals
The students have knowledge in calculation of composite structures, in construction and design calculation of structures and building components made of thin-walled, cold formed steelwork components as well as basics in fire protection in steel constructions and basics in torsion of any cross section.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up, examination preparation:	120 h
total:	180 h

Content

- Basics of steel composite structures
- composite girders and composite columns designed for structural engineering and bridge construction
- fire protection in steel constructions
- the theory of torsion
- light-weight steel construction

Remarks
Literature:
lecture accompanying documents
DIN EN 1993 Bemessung und Konstruktion von Stahlbauten
DIN EN 1994 Bemessung und Konstruktion von Verbundbauten

Module: Surface Structures and Dynamics of Structures [bauiM1P3-FTW-BD]

Coordination: W. Wagner
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Construction Engineering

ECTS Credits	Cycle	Duration
6	Every 2nd term, Winter Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6214701	Surface Structures (p. 286)	L	2	W	3	W. Wagner
6215701	Dynamics of Structures (p. 233)	L	2	W	3	P. Betsch, T. Seelig

Learning Control / Examinations
graded:
partial examination Surface Structures, written, accord. ER/SPO § 4 par. 2 no. 1
partial examination Dynamics of Structures, written, accord. ER/SPO § 4 par. 2 no. 1
grading:
grade of module is defined by weighted average according credit points of grades of the partial examinations

Conditions
none

Recommendations
courses Structural Analysis I+II (6200401, 6200501)

Qualification Goals
Sub-module Surface Structures:
The students will learn the essential principles for surface structures (Theory, models, analytical and numerical solution procedures and error analysis). This is used as the basis for the design and construction of surface structures.
Sub-module Dynamics of Structures:
Analysis of structural vibrations of civil structures - reasons, concepts to reduce vibrations, mathematical models. The technical background will be illustrated by practical examples.

Workload
contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up, examination preparation:	120 h
total:	180 h

Content
Sub-module Surface Structures:

- Panel structures: Models and basic equations, PDE and BCs, analytical solutions, FE for rot. symmetry, FE-application to general panel structures, practical related solutions with truss models
- Plate structures: Models and basic equations, PDE and simplifications, analytical solutions, serial solutions, FE for rot.symmetry, FE-application to general plate structures, practical related solution strategies, elastic foundation and temperature, influence surfaces
- Introduction to shell structures

Sub-module Dynamics of Structures:

- Kinematics: Harmonic vibrations, Periodic vibrations (harmonic analysis), Representation in the frequency range, Non-periodic vibrations (spectra)

- Vibrations with one degree of freedom: Mechanical model for real structures, Non-damped and damped free oscillations, Transient oscillations (impacts), Harmonic excitation
- transfer function: Isolation, Filter effect, Periodical excitation (frequency range)
- Vibrations with 2 degrees of freedom: Free vibrations, Harmonic excitation, Passive mass-damper
- Vibrations with finite degrees of freedom: Equations of motion, Mode decomposition,
- natural frequencies: Different kind of excitation, Participation factor, Damping

Remarks
Literature sub-module Surface Structures:
lecture notes Flächentragwerke
Hake, E. , Meskouris, K. (2007): Statik der Flächentragwerke, Springer.
Altenbach, H., Altenbach, J., Naumenko, K. (1998): Ebene Flächentragwerke, Grundlagen der Modellierung und Berechnung von Scheiben und Platten, Springer.
Literature sub-module Dynamics of Structures:
lecture notes
P. Vielsack: Grundlagen der Baudynamik

Module: Bracing and Stability in Reinforced Concrete [bauiM1S01-STABISTB]

Coordination: L. Stempniewski
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Construction Engineering

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6211801	Bracing and Stability in Reinforced Concrete (p. 231)	L/E	2/2	S	6	L. Stempniewski

Learning Control / Examinations
graded:
examination Bracing and Stability in Reinforced Concrete, written, 90 min., accord. ER/SPO § 4 par. 2 no. 1
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
course Basics of Reinforced Concrete I (6200601),
module Design and Construction of Components in Reinforced Concrete [bauiM1P1-BEMISTB]

Qualification Goals
Based on the module "Basics in Reinforced Concrete", "Design and Construction of Components in Reinforced Concrete" and cross-cutting modules such as "Structural Analyses" the students can transfer and apply the methods from the module "Non-linear Analysis of Beam Structures" to the subject of reinforced concrete with respect to bracing and stability of buildings. Furthermore, the students can analyse and solve problems in special issues of reinforced concrete. Given problems can be assigned to the respective design problems, be conducted subsequently and the current standards can be applied.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up, examination preparation:	120 h
total:	180 h

Content

- Theory of Second Order
- Design of Slender Columns
- Bracing and Stability of Buildings
- Fatigue

Remarks
Literature:
lecture notes

Module: Basics of Prestressed Concrete [bauiM1S02-GDLSPANNB]

Coordination: L. Stempniewski
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Construction Engineering

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6211803	Basics of Prestressed Concrete (p. 303)	L/E	2/2	S	6	L. Stempniewski

Learning Control / Examinations
graded:
examination Basics of Prestressed Concrete, written, 90 min., accord. ER/SPO § 4 par. 2 no. 1
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
module Design and Construction of Components in Reinforced Concrete [bauiM1P1-BEMISTB]

Qualification Goals
The students know the basics and can reconstruct the functional principle of prestressed concrete. The students understand the importance of already obtained knowledge in the subjects “Strength of Materials”, “Structural Anlsysis” and “Design and Construction of Components in Reinforced Concrete” and can transfer these to the methods in prestressed concrete. Design of of buildings in structural engineering can be conducted safely and economically by reference to current standards.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up, examination preparation:	120 h
total:	180 h

Content

- Types and Systems for Prestressing
- Loss of Prestressing Forces caused by friction
- Creep, Shrinkage and Relaxation

Remarks
Literature:
lecture notes

Module: Solid Construction Bridges [bauiM1S03-MASSBRUE]

Coordination: L. Stempniewski
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Construction Engineering

ECTS Credits	Cycle	Duration
6	Every 2nd term, Winter Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6211901	Solid Construction Bridges (p. 326)	L/E	2/2	W	6	L. Stempniewski

Learning Control / Examinations
graded:
examination Solid Construction Bridges, written, 90 min.,accord. ER/SPO § 4 par. 2 no. 1
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
module Basics of Prestressed Concrete [bauiM1S02-GDLSPANNB]

Qualification Goals
Based on the module “Basics of Prestressed Concrete” the students understand the peculiarity of bridge constructions. In addition, they understand the principle procedure of the design of solid construction bridges and can conduct these. A special focus is laid on the differences to classical structural engineering and the introduction of current standards. The students receive a holistic impression of the desing regarding span, architecture, environment and design.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up, examination preparation:	120 h
total:	180 h

Content

- Equipment of Bridges
- Load Assumptions
- Construction Methods
- Types of Supports
- Fatigue

Remarks
Literature:
lecture notes

Module: Applied Dynamics of Structures [bauiM1S04-BAUDYN]

Coordination: L. Stempniewski
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Construction Engineering

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	2

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6211805	Applied Dynamics of Structures (p. 348)	L/E	1/1	S	3	L. Stempniewski
6211903	Earthquake Engineering (p. 273)	L/E	1/1	W	3	L. Stempniewski

Learning Control / Examinations
graded:
examination Applied Dynamics of Structures, oral, 30 min., accord. ER/SPO § 4 par. 2 no. 2
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
none

Qualification Goals
The students deepen their knowledge of the modules “Dynamics” and “Surface Structures and Dynamics of Structures” in the field of dynamics of structures and extent them by knowledge in the field of earthquake engineering.
Course Applied Dynamics of Structures:
Based on modules “Dynamics” and “Surface Structures and Dynamics of Structures” the students learn the practical procedure for the evaluation of the dynamic behaviour of structures. At this the three important interactions mankind - machinery - wind are at the forefront.
Course Earthquake Engineering:
Based on material science and the modules “Geology in Civil Engineering” and “Bracing and Stability in Reinforced Concrete “ the students learn the basic seismological relationships regarding soil-building-interaction. The students master the basics of the design of structures by impact of earthquake loads.

Workload
contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up, examination preparation:	120 h
total:	180 h

Content
- basics of Dynamics of Structures
- man-made excited vibrations and counteractions
- machinery excited vibrations and counteractions
- wind excited vibrations and counteractions
- seismic basics
- earthquake scales, earthquake waves, analysis
- determination of response spectra

- bearing capacity and ductility
- determination of inelastic response spectra

Remarks
Literature:
Stempniewski, L.; Haag, B. (2010): Baudynamik-Praxis, Beuth

Module: Anchorage in Concrete [bauiM1S05-BEFTECH]

Coordination: L. Stempniewski
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Construction Engineering

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	2

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6211807	Anchorage in Concrete I (p. 242)	L/E	1/1	S	3	W. Fuchs
6211905	Anchorage in Concrete II (p. 243)	L/E	1/1	W	3	W. Fuchs

Learning Control / Examinations
graded:
examination Anchorage in Concrete, oral, accord. ER/SPO § 4 par. 2 no. 2
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
none

Qualification Goals
Comprehension of the Importance of using the right Anchorage System in a specific case and in the right Way

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up, examination preparation:	120 h
total:	180 h

Content

- Anchorage Systems
- Basics
- Load Bearing Behavior of different Systems
- Construction

Remarks
Literature:
Eligehausen, Mallée: “Befestigungstechnik im Beton- und Mauerwerksbau”

Module: Material Science, Welding and Fatigue [bauiM1S06-SCHWEISSEN]

Coordination: P. Knödel
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Construction Engineering

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6212803	Material Science, Welding and Fatigue (p. 379)	L/E	3/1	S	6	P. Knödel

Learning Control / Examinations
graded:
examination Material science, welding and fatigue, written, 90 min., accord. ER/SPO § 4 par. 2 no. 1
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
course Theory of Building Materials (6200206), Basics in Steel Structures (6200504)

Qualification Goals
The students can

- assess the usability of different steel materials for different requirements,
- design constructionally weld joints and define requirements for their production and quality assurance,
- differentiate the usability of different welding techniques,
- design and construct steel components stressed by fatigue,
- evaluate failures of steel components

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up:	60 h
examination preparation and examination:	60 h
total:	180 h

Content

- materials: denotation of steels, physical and technological properties
- fatigue: influencing parameters, calculation concepts
- welding technology: welding techniques, welding instructions
- quality management: building law, implementation categories, competences
- fracture toughness: linear fracture mechanics
- desing of welded constructions: internal stresses, welding distortion
- material testing: non-destructive testing, material and weld joint failures

Remarks
Literature:
lecture accompanying documents
DIN EN 1993-1-9: Bemessung und Konstruktion von Stahlbauten - Teil 1-9: Ermüdung
DIN EN 1993-1-10: Bemessung und Konstruktion von Stahlbauten - Teil 1-10: Stahlsortenauswahl im Hinblick auf Bruchzähigkeit und Eigenschaften in Dickenrichtung
DIN EN 1090: Ausführung von Stahltragwerken und Aluminiumtragwerken

Module: Construction of Steel and Composite Bridges [bauiM1S07- STAHLBRÜ]

Coordination: T. Ummenhofer
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Construction Engineering

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6212901	Construction of Steel and Composite Bridges (p. 378)	L/E	2/2	S	6	T. Ummenhofer

Learning Control / Examinations
graded:
examination Construction of Steel and Composite Bridges, written, 60 min., accord. ER/SPO § 4 par. 2 no. 1
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
course Basics in Steel Structures (6200504),
module Steel and Composite Structures [bauiM1P2-STAHLBAU]

Qualification Goals
The students have knowledge in design, construction, design calculation and assembly of steel and steel composite bridges.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up, examination preparation:	120 h
total:	180 h

Content

- Historical development
- design basics
- pavement constructions
- 3d-bearing capacity of steel-bridges
- main beams in solid-webbed constructions
- main beams in composite constructions
- main beams in framework construction
- bridge bearings
- assembly process

Remarks
Literature:
lecture accompanying documents

DIN Fachbericht 101: Einwirkungen auf Brücken
DIN Fachbericht 103: Stahlbrücken
DIN Fachbericht 104: Verbundbrücken

Module: Hollow Section Structures [bauiM1S08-HOHLPROFIL]

Coordination: S. Herion
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Construction Engineering

ECTS Credits	Cycle	Duration
6	Every 2nd term, Winter Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6212903	Hollow Section Structures (p. 308)	L/E	2/2	W	6	S. Herion

Learning Control / Examinations
graded:
examination Hollow Section Structures, oral, 30 min., accord. ER/SPO § 4 par. 2 no. 2
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
course Basics in Steel Structures (6200504)

Qualification Goals
The students have knowledge in construction and dimensioning of predominantly static and of non predominantly static stressed constructions made of hollow sections as well as their connections.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up, examination preparation:	120 h
total:	180 h

Content

- Appliance in steel- and bridge engineering
- welded joints
- cast joints
- fatigue behavior
- calculation examples

Remarks
Literature:
lecture notes “Hollow section structures”, Karlsruher Institut für Technologie (KIT), Versuchsanstalt für Stahl, Holz und Steine

Module: Glass, Plastic and Cable Structures [bauiM1S09- GlaKunSe]

Coordination: D. Ruff
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Construction Engineering

ECTS Credits	Cycle	Duration
6	Every 2nd term, Winter Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6212905	Glass, Plastic and Cable Structures (p. 297)	L/E	3/1	W	6	D. Ruff

Learning Control / Examinations
graded:
examination Glass, Plastic and Cable Structures, oral, 30 min., accord. ER/SPO § 4 par. 2 no. 2
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
course Basics in Steel Structures (6200504)

Qualification Goals
The students have knowledge in material characteristics of glass construction materials, in glass-steel constructions, their structural behaviour and the check of load-carrying capacity. The students have knowledge in manufacturing, characteristics and processing capacities of plastics, as well as types of constructions and design rules. The students have knowledge of assembly and the characteristics of cables, high-strength tension members as well as types of constructions and design rules of cable structures.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up, examination preparation:	120 h
total:	180 h

Content

- Glass in civil engineering
- construction details of glass, design calculation glass structures
- plastics in civil engineering, construction details
- design of wires, cables, cords
- end-connections, clampings, buffles
- static and dynamic structural behaviour
- construction and design calculation

Remarks
Literature:
lecture accompanying documents
Siebert, G., Maniatis, I: Tragende Bauteile aus Glas: Grundlagen, Konstruktion, Bemessung, Beispiele. Verlag

Ernst & Sohn, Berlin, 2012.
Technische Regeln für die Verwendung von linienförmig gelagerten Verglasungen (TRLV). Deutsches Institut für Bautechnik, Berlin, 2006.
Technische Regeln für die Bemessung und die Ausführung punktförmig gelagerter Verglasungen (TRPV). Deutsches Institut für Bautechnik, Berlin, 2006.
Technische Regeln für die Verwendung von absturzsichernden Verglasungen (TRAV). Deutsches Institut für Bautechnik, Berlin, 2003
DIN 18008 Teil 1 bis Teil 5: Glas im Bauwesen. Beuth-Verlag, Berlin, 2010 bis 2013.
Domininghaus, H. et. al.: Kunststoffe: Eigenschaften und Anwendungen. Springer-Verlag, Berlin, 2012.
Hellerich, W.: Werkstoff-Führer Kunststoffe. Springer-Verlag, Berlin, 2010.
DIN 18800-1: 2008-11: Stahlbauten – Teil 1: Bemessung und Konstruktion. Beuth-Verlag, Berlin.
DIN EN 1993-1-11: 2010-12: Eurocode 3: Bemessung und Konstruktion von Stahlbauten – Teil 1-11: Bemessung und Konstruktion von Tragwerken mit Zuggliedern aus Stahl. Beuth-Verlag, Berlin.
Feyrer, K: Drahtseile: Bemessung, Betrieb, Sicherheit. Springer-Verlag, Berlin, 2001.
Seidel, M: Textile Hüllen - Bauen mit biegeweichen Tragelementen: Materialien, Konstruktion, Montage. Verlag Ernst & Sohn, Berlin, 2008.

Module: Structures in Steel and Timber [bauiM1S10-BAUING-TSH]

Coordination: T. Ummenhofer
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Construction Engineering

ECTS Credits	Cycle	Duration
6	Every 2nd term, Winter Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6212907	Supporting Steel Structures (p. 392)	L/E	1/1	W	3	T. Ummenhofer
6213901	Supporting Timber Structures (p. 391)	L/E	2	W	3	M. Frese

Learning Control / Examinations
graded:
examination Structures in Steel and Timber, oral, 60 min., accord. ER/SPO § 4 par. 2 no. 2
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
course Basics in Steel Structures (6200504),
modules Steel and Composite Structures [bauiM1P2-STAHLBAU], Timber Structures [bauiM1S12-BAUING-HB]

Qualification Goals
The students can name typical supporting structures for building construction (for steel and timber) and the construction and connecting elements required for production. They can describe, model correctly and outline analytically the supporting effect of constructions and their single elements. They can identify assets and drawbacks of constructions, and they are able to develop design options under given conditions, to assess these and based on this to opt for reasonable design and construction solutions.
Structures in Steel:
By attendance of this course the student can strengthen their thinking in alternative design concepts. By developing different design variants in paralleland and their rough calculation the students learn a creative and concurrently targeted selection of constructive realizations. The collective processing of the term paper together with students of architecture simulates the interplay during the design process by which the students promote their skills in assessing the subject-specific requirements and can develop solutions in common.
Structures in Timber:
The students can describe, identify and evaluate the most important damages in timber structures and their reasons. They can derive thereof that creativity, accuracy and complex cross-linked thinking prevent damages during constructing and designing supporting timber structures. They can select flexibly amongst analytical and pragmatical solutions specific for timber structures and apply these, so that developed, constructed and designed timber supporting structures by themselves are reliable, durable, usable and by that fit for the future. They can classify the importance of damages for research and science and address in this respect incentives for the engineering progress.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lecture Supporting Steel Structures, adjustment discussion:	15 h
lecture Supporting Timber Structures:	30 h
independent study:	
working on design project Supporting Steel Structure, preparation of final presentation:	80 h
preparation and follow-up lecture Supporting Timber Structures:	45 h
examination preparation and examination:	15 h
total:	185 h

Content

Structures in Steel:

- Structure design and constructive detail design in structural- and bridge engineering

Structures in Timber:

- Classification of damages
- definitions of the sphere, in which damages and failures occur
- damages and failures that are typical for timber structures

Remarks

Literature Structures in Steel:
lecture accompanying documents
Literature Structures in Timber:
lecture accompanying documents

Module: Preservation of Steel and Timber Structures [bauiM1S11-BAUING-BSH]

Coordination: R. Görlacher
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Construction Engineering

ECTS Credits	Cycle	Duration
6	Every 2nd term, Winter Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6212909	Preservation of Steel Structures (p. 240)	L	2	W	3	T. Ummenhofer
6213903	Preservation of Timber Structures (p. 239)	L/E	2	W	3	R. Görlacher

Learning Control / Examinations
graded:
examination Building Preservation of Steel and Timber Structures, written, 90 minutes (45 min. each), accord. ER/SPO § 4 par. 2 no. 1
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
module Timber Structures (bauiM1S12-BAUING-HB)

Qualification Goals
Preservation of Steel Structures:
The students have knowledge in investigation of old building fabric, in character- istics of old steel and cast productions made of iron materials, in typical defects, to load bearing evaluation and for elimination of damages or for reinforcement as well as investigation of remaining service life of predominantly static- and non-predominantly static stressed constructions.
Preservation of Timber Structures:
The students know the historical development of timber structures as well as load and force distribution in historical timber constructions. They are aware of techniques of inspection and evaluation of timber constructions. The students are able to detect decay and damage as well as determine timber qualities (in-situ strength grading of timber). They are aware of calculation of carpentry joints. They know particularities in designing a historical timber roof structure. The students know methods for repairing and strengthening for the conservation of cultural heritage taking into consideration carpentry and engineered solutions.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up, examination preparation:	120 h
total:	180 h

Content
Preservation of Steel Structures:

- Old steels
- cast materials
- investigation of constructions and building parts

- damage-mechanisms
- investigation of bearing capacity
- maintenance procedures

Preservation of Timber Structures:

- History of timber constructions: Simple timber constructions, development of timber-frame construction and timber roof structures, history of timber bridges
- Inspection and evaluation of an existing timber construction: Limit state design, strength of timber used in historical constructions, inspection of built-in timber.
- Calculation of carpentry joints.
- Design of historical timber constructions: Consideration of ductility of the joints, modelling (plane - spatial systems).
- Methods of repair and strengthening: Concepts for the conservation of cultural heritage, repair, strengthening, additional load bearing structures

Remarks
Literature Preservation in Steel Structures:
lecture accompanying documents
Literature Preservation of Timber Structures:
Blaß, H.J.; Görlacher, R.; Steck, G. (Ed.) Holzbauwerke STEP 1 - Bemessung und Baustoffe. Fachverlag Holz, Düsseldorf, 1995 (ISSN-Nr. 04462114)
Görlacher, R.: Historische Holzbauwerke. Untersuchen, Berechnen und Instandsetzen. Karlsruhe 1999. ISBN 3-934540-01-5
lecture notes „Bauwerkserhaltung im Holzbau“, Lehrstuhl für Ingenieurholzbau und Baukonstruktionen, Universität Karlsruhe (TH)

Module: Timber Structures [bauiM1S12-BAUING-HB]

Coordination: H. Blaß
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Construction Engineering

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6213801	Timber Structures (p. 310)	L/E	2/2	S	6	H. Blaß

Learning Control / Examinations
graded:
examination Timber Structures, written, 90 min., accord. ER/SPO § 4 par. 2 no. 1
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
none

Qualification Goals
The students are able to design composite glued or mechanically jointed components as well as special connection details. They have knowledge about detailing for durability and fire resistance of timber. The students are qualified to design timber structures.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up, examination preparation:	120 h
total:	180 h

Content

- Elements: Mechanically jointed beams, stressed skin panels, tapered, curved and pitched cambered beams
- Joints: Moment resisting connections, multiple shear plane connections with dowel-type fasteners, joist hangers and framing anchors, reinforced connections
- Details: Tension perpendicular to the grain in joints, notched beam and holes in glulam beams, fire resistance, detailing for durability, durability - preservative treatment

Remarks
Literature:
Blaß, H.J.; Görlacher, R.; Steck, G. (Ed.) Holzbauwerke STEP 1 - Bemessung und Baustoffe. Fachverlag Holz, Düsseldorf, 1995 (ISSN-Nr. 04462114)

Module: Timber and Wood-based Materials [bauiM1S13-BAUING-HHW]

Coordination: H. Blaß
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Construction Engineering

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6213803	Timber and Wood-based Materials (p. 309)	L/E	2/2	S	6	C. Sandhaas

Learning Control / Examinations
graded:
examination Timber and Wood-based Materials, oral, 30 min., accord. ER/SPO § 4 par. 2 no. 2
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
module Timber Structures [bauiM1S12-BAUING-HB]

Qualification Goals
The students can utilize the building material timber and its derived products in civil engineering appropriately and are aware of possible problems caused by the hygroscopic, anisotropic, heterogeneous and biological properties of wood. They developed methods to handle the variable properties of timber in construction practise. The students can develop different timber-based materials target-oriented by themselves based on wood-anatomic, wood-physical and bilogical knowledge.
Their questionable and critical cogitation is educated with respect to well realized, robust and reliable details of timber construction and the students can transfer problems from civil engineering to other context. Based on their material understanding the students can analyse and evaluate the material-specific quality of construction details.
Another comptence after completing the modul is the ability to read, analyse and comprehend coherently and critically English-language technical texts. A short scientific article is developed by teamwork and presented in English.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up, term paper with presentation:	60 h
examination preparation and examination:	60 h
total:	180 h

Content

- wood anatomy
- wood characteristics
- wood physics
- durability
- drying and strength grading of wood
- solid timber

- engineered wood products
- glued laminated timber
- wood-based panels

Remarks
Literature:
Lecture notes „Holz und Holzwerkstoffe“, Lehrstuhl für Holzbau und Baukonstruktionen, Karlsruher Institut für Technologie (in German)

Module: Non-linear Analysis of Beam Structures [bauiM1S14-NILI-STAB]

Coordination: W. Wagner
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Construction Engineering

ECTS Credits	Cycle	Duration
6	Every 2nd term, Winter Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6214702	Non-linear Analysis of Beam Structures (p. 340)	L/E	2/2	W	6	I. Münch

Learning Control / Examinations
graded:
examination Non-linear Analysis of Beam Structures, written, 90 min., accord. ER/SPO § 4 par. 2 no. 1
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
courses Structural Analysis I+II (6200401, 6200501)

Qualification Goals
Students will learn the main essential principles of the nonlinear analysis of beam structures (ultimate load design, II. Order theory, extensions and error analysis). This is used as the basis for the design and construction of structures.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up, examination preparation:	120 h
total:	180 h

Content

- Material Nonlinearity: Basics of ultimate load design, plastic hinge theory I. O., incremental and direct calculation of the ultimate load, limit value theorems
- Geometrical Nonlinearity: PDE of II. O. theory , VV, imperfections, iteration procedures, stability problems
- Geometrical and Material Nonlinearity: Plastic hinge theory of II. O.

Remarks
Literature:
lecture notes Nichtlineare Modellierung von Stabtragwerken

Module: Computational Analysis of Structures [bauiM1S15-CTWM]

Coordination: W. Wagner
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Construction Engineering

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6214801	Computational Analysis of Structures (p. 259)	L/E	2/2	S	6	W. Wagner

Learning Control / Examinations
graded:
examination Computational Analysis of Structures, oral, 30 min., accord. ER/SPO § 4 par. 2 no. 2
attested:
student research paper as examination prerequisite, accord. ER/SPO § 4 par. 2 no. 3, definition of a project available from lecturer
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
module Surface Structures and Dynamics of Structures [bauiM1P3-FTW-BD]

Qualification Goals
Students will learn the essential principles for the computational modeling of structures (FE-Models for Beam and Surface Structures, Modeling of practical problems, error analysis). This allows the computer aided design and construction of structures.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation of student research project:	40 h
preparation and follow-up, examination preparation:	80 h
total:	180 h

Content

- Numerical Modeling of 2D/3D beams, surface structures
- Application to 2D/3D beams, surface structures
- Further Problem: Exactness and improvement of the solutions, folded plates, rotational shells, adaptive mesh generation, stationary heat conduction 2D/3D, further problems of building physics, commercial software for design and construction

Remarks
Literature:
lecture notes Computergestützte Tragwerksmodellierung
Krätzig, W.B., Basar, Y. (1997): Tragwerke 3 - Theorie und Anwendung der Methode der Finiten Elemente, Springer.
Werkle, H. (2007): Finite Elemente in der Baustatik, Statik und Dynamik der Stab- und Flächentragwerke, Vieweg.

Module: FE-Applications in Practical Engineering [bauiM1S16-FE-PRAXIS]

Coordination: W. Wagner
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Construction Engineering

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6214803	FE-Applications in Practical Engineering (p. 281)	L/E	2/2	S	6	W. Wagner

Learning Control / Examinations
graded:
examination FE-Applications in Practical Engineering, oral, 30 min., accord. ER/SPO § 4 par. 2 no. 2
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
module Computational Analysis of Structures [bauiM1S15-CTWM]

Qualification Goals
Students will enhance their skills in computer aided modeling of structures by using commercial FE-codes for practical civil engineering projects.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up, examination preparation:	120 h
total:	180 h

Content

- Use of different commercial software for the modeling of beam- and surface structures
- structural analysis and design
- discussion of approximation behaviour at examples
- analytical comparative calculations
- software comparisons
- control options

Remarks
Literature:
lecture notes Computergestützte Tragwerksmodellierung

Module: Shell Structures and Stability of Structures [bauiM1S17-STABISHELL]

Coordination: W. Wagner
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Construction Engineering

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6214805	Shell Structures (p. 359)	L/E	1/1	S	3	I. Münch
6214807	Stability of Structures (p. 373)	L/E	1/1	S	3	I. Münch

Learning Control / Examinations
graded:
examination Shell Structures and Stability of Structures, oral, 40 min., accord. ER/SPO § 4 par. 2 no. 2
attested:
student research paper as examination prerequisite, accord. ER/SPO § 4 par. 2 no. 3, definition of a project available from lecturer
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
course Surface Structures (6214701)

Qualification Goals
Students will learn the theory and analytical and computational modeling of shell structures and of stability problems.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation of student research project:	40 h
preparation and follow-up, examination preparation:	80 h
total:	180 h

Content
Shell Structures:

- Examples in nature and technique
- membrane- and bending theory of rotational shells
- analytical solutions
- KV for rotational shells
- FE-modeling of shells
- stability of shell structures

Stability of Structures:

- math., stat. and physical basics of stability theory
- sensitivity, imperfections

- analytical solutions
- calculations for 2D/3D-beam-, plate- and shell structures
- numerical models
- path following, bifurcation, practical examples

Remarks
Literature:
lecture notes Schalentragwerke
lecture notes Stabilität von Tragwerken

Module: Numerical Methods in Structural Analysis [bauiM1S18-FEM-BS]

Coordination: W. Wagner
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Construction Engineering

ECTS Credits	Cycle	Duration
6	Every 2nd term, Winter Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6214901	Numerical Methods in Structural Analysis (p. 344)	L/E	2/2	W	6	I. Münch

Learning Control / Examinations
graded:
examination Numerical Methods in Structural Analysis, oral, 30 min., accord. ER/SPO § 4 par. 2 no. 2
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
module Computational Analysis of Structures [bauiM1S15-CTWM]

Qualification Goals
Students will develop main parts of a finite element program for beam and surface structures on the basis of the lectures in Structural Analysis

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up, examination preparation:	120 h
total:	180 h

Content

- Development of a program for truss structures with VBA
- input and output of data
- element stiffness matrices
- transformation
- solving of equations
- calculation of stress resultants
- visualisation
- extension to surface structures
- numerical integration for surface structures
- demonstraion of the limits of finite element method for approximation with low interpolation functions
- elimination of numerical stiffening effects by means of spezific integration and interpolation methods

Remarks
Literature:
lecture notes Computergestützte Tragwerksmodellierung

Module: Non-linear Analysis of Surface Structures [bauiM1S19-NILI-FTW]

Coordination: W. Wagner
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Construction Engineering

ECTS Credits	Cycle	Duration
6	Every 2nd term, Winter Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6214903	Non-linear Analysis of Surface Structures (p. 339)	L/E	2/2	W	6	W. Wagner

Learning Control / Examinations
graded:
examination Non-linear Analysis of Surface Structures, oral, 30 min., accord. ER/SPO § 4 par. 2 no. 2
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
course Surface Structures (6214701),
module Computational Analysis of Structures [bauiM1S15-CTWM]

Qualification Goals
Students will learn the essential principles of nonlinear analysis of surface structures.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up, examination preparation:	120 h
total:	180 h

Content

- Geometric nonlinear models of surface structures
- nonlinear material models for thin structures
- analytical and numerical surface structure analysis
- introduction to the modelling of shell structures
- application of stability and dynamic problems
- modelling of laminated structures
- practial examples

Remarks
Literature:
lecture notes

Module: Basics of Finite Elements [bauiM1S20-GRUNDFE]

Coordination: P. Betsch
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Construction Engineering

ECTS Credits	Cycle	Duration
6	Every 2nd term, Winter Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6215901	Basics of Finite Elements (p. 305)	L/E	2/2	W	6	C. Hesch

Learning Control / Examinations
graded:
examination Basics of Finite Elements, oral, 30 min., accord. ER/SPO § 4 par. 2 no. 2
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
none

Qualification Goals
The students are familiar with the structure and the functionality of FE codes. They know variational principles of FEM as well as the Lagrangian element family of different order of projection for one-dimensional, planar and spatial problems in the fields of linear strength of materials and heat transport. They know, that it is an approximate solution method for boundary value problems, and they are aware of its limits. They are prepared for the useful application of commercial FE codes, so that an efficient training is guaranteed.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up, examination preparation:	120 h
total:	180 h

Content
The theoretical principles as well as the numerical implementation of Finite Element Methods are discussed. A one-dimensional problem is considered for the demonstration of the principle procedure and the major properties of the method in a relative simple and clear manner.
Beside the one-dimensional model problem two- and three-dimensional boundary value problems of heat transport and elasticity theory are discussed. The numerical implementation is carried out by means of MATLAB, respectively. Starting with differential equations describing the problem the integral formulation of the boundary value problem is derived by means of the variational calculus as characteristic for the method. The major terms are discussed such as weak form of the boundary value problem, test function, projection function, continuity requirements, domain discretization, Galerkin approximation, stiffness matrix, assembly, iso-parametric concept, numerical integration and accuracy of finite element approximation.

Remarks
Literature:
[1] Cook, Malkus, Plesha: Concept and Applictaions of Finite Element Analysis, 1989.
[2] Hughes: The Finite Element Method, 1987.
[3] Zienkiewicz, Taylor: The Finite Element Method, Volume 1,2 & 3, 2000.
[4] Bathe: Finite-Elemente-Methoden, 2001.

Module: Fracture and Damage Mechanics [bauiM1S21-BRUCHMECH]

Coordination: T. Seelig
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Construction Engineering

ECTS Credits	Cycle	Duration
6	Every 2nd term, Winter Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6215903	Fracture and Damage Mechanics (p. 257)	L/E	2/2	W	6	T. Seelig

Learning Control / Examinations
graded:
examination Fracture and Damage Mechanics, oral, 45 min., accord. ER/SPO § 4 par. 2 no. 2
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
course Introduction to Continuum Mechanics (6200607)

Qualification Goals
Fundamental concepts and methods of fracture mechanics and damage mechanics are presented which are used in the analysis of structures containing cracks as well as in the modelling of complex material behaviour. Besides the continuum mechanical description, material specific aspects are also discussed

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up, examination preparation:	120 h
total:	180 h

Content

- phenomenology and mechanisms of fracture
- linear elastic fracture mechanics (crack tip fields, K-concept, energy balance, J-integral, small scale yielding)
- elastic plastic fracture mechanics (Dugdale model, HRR-field, J-controlled crack growth)
- dynamic fracture mechanics (dynamic loading, fast running cracks)
- micromechanics of heterogeneous solids (defects and eigenstrain, RVE-concept, homogenization)
- damage mechanics (mechanisms of brittle and ductile damage, micromechanical and phenomenological models, softening and localization)

Remarks
Literature:
[1] Anderson, T.L.: Fracture Mechanics - Fundamentals and Application. CRC Press, 1995
[2] Gdoutos, E.E.: Fracture Mechanics - An Introduction. Kluwer Acad. Publ., 1993
[3] Gross, D., Seelig, Th: Bruchmechanik - mit einer Einführung in die Mikromechanik, Springer, 2007
[4] Knott, J.F.: Fundamentals of Fracture Mechanics. Butterworth, 1973

[5] Krajcinovic, D.: Damage Mechanics. Elsevier, 1996
[6] Mura, T.: Micromechanics of Defects in Solids. Martinus Nijhoff Publishers, 1982
[7] Nemat-Nasser, S., Hori, M.: Micromechanics - Overall Properties of Heterogeneous Materials. North-Holland, 1993

Module: Material Models in Solid Mechanics [bauiM1S22-MATTHEO]

Coordination: T. Seelig
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Construction Engineering

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6215801	Material Models in Solid Mechanics (p. 230)	L/E	2/2	S	6	T. Seelig, C. Hesch

Learning Control / Examinations
graded:
examination Material Models in Solid Mechanics, oral, 45 min., accord. ER/SPO § 4 par. 2 no. 2
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
course Introduction to Continuum Mechanics (6200607)

Qualification Goals
Numerous tasks in engineering require a theoretical description of a material's response beyond the elastic range. The course focuses on the continuum mechanical description of various kinds of inelastic material behavior. Besides the different phenomena their physical origins are also discussed.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up, examination preparation:	120 h
total:	180 h

Content

- general purpose of material theories and constitutive laws
- elasticity (isotropic / anisotropic material models)
- phenomenology of inelastic material behavior (residual deformation, rate-dependence / creep, plastic incompressibility / dilatancy, pressure-dependence / independence, damage)
- concepts of constitutive modeling (internal variables, yield condition, flow rule, hardening laws, incremental constitutive equations)
- material theories: viscoelasticity, plasticity, viscoplasticity
- applications (metals, geomaterials, concrete, thermoplastic polymers, wood)

Remarks
Literature:
[1] Chen, W.F., Hahn, D.J.: Plasticity for Structural Engineers. Springer, 1988
[2] de Souza Neto, E.A., Peric, D., Owen, D.R.J.: Computational Methods for Plasticity. Wiley, 2008
[3] Doghri, I.: Mechanics of Deformable Solids. Springer, 2000

[4] Khan, A.S., Huang, S.: Continuum Theory of Plasticity. Wiley,1995
[5] Lemaitre, J., Chaboche, J.L.: Mechanics of Solid Materials. Cambridge University Press, 1990
[6] Lubliner, J.: Plasticity Theory. Macmillan, 1990; Dover, 2008
[7] Seelig, Th.: Anwendungsorientierte Materialtheorien. Skript zur Vorlesung

Module: Concrete Construction Technology [bauiM1S24-BETONTECH]

Coordination: M. Haist
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Construction Engineering

ECTS Credits	Cycle	Duration
6	Every 2nd term, Winter Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6211809	Concrete Technology (p. 249)	L/E	3	W	4,5	M. Haist, V. Kvitsel, H. Müller
6211810	Deformation and Fracture Processes (p. 408)	L	1	W	1,5	H. Müller, E. Kotan

Learning Control / Examinations
graded:
examination Concrete Construction Technology, oral, 30 min., accord. ER/SPO § 4 par. 2 no. 2
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
none

Qualification Goals
see German version

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up, examination preparation:	120 h
total:	180 h

Content
see German version

Module: Durability and Service Life Design [bauiM1S25-DAUERLEB]

Coordination: J. Eckhardt
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Construction Engineering

ECTS Credits	Cycle	Duration
6	Every 2nd term, Winter Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6211907	Corrosion Processes and Life Time (p. 318)	L/E	3	W	4,5	J. Eckhardt, M. Haist
6211908	Analytic Methods (p. 225)	L	1	W	1,5	J. Eckhardt, M. Vogel

Learning Control / Examinations
graded:
examination Durability and Service Life Design, oral, 30 min., accord. ER/SPO § 4 par. 2 no. 2
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
course Building Chemistry (6200108)

Qualification Goals
see German version

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up, examination preparation:	120 h
total:	180 h

Content
see German version

Module: Building Preservation of Concrete and Masonry Constructions [bauiM1S26-BBM]

Coordination: E. Kotan
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Construction Engineering

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6211811	Protection, Rehabilitation and Reinforcement of Concrete and Masonry Constructions (p. 362)	L/E	2/1	S	4,5	E. Kotan, H. Müller
6211813	Building Analysis (p. 238)	L	1	S	1,5	E. Kotan, M. Vogel

Learning Control / Examinations
graded:
examination Building Preservation of Concrete and Masonry Constructions, oral, 30 min., accord. ER/SPO § 4 par. 2 no. 2
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
none

Qualification Goals
After successful completion of the module, the students have detailed knowledge about the relevant causes and processes of degradation in concrete and masonry constructions. Thus they are able to take appropriate measures to enhance the durability of solid buildings and to plan and execute effective measures to repair damaged concrete and masonry constructions. Moreover the students have also the knowledge about the main aspects and basic techniques of building reinforcement.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up, examination preparation:	120 h
total:	180 h

Content
This course provides fundamental knowledge of the possibilities to preserve concrete and masonry constructions. Besides an introduction into the characteristics of masonry, plaster, concrete and reinforced concrete structures, various damage patterns and their origins are discussed. Based on the knowledge of the essential damage processes, efficient measures for the increase of the durability are described, which include material and constructional precautions as well as additional preventive measures. Furthermore the course focuses on the repair of already damaged concrete and masonry constructions. In this connection different research methods for the analysis of damages are presented and various possibilities are shown to predict the time-development of these damages. Finally repair materials as well as procedures are described which are necessary for the realization of a durable repair measure. A further main part of the course covers the different possibilities of an additional reinforcement of concrete and masonry constructions. Applicable materials and their characteristics in design and construction are introduced and discussed. In the accompanying exercises the subject matter shall independently be developed

and the practical realization will be practised by means of several design problems.

Remarks
Literature:
hand-outs
[1] Blaich, J.: Bauschäden - Analyse und Vermeidung; EMPA; Stuttgart, 1999
[2] Pfefferkorn, W.: Rißschäden an Mauerwerk, Ursachen erkennen - Rißschäden vermeiden; Stuttgart, IRB Verlag, 1994
[3] Reichert, H.: Konstruktiver Mauerwerksbau, Bildkommentar zur DIN 1053-1, Rudolf Müller Verlag, Köln, 1999
[4] Ruffert, G.: Ausbessern und Verstärken von Betonbauteilen; 2. Aufl.; Beton Verlag, 1982
[5] SIVV - Handbuch: Schützen, Instandsetzen, Verbinden und Verstärken von Betonbauteilen; Verarbeiten von Kunststoffen im Betonbau beim Deutschen Beton- und Bautechnik-Verein E.V.; IRB Verlag, Stuttgart, 2008
[6] Stark, J.; Wicht, B.: Dauerhaftigkeit von Beton - Der Baustoff als Werkstoff, Hrsg.: Bauhaus-Univ. Weimar, F.A. Finger- Institut für Baustoffkunde -FIB-; 2001
[7] Tausky, R.: Betontragwerke mit Außenbewehrung; Birkhäuser Verlag, Basel, 1993

Module: Building Physics I [bauiM1S27-BAUPH-I]

Coordination: E. Kotan
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Construction Engineering

ECTS Credits	Cycle	Duration
6	Every 2nd term, Winter Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6211909	Applied Building Physics (p. 227)	L	2	W	3	E. Kotan, H. Müller
6211910	Building Technology (p. 291)	L	2	W	3	S. Wirth

Learning Control / Examinations
graded:
partial examination Applied Building Physics, oral, 20 min., accord. ER/SPO § 4 par. 2 no. 2
partial examination Building Technology, oral, 20 min., accord. ER/SPO § 4 par. 2 no. 2
grading:
grade of module is defined by weighted average according credit points of grades of the partial examinations

Conditions
none

Recommendations
none

Qualification Goals
see German version

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up, examination preparation:	120 h
total:	180 h

Content
see German version

Module: Building Physics II [bauiM1S28-BAUPH-II]

Coordination: E. Kotan
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Construction Engineering

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6211814	Practical Noise Control (p. 350)	L	2	S	3	R. Grigo
6211815	Practical Fire Protection (p. 349)	L	2	S	3	H. Schröder

Learning Control / Examinations
graded:
partial examination Practical Noise Control, written, 60 min., accord. ER/SPO § 4 par. 2 no. 1
partial examination Practical Fire Protection, oral, 20 min., accord. ER/SPO § 4 par. 2 no. 2
grading:
grade of module is defined by weighted average according credit points of grades of the partial examinations

Conditions
none

Recommendations
none

Qualification Goals
see German version

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up, examination preparation:	120 h
total:	180 h

Content
see German version

Module: Materials Testing and Measuring Techniques [bauiM1S29-MATPRÜF]

Coordination: N. Herrmann
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Construction Engineering

ECTS Credits	Cycle	Duration
6	Every 2nd term, Winter Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6211911	Measuring Techniques in Civil Engineering (p. 329)	L/E	1/1	W	3	N. Herrmann
6211913	Materials Testing in the Field of Concrete (p. 327)	L	2	W	3	N. Herrmann

Learning Control / Examinations
graded:
examination Materials Testing and Measuring Techniques, oral, 30 min., accord. ER/SPO § 4 par. 2 no. 2
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
none

Qualification Goals
The basic knowledge of materials testing in the field of construction materials and concrete structures connected with the application in engineering constructions (e.g. bridges, power plants, etc.) will be imparted. As the main focus of high quality materials testing lies on the registration of the relevant measuring parameters, approximately half of the module will deal with the basics of measuring techniques and tasks. A part of the lesson is laboratory training. In these sessions the students will create own measuring concepts for a simple test, perform the test and evaluate the gained data.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up, examination preparation:	120 h
total:	180 h

Content

- Concrete testing according to standards
- Cement and aggregates
- Testing of natural stones
- Bearings and expansion joint for bridges
- Anchors
- Pre-stressing systems
- Testing of structural members
- Vibration measurement
- Monitoring

- Special testing and nuclear safety
- Chemical and physical analyzing methods
- Electronic measurement of mechanical parameters – basics
- Strain measurement
- Stress and pressure measurement
- Temperature measurement
- Humidity measurement
- Displacement measurement
- Force measurement
- Acceleration measurement
- Vibration measurement
- Data evaluation and visualization
- Transient measurement
- Trigger

Remarks
maximum attendance: 12

Module: Continuum Mechanics of Heterogeneous Solids [bauiM1S32-KONTIMECH]

Coordination: T. Seelig
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Construction Engineering

ECTS Credits	Cycle	Duration
6	Every 2nd term, Winter Term	2

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6215702	Continuum Mechanics (p. 317)	L	2	W	3	C. Hesch
6215805	Micromechanics of Heterogeneous Solids (p. 328)	L	2	S	3	T. Seelig

Learning Control / Examinations
graded:
examination Continuum Mechanics of Heterogeneous Solids, oral, accord. ER/SPO § 4 par. 2 no. 2
grading:
grade of module is defined by grade of examination

Conditions
This module must not be selected together with the module Basics in Numerical Modelling [bauiM5P4-NUMGRUND].

Recommendations
none

Qualification Goals
see German version

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up, examination preparation:	120 h
total:	180 h

Content
see German version

Remarks
Literature Continuum Mechanics:
Becker, E., Bürger, W.: Kontinuumsmechanik. Teubner, 1975
Bonet, J., Wood, R.D.: Nonlinear continuum mechanics for finite element analysis. Cambridge, 1997
Doghri, I.: Mechanics of Deformable Solids. Springer, 2000
Fung, Y.C.: Foundations of Solid Mechanics. Prentice Hall, 1965
Malvern, L.: Introduction to the Mechanics of a Continuous Medium. Prentice Hall, 1969
Parisch, H.: Festkörper-Kontinuumsmechanik. Teubner, 2003
Literature Micromechanics of Heterogeneous Solids:
Aboudi, J.: Mechanics of Composite Materials - A Unified Micromechanical Approach, Elsevier, 1991
Christensen, R.M.: Mechanics of Composite Materials, Wiley, 1979
Mura, T.: Micromechanics of Defects in Solids, Martinus Nijhoff Publishers, 1982
Nemat-Nasser, S., Hori, M.: Micromechanics - Overall Properties of Heterogeneous Materials, North-Holland, 1993
Gross, D., Seelig, Th.: Bruchmechanik - Mit einer Einführung in die Mikromechanik, Springer, 2011

Module: Contact Mechanics - Fundamentals and Basics [bauiM1S35-KONTMECH-BASICS]

Coordination: C. Hesch
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Construction Engineering

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6215803	Contact Mechanics - Fundamentals and Basics (p. 315)	L/E	2/2	S	6	C. Hesch

Learning Control / Examinations
graded:
examination Contact Mechanics – Fundamentals and Basics, oral, 30 min., accord. ER/SPO § 4 par. 2 no. 2
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
course Introduction to Continuum Mechanics (6200607),
module Basics of Finite Elements [bauiM1S20-GRUNDFE]

Qualification Goals
This course deals with the numerical treatment of contact problems. In particular, large deformation contact problems of deformable bodies are addressed. The students learn about interface conditions, non-smooth dynamics and inequality constraints. Collocation type conditions as well as advanced integral formulations of the interface are introduced. The practical realisation of the algorithms within a finite element code is shown.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up, examination preparation:	120 h
total:	180 h

Content

- Introduction in the analytical treatment of constraints in continuum mechanics
- Spatial discretisation of the interface conditions
- Non-penetration conditions in normal direction
- Application of friction laws in tangential direction
- Enforcement of constraints: Penalty-, augmented Lagrange and Lagrange multiplier method
- Dynamical treatment of inequality constraints

Remarks
Literature:
[1] Laursen: Computational Contact and Impact Mechanics
[2] Wriggers: Computational Contact Mechanics

Module: Contact Mechanics - Computational Algorithms in a geometrically exact Form [bauiM1S36-KONTMECH-ALGOR]

Coordination: C. Hesch
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Construction Engineering

ECTS Credits	Cycle	Duration
6	Every 2nd term, Winter Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6215907	Contact Mechanics - Computational Algorithms in a geometrically exact Form (p. 316)	L/E	2/2	W	6	A. Konyukhov

Learning Control / Examinations
graded:
examination Contact Mechanics - Computational algorithms in a geometrically exact form, oral, 30 min., accord. ER/SPO § 4 par. 2 no. 2
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
course Introduction to Continuum Mechanics (6200607),
module Basics of Finite Elements [bauiM1S20-GRUNDFE]

Qualification Goals
The basis of the geometrically exact theory for contact interaction is to build the computational algorithms in the proper selected coordinate system in order to describe the contact interaction in all its geometrical details. This results to the special structure of the computational mechanics course - study in applied differential geometry, kinematics of contact, formulation of a weak form and linearization in a special coordinate system in a covariant form. Afterward, most popular methods to enforce contact conditions are formulated consequently, first for 1D and then for 2D systems finally leading to examples in 3D. The closed form results are applied for the finite element discretization. The structure of contact elements for these methods is studied in detail and all numerical algorithms are derived in a ready for implementation form.
Hands on training in implementation of the derived contact algorithms are presented with the institutes research code FEAP-MeKa.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up, examination preparation:	120 h
total:	180 h

Content

- continuum formulation of a contact problem (Signorini's problem): weak and strong formulation.
- necessary information from the differential geometry of curves and surfaces
- curvilinear coordinate systems necessary for the various contact types
- geometry and kinematics for arbitrary two body contact problem in a covariant form

- abstract form of formulations in computational mechanics.
- weak formulation in a covariant form
- various methods of enforcement contact constraints in a covariant and in operator form
- consistent linearization in a covariant form: normal and tangential parts
- various discretization techniques of both the weak form and its linearization: residual and tangent matrix
- a set of analytical solution used for verification of the implemented contact algorithms (Hertz solution, contact patch tests for non-frictional and frictional cases
- modelling of frictional contact: elastoplastic analogy, return-mapping scheme
- a possible way of generalization of Coulomb friction law

Remarks
Literature:
[1.] Johnson K. L. Contact Mechanics. Cambridge University Press. 1987.
[2.] Kikuchi N., Oden J. T. Contact Problems in Elasticity: A Study of Variational Inequalities and Finite Element Methods. SIAM. 1988.[3.] Konyukhov A., Schweizerhof K. 2012 Computational Contact Mechanics Geometrically Exact Theory for Arbitrary Shaped Bodies. Springer. 2012.
[4.] Laursen T. Computational Contact and Impact Mechanics Fundamentals of Modeling Interfacial Phenomena in Nonlinear Finite Element Analysis. Springer, Berlin. 2002.
[5.] Sofonea M., Matei A. Mathematical Models in Contact Mechanics. Cambridge University Press. 2012.
[6.] Taylor R.L. FEAP electronic resourcesa aa http://www.ce.berkeley.edu/projects/feap/
[7.] Wriggers P. Computational Contact Mechanics. John Wiley and Sons. 2002.
[8.] Yastrebov A. Numerical Methods in Contact Mechanics. Wiley-ISTE. 2013

Module: Finite Elements in Solid Mechanics [bauiM1S37-FEFKM]

Coordination: P. Betsch
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Construction Engineering

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6215808	Finite Elements in Solid Mechanics (p. 285)	L/E	2/2	S	6	P. Betsch

Learning Control / Examinations
graded:
examination Finite Elements in Solid Mechanics, oral, 30 min., accord. ER/SPO § 4 par. 2 no. 2
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
module Basics in Finite Elements [bauiM1S20-GRUNDFE]

Qualification Goals
see German version

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up:	60 h
working on programming exercises:	30 h
examination preparation and examination:	30 h
total:	180 h

Content
see German version

Module: Numerical Structural Dynamics [bauiM1S38-NUMSTRDYN]

Coordination: P. Betsch
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Construction Engineering

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6215810	Numerical Structural Dynamics (p. 346)	L/E	2/2	S	6	P. Betsch

Learning Control / Examinations
graded:
examination Numerical Structural Dynamics, oral, 30 min., accord. ER/SPO § 4 par. 2 no. 2
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
module Basics in Finite Elements [bauiM1S20-GRUNDFE]

Qualification Goals
see German version

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up:	60 h
working on programming exercises:	30 h
examination preparation and examination:	30 h
total:	180 h

Content
see German version

Module: Tank Construction [bauiM1S39-BEHBAU]

Coordination: P. Knödel
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Construction Engineering

ECTS Credits	Cycle	Duration
6	Every 2nd term, Winter Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6212910	Tank Construction (p. 244)	L/E	3/1	W	6	P. Knödel

Learning Control / Examinations
graded:
partial examination Tank Construction, oral, 20 min., accord. ER/SPO § 4 par. 2 no. 2,
partial examination term paper Tank Construction, with presentation, accord. ER/SPO § 4 par. 2 no. 3
grading:
grade of module is defined by weighted average of grade of oral examination (50 %) and grade of term paper (50 %)

Conditions
none

Recommendations
The contents of the lecture Basics in Steel Structures (6200504) and the modules Surface Structures and Dynamics of Structures [bauiM1P3-FTW-BD] and Steel and Composite Structures [bauiM1P2-STABISTB] are expected.

Qualification Goals
The students can design and construct tank constructions and they can assess the impacts on the supporting effect of shell structures.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up:	45 h
preparation of term paper:	40 h
examination preparation and examination:	40 h
total:	185 h

Content

- classification of tank types
- impacts: characteristic of loads by wind, filling, internal pressure, earth quake and detonation
- shell structure supporting effect
- proof of strength and stability with liner and non-linear calculation
- design and construction
- specific problems

Remarks
Literature:
lecture notes
DIN EN 1993-1-6: Bemessung und Konstruktion von Stahlbauten - Teil 1-6: Festigkeit und Stabilität von Schalen

DIN EN 1993-4-1: Bemessung und Konstruktion von Stahlbauten - Teil 4-1: Silos
DIN EN 1993-4-2: Bemessung und Konstruktion von Stahlbauten - Teil 4-2: Tankbauwerke
Knödel, P.; Heß, A.; Ummenhofer, T.: Stählerne Tankbauwerke nach DIN EN 1993-4-2. In: Stahlbau-Kalender 2013, S. 523-563.

Module: Modeling in Solid Mechanics [bauiM1S40-MODFEST]

Coordination: P. Betsch
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Construction Engineering

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6215807	Modeling in Solid Mechanics (p. 332)	L/E	2/2	S	6	A. Konyukhov

Learning Control / Examinations
graded:
examination Modeling in Solid Mechanics, oral , 30 min., accord. ER/SPO § 4 par. 2 no. 2
grading:
grade of module is defined by grade of examination

Conditions
must not be selected together with module Formulation in Strength of Materials and Theory of Kinetic Stability for Structures [bauiM1S34-MOFEKIST].

Recommendations
course Introduction to Continuum Mechanics (6200607), module Basics of Finite Elements [bauiM1S20-GRUNDFE]

Qualification Goals
The goal of the course is to study various numerical analysis of engineering structures based on geometrical models of different dimensionality bars, beams, shells and solids. All finite element models are described from the geometrical point of view together with corresponding hypothesis of deformation. This allows to observe the continuous transformation of models and their geometrical model reductions from 3D continuum to the shell, beams and bar models. This process is illustrated by a corresponding set of finite elements available for the finite element analysis engineer.
Various types of the analysis depending on the engineering needs are studied: statical analysis including a-posteriori error analysis and mesh refinement; model analysis and its applications; buckling analysis in linear and non-linear descriptions; dynamic analysis in implicit and explicit formulations; harmonic analysis in application to the resonance phenomena.
All models are illustrated with FEM software, including practical programming in ANSYS APDL.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up, examination preparation:	120 h
total:	180 h

Content
Description of objects in differential geometry: curves, surfaces, special selection of curvilinear coordinate system for solid bodies. Various models of continuum mechanics based on specific geometry.

- 1D based models based on the geometry of curves - bars, chains, curvilinear beams. Kinematics of deformation, forces and moments, necessary boundary conditions. Sequence of mechanical models - chains, Bernoulli beams, Timoshenko beams - relationships with 3D models.
- 2D based models based on the geometry of surfaces - membranes, shells, solid-shells. Kinematics of deformation, membrane and moment stress-states.

Sequence of mechanical models - membrane, Kirchoff shells, Timoshenko shells, solid-shells and possibility of transversial deformations.
Necessary (Dirichlet) and essential (Neumann) boundary conditions. Relationships with 3D models.

- Special selection of a curvilinear coordinate system for a specific geometry of 3D bodies: cylindrical, spherical, spiral etc.

Various types of structural analysis:

- statical analysis for selected system;
- statical analysis for the sequence of the geometrical models 1D-2D-3D, mesh refinement, convergence and a-posteriori error analysis;
- modal analysis and its application to the resonance analysis;
- modal analysis and its application and its application to the mesh analysis as well as to the kinematic analysis of the system;
- buckling analysis in linear and non-linear formulations;
- transient analysis: implicit and explicit. Selection of the time integration step;
- harmonical analysis in application to the resonance phenomena.

Remarks
will be offered newly as from SS 2016, replaces module Model Formulation in Strength of Materials and Theory of Kinetic Stability for Structures [bauiM1S34-MOFEKIST]

Literature:
1. P. Wriggers, Nichtlineare Finite-Element-Methoden, Springer, 508 p., 2008.
2. P. Wriggers, Nonlinear Finite Element Methods, Springer, 560 p., 2008.
3. O. C. Zienkiewicz, R. L. Taylor, J. Z. Zhu, The Finite Element Method. Its Basis and Fundamentals, ITS Basis and Fundamentals, Elsevier Ltd, Oxford; Auflage: 6th ed. 752 p., 2005.
4. Thomas J. R. Hughes, The Finite Element Method: Linear Static and Dynamic Finite Element Analysis, Dover Civil and Mechanical Engineering publication, 672 p., 2000.
5. T. Belytschko, W.K. Liu, B. Moran, Nonlinear Finite Elements for Continua and Structures, Wiley, 300 p., 2000.
6. http://www.ansys.com/Support/Documentation
7. http://www.lstc.com/download/manuals

4.2 Modules Study Focus 2: Water and Environment

Module: Fluid Mechanics for Environmental Flows [bauiM2P4-FMENVFL]

Coordination: O. Eiff
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Water and Environment

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6221704	Fluid Mechanics for Environmental Flows (p. 287)	L/E	4	S	6	O. Eiff

Learning Control / Examinations
graded:
examination Fluid Mechanics for Environmental Flows, written, 90 min., accord. ER/SPO § 4 par. 2 no. 1
grading:
grade of module is defined by grade of examination

Conditions
This module must not be selected together with the module Advanced Fluid Mechanics [bauiM2P1-AFM] not offered any more as from winter term 2015/16.

Recommendations
modules Hydromechanics [bauiBGP04-HYDRO] and advanced mathematics for civil engineering [bauiBGP05-HM1, bauiBGP06-HM2, bauiBGP08-HM3, bauiBFW1-PDGL] (analysis, differential and integral calculus, ordinary and partial differential equations, linear algebra, Fourier analysis, complex numbers)

Qualification Goals
Students acquire a firm understanding of the fundamental mechanics of fluids with emphasis towards environmental flows on the basis of the local conservation laws. They will be able to differentiate and apply the different set of assumptions and methods in order to better understand the different flow classes and solutions. They are capable of solving basic flow problems after forming the relevant assumptions. Participants will be able to use the knowledge and competence gained for more detailed and applied studies of environmental flows.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up:	30 h
working on exercises:	30 h
examination preparation and examination:	60 h
total:	180 h

Content
This module covers the fundamental mechanics of fluids forming the foundation of environmental fluid mechanics. The approach is based on the basic local conservation laws. Emphasis is on the phenomena and the possible analytical solutions associated with the various flow classes. Topics covered include the general and special forms of the governing equations, flow kinematics, viscous incompressible flows, ideal-fluid flows, shallow flows, and buoyancy effects in fluids. Waves and turbulence will also be addressed as well as different methods of analysis such as scaling.

Remarks
newly offered as from winter term 2015/16

Literature:
I.G. Currie, Fundamental Mechanics of Fluids, Fourth Edition 2012.

Module: Numerical Fluid Mechanics [bauiM2P5-NUMFLMECH]

Coordination: M. Uhlmann
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Water and Environment

ECTS Credits	Cycle	Duration
6	Every 2nd term, Winter Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6221702	Numerical Fluid Mechanics I (p. 341)	L/E	2/2	W	6	M. Uhlmann

Learning Control / Examinations
graded:
examination Numerical Fluid Mechanics I, written, 90 min., accord. ER/SPO § 4 par. 2 no. 1
grading:
grade of module is defined by grade of examination

Conditions
This module must not be selected together with the module Advanced Fluid Mechanics [bauiM2P1-AFM] not offered any more as from winter term 2015/16.

Recommendations
modules Hydromechanics [bauiBGP04-HYDRO] (knowledge of the fundamental processes of advection and diffusion, familiarity with the Navier-Stokes equations) and Mathematics [bauiBGP05-HM1, bauiBGP06-HM2, bauiBGP08-HM3, bauiBFW1-PDGL] (analysis - partial differential equations, Fourier analysis, series expansions, complex numbers; linear algebra - matrices, determinants, eigensystems), Numerics (discrete number representation, round-off, floating point operations, numerical treatment of partial differential equations)

Qualification Goals
Students will be enabled to describe the fundamental approaches of numerical solution of flow problems. They are capable of evaluating the advantages and disadvantages of these approaches in the various areas of application, enabling them to make an appropriate choice. Participants will be able to apply the numerical methods to simple flow problems; this involves the generation and application of basic computer programs. They are able to analyze the results with respect to precision, stability and efficiency.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up:	60 h
examination preparation and examination:	60 h
total:	180 h

Content
This module constitutes a general introduction to the numerical solution of flow-related problems. The mathematical properties of the conservation equations will be analyzed. The principles of numerical discretization are studied with the aid of the finite-difference and the finite-volume method. The concept of numerical stability is introduced, and various techniques of error analysis are presented theoretically and by way of examples.

Module: Hydraulic Engineering [bauiM2P6-ADVHYENG]

Coordination: F. Nestmann
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Water and Environment

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6222701	Multiphase Flow in Hydraulic Engineering (p. 335)	L/E	1/1	S	3	F. Nestmann
6222703	Design of Hydraulic Structures (p. 264)	L/E	1/1	S	3	F. Nestmann

Learning Control / Examinations
graded:
examination Hydraulic Engineering, written, 75 min., accord. ER/SPO § 4 par. 2 no. 1
grading:
grade of module is defined by grade of examination

Conditions
This module must not be selected together with the module Dynamics of Water and Mass Transport in River Basins [bauiM2P2-WSF] not offered any more as from winter term 2015/16.

Recommendations
none

Qualification Goals
Students will be able to describe and analyze inter-active water management processes (water-air and water- solid). They are able to assign these basic inter-active processes to engineering tasks and carry out the dimensioning of structures with suitable approaches. Based on the acquired process knowledge, they are able to analyze the different results of these dimensioning in a critical manner.
Students are able to use and link their knowledge logically. They can work in a reflexive and self-critical manner.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up:	60 h
examination preparation and examination:	60 h
total:	180 h

Content
The module provides students with basic theoretical and practical aspects of water-air and water-solid interactions as well as the relevance to engineering.
The course „Multiphase Flow“ contains the following topics:

- Basic morphodynamics: classification of solids, bed load and suspended load processes
- Flow-sediment interaction: Approaches for bed load transport and rates
- Mass transport at stream beds: structures, development, modeling
- Water- air mixes: basics, behavior specification, engineering applications

In the course „Design of Hydraulic Structures“ the following topics will be discussed in depth:

- Overview: Hydraulic structures and water management as well as their inclusion in the surrounding flowing waters
- Dimensioning, norms and state of the art in hydraulic engineering planning

Remarks
newly offered as from winter term 2015/16

Module: Urban Material Flows [bauiM2P7-URBMATFL]

Coordination: S. Fuchs
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Water and Environment

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6223702	Urban Material Flows (p. 402)	L/E	2/2	S	6	S. Fuchs

Learning Control / Examinations
graded:
examination Urban Material Flows, written, 60 min., accord. ER/SPO § 4 par. 2 no. 1
grading:
grade of module is defined by grade of examination

Conditions
This module must not be selected together with the module Mass Fluxes and Cycles [bauiM2P-STK] not offered any more as from winter term 2015/16.

Recommendations
course Sanitary Environmental Engineering (6200603)

Qualification Goals
Students analyse and evaluate fundamental methods of sanitary engineering. They recognize the interaction between natural and technical systems. They have available the knowledge of different options of process engineering and are able to implement them into functional urban systems (infrastructure elements). The students are capable of analysing sanitary engineering problems in the context of river basins and of making appropriate and sustainable decisions in the context of energy efficiency and costs.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up:	60 h
examination preparation and examination:	60 h
total:	180 h

Content
This module constitutes deepened knowledge for the design, analysis and evaluation of sanitary engineering facilities. The required chemical, physical and biological fundamentals will be deepend as well as the concept of system analysis will be introduced as basic tool for representing complex processes. Based on the detailed consideration of individual infrastructure elements, an overall understanding of urban water systems and its interaction with surface and groundwater bodies is imparted. For this purpose, the theoretical and practical tools as well as modeling approaches are studied. The students consider the factors costs and energy for their analysis and evaluate the water management system.

Remarks
newly offered as from winter term 2015/16

Literature:
Metcalf and Eddy (2003) Wastewater Engineering – Treatment and Reuse, McGraw-Hill, New York.
Imhoff, K. u. K.R. (1999) Taschenbuch der Stadtentwässerung, 29. Aufl., Oldenbourg Verlag, München, Wien.

Module: Water and Energy Cycles [bauiM2P8-WATENCYC]

Coordination: E. Zehe
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Water and Environment

ECTS Credits	Cycle	Duration
6	Every 2nd term, Winter Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6224702	Water and Energy Cycles in Hydrological Systems: Processes, Predictions and Management (p. 420)	L/E	2/2	W	6	E. Zehe

Learning Control / Examinations
graded:
examination Water and Energy Cycles, oral, appr. 30 min., accord. ER/SPO § 4 par. 2 no. 2, prerequisites programming exercises
grading:
grade of module is defined by grade of examination

Conditions
This module must not be selected together with the module Dynamics of Water and Mass Transport in River Basins [bauiM2P2-WSF] not offered any more as from winter term 2015/16.

Recommendations
course Hydrology (6200511) and module Water resources management and engineering [bauiBFW9-WASSRM]; preliminary knowledge in Matlab programming, otherwise the attendance of the course 'Introduction to Matlab' is strongly recommended

Qualification Goals
The students are able to explain the relevant processes of the terrestrial water and energy cycle, including its central feed backs and limitations. They are familiar with the quantitative concepts to characterize and predict these processes in the context of science and management and can implement them into simple simulation- and analysis tools. The students are able to quanitfy and evaluate the necessary data basis and the uncertainties of predictions based upon these.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up, working on programming exercises:	60 h
examination preparation and examination:	60 h
total:	180 h

Content
This module deepens the fundamentals of the water and energy cycle with particular regard to:

- evaporation, energy balance and processes in the atmospheric boundary layer (Reynolds decomposition, turbulence parametrization, Eddy-Covariance-method);
- soil, as the central control element of the water and energy cycle and of the interplay of soil water and ground heat balance (Richards equation, heat transfer equation, hydraulic and thermal soil properties);
- the interplay between runoff processes and soil water balance, and the soil as filter system;
- concepts of hydrological similarity;

- process based and conceptual models to predict floods, the water balance and evaporation.

Remarks
Literature:
Kraus, H. (2000): Die Atmosphäre der Erde. Vieweg
S. P. Aryan (2001): Introduction to Micrometeorology, 2nd Ed., Academic Press
Hornberger et al. (1998): Elements of physical hydrology. John Hopkins University Press
Beven, K. (2004): Rainfall runoff modelling – The primer: John Wiley and Sons
Plate, E. J.,Zehe, E. (2008): Hydrologie und Stoffdynamik kleiner Einzugsgebiete. Prozesse und Modelle, Schweizerbart, Stuttgart, 2008.

Module: Water Resources and River Basin Management [bauiM2S01-HY1]

Coordination: U. Ehret
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Water and Environment

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6224801	Water Resources and River Basin Management (p. 417)	L/E	4	S	6	U. Ehret

Learning Control / Examinations
graded:
examination Water Resources and River Basin Management, course accompanying homeworks, short reports appr. 2 pages each, and final term paper, report appr. 15 pages, with colloquium, accord. ER/SPO § 4 par. 2 no. 3
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
course Hydrology (6200511) and module “Water resources management and engineering hydrology” [bauiBFW9-WASSRM]

Qualification Goals
The students can subdivide a problem in water management into its components und can formulate solutions therefore in terms of an integrated river basin management.
The students are familiar with the principles, methods and limitations of environmental system modelling and can set up hydrological models by themselves and apply them to specific problems. They can interprete their results and evaluate them with respect their uncertainties.
The students can work on problems in a team and present the results.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up:	20 h
homeworks (examination parts):	60 h
preparation of term paper (examination part):	40 h
total:	180 h

Content

- Definitions, contents and examples of integrated river basin management
- methods of multi-criteria decision making (Utility Matrix)
- Hydrologic modelling: environmental system theory, calibration and validation, sensitivity and uncertainty analysis
- methods for hydrologic dimensioning
- computer aided application of hydrologic models (HBV, LARSIM): manual and automatic calibration, Mote-Carlo simulations for estimating uncertainties, determination of design flood time series

The attestations are worked out and are presented in teams.

Remarks
Literature:
Larsim: Ludwig, K. and Bremicker, M., 2006. The Water Balance Model LARSIM - Design, Content and Applications. Freiburger Schriften zur Hydrologie, 22. Institut für Hydrologie, Uni Freiburg i. Br.
Good modelling practice: Van Waveren, R. H., S. Groot, H. Scholten, F. van Geer, H. Wösten, R. Koeze and J. Noort. 1999: Handbook Good Modelling Practice. STOWA/RWS-RIZA, Utrecht/Lelystad, the Netherlands. Download: http://harmoniqua.wau.nl/public/Reports/Existing Guidelines/GMP111.pdf
Calibration: Gupta, H.V., Sorooshian, S. and Yapo, P.O., 1998. Toward improved calibration of hydrologic models: Multiple and noncommensurable measures of information. Water Resources Research, 34(4): 751-763.

Module: Thermodynamics in Environmental Systems [bauiM2S02-HY2]

Coordination: U. Ehret
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Water and Environment

ECTS Credits	Cycle	Duration
6	Every 2nd term, Winter Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6224901	Thermodynamics in Environmental Systems (p. 389)	L/E	4	W	6	E. Zehe, U. Ehret

Learning Control / Examinations
graded:
examinatoin Thermodynamics in Environmental Systems, course accompanying homeworks, short reports appr. 2 pages each, and final term paper, report appr. 10 pages, with colloquium, accord. ER/SPO § 4 par. 2 no. 3
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
preliminary knowledge in Matlab programming, otherwise the attendance of the course 'Introduction to Matlab' is strongly recommended

Qualification Goals
The students can describe environmental systems as hierarchically structured parts of the earth system and are able to name the limits, state variables and prozesses of the water and energy transport of selected environmental systems.
The students know the principles in thermodynamics an can explain why and how these build a relevant base for the description of environmental system processes.
The students know the basic mechanisms of self-organisation and can explain based upon them how environmental systems move away locally from the thermodynamic equilibrium by structuring in contrary to the global development direction towards this determined by the second thermodynamic principle.
The students are able to set up simple environmental systems by themselves and based on simple numerical methods and to simulate the dynamics of selected processes of water and energy transport along the water cycle.
The students can work on the problems in a team and present the results.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up:	20 h
homeworks (examination parts):	60 h
preparation of term paper (examination part):	40 h
total:	180 h

Content

- Fundamentals of environmental systems theory and modelling (system boundaries, system states, deterministic, complex, chaotic systems)
- energy and entropy
- work and power, dissipation and thermodynamic equilibrium

- the four principles in thermodynamics
- Carnot limits
- basics of self-organisation (positive and negative feedbacks, order parameters)
- entropy in thermodynamics and information theory: similarities and differences
- computer based set-up of models for simulating the dynamics of simple environmental systems regarding water and energy based on simple numiercal methods
- The attested home works are developed in teams and presented

Remarks
Literature:
Prigogine, I. (1989): What is entropy? Naturwissenschaften, 76, 1-8, 10.1007/bf00368303.
Kleidon, A. (2010): Life, hierarchy, and the thermodynamic machinery of planet Earth, Physics of Life Reviews, 7, 424-460.

Module: Dynamics of Water and Mass Transport in Watersheds [bauiM2S03-HY3]

Coordination: E. Zehe
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Water and Environment

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6224803	Dynamics of Water and Mass Transport in Watersheds (p. 414)	L/E	4	S	6	E. Zehe, J. Wienhöfer

Learning Control / Examinations
graded:
examination Dynamics of Water and Mass Transport in Watersheds, take home exam and colloquium, accord. ER/SPO § 4 par. 2 no. 3
grading:
grade of module is defined by grade of examination

Conditions
compulsory module Dynamics of Water and Mass transport in river basins [bauiM2P2-WSF]

Recommendations
take core elective course “Experimental hydrology and process monitoring in natural systems” [bauiM2S05-HY5] in parallel

Qualification Goals
Students will be familiar with the transport processes of nutrients and contaminants in surface runoff and in the unsaturated zone of rural catchments. This includes the processes of infiltration, overland flow, soil water flow, advective and dispersive transport of solutes, particulate transport via erosion as well as reaction and degradation of substances. Students will independently apply analytical and process based modelling instruments and will thus be able to estimate model parameters from field experiments, balance the fluxes of water and substances in the critical zone and perform risk assessments on the travel distances of contaminants. In addition, students will be capable of assessing the limits of applicability of the models in natural structured soils.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up:	60 h
preparation of term paper (examination):	60 h
total:	180 h

Content

- Transport in the unsaturated zone: advective-dispersive transport in homogeneous and heterogeneous soils; adsorption isotherms, microbiological degradation, reaction processes
- Modelling of solute transport in soils (i.e. of pesticides) using analytical models: risk analysis for pesticides in the soil (transport, residence time, adsorption, degradation); estimation of model parameters from field experiments; parameterisation of adsorption isotherms; break through curves
- Application of process based models: introduction into process based modelling (processes, data need and management, time step controls) using a hydrological model (i.e. CATFLOW); simulation of soil water fluxes, overland flow and associated transport processes at various scales; sensitivity analysis, goodness of fit measures

Remarks
IMPORTANT:
will not be offered any more as from winter term 2016/17.

Literature:
Jury, W. and Horton, R. (2004): Soil physics. John Wiley
Hillel, D. (1995): Environmental Soil Physics. Academic Press
Fritsche, W. (1998) Umweltmikrobiologie, Grundlagen und Anwendungen. Gustav Fischer Verlag, 248pp.
Roth, K. (1994): Lecture notes in soil physics. www.uphys.uni-heidelberg.de
Plate, E. und Zehe, E. (2008): Hydrologie und Stoffdynamik kleiner Einzugsgebiete: Prozesse und Modelle. Schweizerbart

Module: Data Analysis and Environmental Monitoring [bauiM2S04-HY4]

Coordination: E. Zehe
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Water and Environment

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6224805	Data Analysis and Environmental Monitoring (p. 262)	L/E	4	S	6	E. Zehe

Learning Control / Examinations
graded:
examination Data Analysis and Environmental Monitoring, take home exam and colloquium, accord. ER/SPO § 4 par. 2 no. 3
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
Basic knowledge of statistics, take module “experimental hydrology and process monitoring in natural systems” [bauiM2S05-HY5] in parallel

Qualification Goals
Students will become familiar with advanced analysis methods of spatial and temporal environmental data sets. In addition they will gain knowledge on the planning of experimental designs for field campaigns. Special emphasis will be put on the regionalization of point measurements. Students will learn the application and suitability of various kriging methods and will be able to evaluate interpolated maps critically.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up:	60 h
preparation of term paper (examination):	60 h
total:	180 h

Content

- Geostatistics: eExperimental variogram, directional variograms, indicator variogram, fitting of theoretical variogram functions, anisotropy
- Krigginig methods: Ordinary Kriging, Kriging equations; screening property of Kriging weights, BLUE, pure nugget effect; cross validation, RMSE
- Estimation of spatial patterns in case of non-stationary data: External Drift Kriging, Simple Updating
- Estimation of spatial patterns by simulations: Smoothing problem of interpolation methods, Turning Band Simulations
- Field campaign for measuring soil moisture: planning of the measuring design, measurement of soil moisture and data analysis

Remarks
IMPORTANT:

will not be offered any more as from winter term 2016/17 in this form.

Literature:
Bárdossy, A. (2001): Introduction into Geostatistics. Inst. f. Wasserbau, Universität Stuttgart.
Kitanidis, P. K. (1999): Introduction into Geostatistics. Applications in Hydrogeology. Cambridge University Press.
Bras, R. L. and Rodriguez-Iturbe, I. (1985): Random Functions and Hydrology. Addison-Wesley Massachusetts.
Brooker, I. (1982): Two-dimensional simulation by turning bands. Math. Geology 17 (1).

Module: Experimental Hydrology and Process Monitoring in Environmental Systems [bauiM2S05-HY5]

Coordination: J. Wienhöfer
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Water and Environment

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6224807	Experimental Hydrology and Process Monitoring in Environmental Systems (p. 277)	E	4	S	6	J. Wienhöfer, U. Ehret

Learning Control / Examinations
graded:
examination Experimental Hydrology and Process Monitoring in Environmental Systems, report on field and laboratory investigations and colloquium, accord. ER/SPO § 4 par. 2 no. 3
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
none

Qualification Goals
The students can list the processes of the terrestrial water cycle on advanced level and can explain their influence on the landscape development in catchments. The students can describe meausrment principles and instruments for field and laboratory for the observation water related catchment properties, states and water flows on several scales (soil column, plot-scale, slope-scale, catchment) and can apply these self-reliantly in flied and laboratory. The students can analyse measured data with statistical methods and quantify and evaluate the uncertainties correlated the the measured data. The students can work on problems in a team and present the results.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, lab and field exercises:	60 h
independent study:	
preparation and follow-up:	60 h
preparation of report (examination):	60 h
total:	180 h

Content

- principles of environmental systems theory and envornmental metrology (scales, uncertainties)
- literature review and discussion on environmeltal measurements
- hydrologic messurement equipement and measurement techniques for field and laboratory: discharge, soil moisture, infiltration, matrix potential, groundwater levels
- statistical data analaysis and error calculation

Remarks
IMPORTANT:

will not be offered any more as from winter term 2016/17 in this form.

Literature:
lecture notes on environmental monitoring and field measurement techniques,
hydrologic journal papers

Module: Aquatic Ecosystems [bauiM2S06-HY6]

Coordination: C. Kämpf
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Water and Environment

ECTS Credits	Cycle	Duration
6	Every 2nd term, Winter Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6224903	Aquatic Ecosystems (p. 296)	L/E	2/1	W	6	C. Kämpf

Learning Control / Examinations
graded:
examination Aquatic Ecosystems, presentation, appr. 15 min., study paper, appr. 4000 words, and poster, accord. ER/SPO § 4 par. 2 no. 3
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
none

Qualification Goals
The students are able to sort interdisciplinary texts about aquatic ecosystems according to their relevance and formulate further questions accordingly. The students can conduct searches specifically and by themeselves for answering of a scientific question. Students can put the texts in the context of basic aquatic-ecologic principles and current problems of the resource water.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
seminar (lecture), exercise:	45 h
independent study:	
preparation and follow-up:	60 h
preparation of presenation, study paper and poster (examination):	75 h
total:	180 h

Content

- riverine landscapes: rivers and flood plains as biotopes
- function of natural and cultivated landscape
- assessment and evaluation: structural quality, bio-indicators, saprobial System, dose-effect-correlation, and value-functions
- construction measures and their impact on biocoenoses: changes in flow dynamics and nutrient availability
- sustainable river and landscape management: principles and objectives for the protection of nature, species and habitats
- excursion to Rhine floodplains

Remarks
Literature:
semester reader & session handouts

Module: Environmental Communication [bauiM2S07-HY7]

Coordination: C. Kämpf
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Water and Environment

ECTS Credits	Cycle	Duration
6	Every 2nd term, Winter Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6224905	Environmental Communication (p. 399)	S	2	W	6	C. Kämpf

Learning Control / Examinations
graded:
examination Environmental Communication,presentation, appr. 15 min., study paper, appr. 4000 words, and poster, accord. ER/SPO § 4 par. 2 no. 3
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
none

Qualification Goals
The students are able to analyse and evaluate texts about environmental topics. They can put the texts in the context of basic ecological principles and current environmental themes. The students can optimize a text according to the principls of rhetorics for different reader groups.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
seminar (lecture), exercise:	30 h
independent study:	
preparation and follow-up:	30 h
preparation of presenation, study paper and poster (examination):	120 h
total:	180 h

Content

- complex socio-technical environmental systems: scientific principles, dynamics of real systems; interactions; ecosystem services; structural and process variety of the environment, (ecosystem theory)
- environment in 21. century: resources exploitation, global changes, strategies: nature and landscape conservation; environmental evaluation, context: legal framework;
- communication: Interdisciplinarityt, transdisciplinarity; environmental management: uncertainty, ignorance, risk

1. text type (genres), publ. cultures in acad. disciplines (purpose: decision making, learning, research)
2. annotated bibliography; lit.research, citations, references
3. glossaries (order principles, classes|categories)
4. text production ARISTOTELES: ethos & logos & pathos CICERO inventio, dispositio, elocutio, memoria, action IMRaD, Stil; doc cycle (recycling) text production (design principles WERTHEIMER, .ppt); visuals (tables, figures), page layout Guide for scientific texts, peer edit
5. communication models

Remarks
Literature:
course pack (actual papers of various relevant journals, news clippings)

Module: Groundwater Management [bauiM2S08-HY8]

Coordination: U. Mohrlok
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Water and Environment

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	2

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6221801	Groundwater Management (p. 298)	L/E	2	S	3	U. Mohrlok
6221901	Numerical Groundwater Modelling (p. 343)	Pj	2	W	3	U. Mohrlok

Learning Control / Examinations
graded:
partial examination Groundwater Management, oral, 30 min., accord. ER/SPO § 4 par. 2 no. 2
partial examination Numerical Groundwater Modelling, project report, appr. 15 pages, with presentation, accord. ER/SPO § 4 par. 2 no. 3
grading:
grade of module is defined by weighted average according credit points of grades of the partial examinations

Conditions
none

Recommendations
fundamental knowledge in fluid mechanics, hydrology, solute transport and numerical methods

Qualification Goals
Based on the understanding of the hydrogeologic conditions and the fluid mechnical processes in the subsurface the students can characterize several kinds of groundwater systems. They can quanitfy the relevant flow and transport processes for different problems of groundwater quantity and quality with simple analytical and numerical methods. Hence, they are able to conceive and evaluate the important relationships for the management of groundwater resources.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercise:	45 h
independent study:	
preparation and follow-up, working on exercises:	45 h
preparation of oral examination and examination:	20 h
working on study project, incl. report preparation and presentation (examination):	80 h
total:	190 h

Content
Groundwater Management:

- fluid mechanical processes in porous media
- groundwater flow: regional, potential flow, flow towards a well
- processes of groundwater recharge
- aolute transport processes
- grundwater management: well catchments, protection zones, groundwater pollution, salt water intrusion

Numerical Grondwater Modelling:

- numerical methods
- space and time discretization
- accuracy, stability
- working on a study project

Remarks
course “Groundwater Management” in English

Literature:
Anderson, M.P. and W.W. Woessner (1992). Applied Groundwater Modelling Simulation of Flow and advective Transport. San Diego, CA, U.S.A.: Academic Press, Inc. Harcourt Brace Jovanovich Publisher.
Bear, J. (1979). Hydraulics of Groundwater. McGraw Hill.
Chiang, W.-H., Kinzelbach, W. & R. Rausch (1998). Aquifer simulation model for Windows - Groundwater flow and transport modeling, an integrated program. Berlin, D.:Gebrüder Borntraeger.
Fetter, C.W. (1999). Contaminant Hydrogeology , 2/e. Upper Saddle River, NJ, U.S.A.: Prentice Hall.
Hiscock, K.M. (2005). Hydrogeology: principles and practice. Malden, MA, U.S.A.: Blackwell.
Kruseman, G.P. and N.A. de Ridder (1991). Analysis and Evaluation of Pumping Test Data. NL: ILRI public 47.
Nielsen, D.M. and A.J. Johnson (1990). Ground Water and Vadose Zone Monitoring. Albuquerque, NM, USA: ASTM.
Schwartz, F. and H. Zhang (2003). Fundamentals of Ground Water. New York, NY, U.S.A.: John Wiley & Sons.
Zheng, Ch. and G.D. Bennett (2002). Applied Contaminant Transport Modeling. New York, NY, U.S.A.: John Wiley.

Module: Studies of Development Projects in Water Resources Management [bauiM2S09-WB1]

Coordination: F. Nestmann
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Water and Environment

ECTS Credits	Cycle	Duration
6	Every 2nd term, Winter Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6222901	Studies of Development Projects in Water Resources Management (p. 419)	L	4	W	6	F. Nestmann

Learning Control / Examinations
graded:
examination Studies of Development Projects in Water Resources Management, study paper, appr. 15 pages, and colloquium, accord. ER/SPO § 4 par. 2 no. 3
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
module River Dynamics [bauiM2S13-WB5]

Qualification Goals
The students can go through all steps relating to a project of renaturation by themselves. They can identify engineering problems and apply the associated design approaches.
The students can work self-organized and refexively. They are able to structure and interlink knowledge logically and they have organizing competences in the fields of team work and presentation.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercise:	30 h
independent study:	
preparation and follow-up:	30 h
preparation of study paper (examination):	120 h
total:	180 h

Content
The module covers the procedural steps of a real water management project. The project work is organized in groups, where the students can apply the topics of the module. University members and external lecturers will provide insight into actual projects. An excursion shall allow the students to gain an authentic impression of practical application of the contents of the module.

Remarks
IMPORTANT:
This module will not be offered any more as from winter term 2016/17. It will be replaced by a newly configured module.

Literature:
Handouts

Module: Practical Use of Numerical Methods in Fluid Mechanics [bauiM2S10-WB2]

Coordination: P. Oberle, M. Musall
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Water and Environment

ECTS Credits	Cycle	Duration
6	Every 2nd term, Winter Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6222903	Practical Use of Numerical Methods in Fluid Mechanics (p. 331)	L/E	2/2	W	6	P. Oberle, M. Musall

Learning Control / Examinations
graded:
examination Practical Use of Numerical Methods in Fluid Mechanics, written, 40 min., accord. ER/SPO § 4 par. 2 no. 1
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
fundamental knowledge in hydrology, hydraulic engineering, water resources management and fluvial hydraulics

Qualification Goals
The students can handle geographic information systems as tool of pre- and postprocessing for the simulation of river flows. The students can describe the principles of the applied procedures and their methodology. The students are able to evaluate the fields of application of different hydrodynamic-numerical (HN-) procedures. They have the competencies to analyse case studies regarding the application of different methods and derive solution options.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercise:	60 h
independent study:	
preparation and follow-up:	60 h
examination preparation and examination:	60 h
total:	180 h

Content
The course introduces to physical and numerical basics as well as to areas of application and examples of use of different hydrodynamic-numerical (HN-) procedures. Furthermore, the related use of Geographical Information Systems (GIS) in pre- and post-processing as well as their coupling with HN-procedures are presented. Other aspects covered are the coupling of elements of automation with HN-procedures and the implementation of morphodynamic models.

Remarks
IMPORTANT:
This module will not be offered any more as from winter term 2016/17. It will be replaced by a newly configured module.

Literature:
course accompanying papers

Module: Hydro Power Engineering [bauiM2S11-WB3]

Coordination: P. Oberle
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Water and Environment

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6222801	Hydro Power Engineering (p. 269)	L/E	4	S	6	P. Oberle

Learning Control / Examinations
graded:
examination Hydro Power Engineering, oral, 20 min., accord. ER/SPO § 4 par. 2 no. 2
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
course Hydraulic Engineering and Water Management (6200509)

Qualification Goals
The students can describe the functioning of different types of turbines and define selection criteria for their fields of application. They are able to reproduce the basic approach for planning and designing hydro power plants and to conduct calcultions for the preselection of turbines. They can select and apply appropriately the necessary tools for this purposes.
The students can discuss critically with the fellow students the current political framework regarding the transformation of the energy system and supply their personal view on this subject with arguments.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercise:	60 h
independent study:	
preparation and follow-up:	60 h
examination preparation and examination:	60 h
total:	180 h

Content
The course explains the technical background for planning and designing waterpower plants. Among others, it covers the constructional characteristics of river and high-pressure power plants, the operating modes and selection criteria of different types of turbines as well as electro-technical aspects of the plants' operation. In addition, ecological aspects and energy policy are considered as frame conditions. The lecture sessions are complemented by the presentation of current projects and excursions.

Remarks
Literature:
presentation slides;
Giesecke J., Mosonyi E., 2005, Wasserkraftanlagen, Planung, Bau und Betrieb, Springer Verlag, Berlin

Module: Waterway Engineering [bauiM2S12-WB4]

Coordination: A. Kron
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Water and Environment

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6222803	Waterway Engineering (p. 411)	L/E	4	S	6	A. Kron

Learning Control / Examinations
graded:
examination Waterway Engineering, oral, 20 min., accord. ER/SPO § 4 par. 2 no. 2
attested examination prerequisite:
student research project Waterway Engineering, approx. 15 pages, accord. ER/SPO § 4 par. 2 no. 3
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
course Hydraulic Engineering and Water Management (6200509)

Qualification Goals
The students have knowledge about the various types of navigable waterways and their hydraulic structures. They can describe and apply the hydraulic basics for the design of these hydraulic structures and the interaction of ship and waterway. Furthermore, the students are able to assign the arising tasks and responsibilities related to waterway engineering to the administrative structure of the waterways and shipping authorities in Germany.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercise:	60 h
independent study:	
preparation and follow-up:	30 h
preparation of student research project:	30 h
examination preparation and examination:	60 h
total:	180 h

Content

- inland waterways
- navigation locks
- ship lifts
- dynamics of ship movement
- bed and bank stabilisation
- interaction ship-waterway

Remarks
Literature:
lecture notes,
course pack

Module: River Dynamics [bauiM2S13-WB5]

Coordination: F. Seidel
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Water and Environment

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6222805	Morphodynamics (p. 334)	L/E	2	S	3	F. Nestmann
6222807	Flow Behavior (p. 386)	L/E	2	S	3	F. Seidel

Learning Control / Examinations
graded:
examination River Dynamics, oral, 30 min., accord. ER/SPO § 4 par. 2 no. 2
attested examination prerequisite:
student research project Flow Behavior, approx. 15 pages, accord. ER/SPO § 4 par. 2 no. 3
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
module Dynamics of Water and Mass Transport in River Basins [bauiM2P2-WSF] or Hydraulic Engineering [bauiM2P6-ADVHYENG]

Qualification Goals
The students can denote and describe the fundamental relationships and interactions between topography, flow and morphodynamics. They can describe and apply the related design approaches. They are able to analyse the engineering design approaches and relate them to the hydromechanic principles. They deal with the state of the art by themselves and can select adequate methods for solving engineering problems. They hold their findings against professionals and argue specialized.

Workload
contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercise:	60 h
independent study:	
preparation and follow-up:	30 h
preparation of student research project:	45 h
examination preparation and examination:	45 h
total:	180 h

Content
The module focuses on the interaction effects between flow-structures, flow-resistance and river-morphodynamics. The theoretical background is discussed with a view on the practical application in river engineering. Within the module, only the one-dimensional models are being discussed – multidimensional models are content of the module "Practical Use of Numerical Methods in Fluid Mechanics [bauiM2S10-WB2]"

Remarks
Literature:
course pack

Module: Experimental Techniques I: Small Scale Experiments [bauiM2S15-SM1]

Coordination: C. Lang
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Water and Environment

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	2

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6221802	Experimental Methods (p. 278)	L/E	1/2	S	4,5	C. Lang
6220901	Hydraulic Engineering Project (p. 416)	Pj	1	W	1,5	C. Lang

Learning Control / Examinations
graded:
partial examination Experimental Methods, oral, 40 min., accord. ER/SPO § 4 par. 2 no. 2
partial examination Hydraulic Engineering Project, test protocoll and report, accord. ER/SPO § 4 par. 2 no. 3
attested:
test protocol and report as prerequisite for partial examination Experimental Methods, accord. ER/SPO § 4 par. 2 no. 3
grading:
grade of module is defined by weighted average according credit points of grades of the partial examinations

Conditions
none

Recommendations
courses Hydromechanics (6200304), Hydraulic Modelling Methods (6200609)

Qualification Goals
Students have the subject-related knowledge and skills for the comparative analysis of basic flow situations in physical models, using various measurement technologies. They are able to assess and evaluate the results. In addition, students will be able to compare the results of their measurements with theoretical deductions and evaluate them with regard to practical applications in the technical hydraulics. Competence: students will present the results of the comparative analysis to a chosen audience.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercise:	60 h
independent study:	
preparation and follow-up:	30 h
analyses and reports of the experiments:	60 h
examination preparation and examination:	30 h
total:	180 h

Content
Lecture:

- Typical set-up of hydraulic and aerodynamic models
- Measurement instrumentation for basic and applied research
- Dimensional analysis, dimensionsless fluid parameters, ratio of forces
- Experimental techniques: analogy numerical/physical modeling, model distortion

Exercises in the students lab:

- Pipe flow with orifice plate
- Open channel flow with gate and hydraulic jump
- Venturi pipe flow with cavitation
- Settling velocities of spheres
- Diffusion of a turbulent air jet

Engineering application:

- Small-scale experiment in the context of a authentic engineering project

Remarks
IMPORTANT:
This module will not be offered any more as from winter term 2016/17. It will be replaced by a newly configured module.

Literature:
Kobus, H. 1984, Wasserbauliches Versuchswesen, DVWK-Schrift Heft 39, Verlag Paul Parey Berlin
Zierep, J.,1991, Ähnlichkeitsgesetze und Modellregeln der Strömungslehre, Verlag Braun, Karlsruhe
Tropea, C. et.al., 2007, Springer Handbook of Experimental Fluid Mechanics, Springer Verlag Berlin

Module: Interaction Flow - Building Structure [bauiM2S16-SM2]

Coordination: B. Ruck
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Water and Environment

ECTS Credits	Cycle	Duration
6	Every 2nd term, Winter Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6221903	Interaction Flow - Building Structure (p. 421)	L/E	1/1	W	3	C. Lang
6221905	Building and Environmental Aerodynamics (p. 289)	L/E	1/1	W	3	B. Ruck

Learning Control / Examinations
graded:
partial examination Interaction Flow - Building Structure, oral, 30 min., accord. ER/SPO § 4 par. 2 no. 2
partial examination Building- and Environmental Aerodynamics, oral, 30 min., accord. ER/SPO § 4 par. 2 no. 2
grading:
grade of module is defined by weighted average according credit points of grades of the partial examinations

Conditions
none

Recommendations
course Hydromechanics (6200304),
modules Advanced Fluid Mechanics [bauiM2P1-AFM] or Fluid Mechanics for Environmental Flows [bauiM2P4-FMENVFL], Technical Hydraulics [bauiM2S17-SM3]

Qualification Goals
The students have the competence to analyse and calculate steady and unsteady flow loading on hydro-engineering and aerodynamic structures as well as natural structures. They characterize flow induced vibrations and can categorize and pre-estimate them. With typical applications the connection between theory and practice is given.

Workload
contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercise:	60 h
independent study:	
preparation and follow-up:	60 h
examination preparation and examination:	60 h
total:	180 h

Content
Gates in Hydraulic Engineering:
Particularities of gates in hydraulic steel engineering will be presented, their construction and calculation of their loading will be discussed.
presented topics:

- determination of hydrostatic and hydrodynamic flow forces
- principles of calculation
- overview gates: lock gates, weir gates, submerged gate leafs
- flow dependent building vibrations
- cavitation

- packings, sealings
- corrosion protection

Building- and Environmental Aerodynamics:
The lecture gives an introduction to the field of buidling- and environmental aerodynamics. Part 1 is dedicated to building aerodynamics and to the assessment of wind loads, whereas part 2 deals with aspects of flows in natural environments.
presented topics:

- Atmospheric boundary layer and natural wind
- Wind loads on technical and natural structures
- Wind induced vibrations
- Wind shelter
- Wind tunnel modelling

Remarks
Literature:
Wickert, G., Schmaußer, G.,1971, Stahlwasserbau, Springer Verlag, Berlin,
Schmaußer, G., Nölke, H., Herz, E., 2000, Stahlwasserbauten - Kommentar zur DIN 19704, Ernst und Sohn Verlag, Berlin
Naudascher, E., 1991, Hydrodynamic Forces, Balkema Pub., Rotterdam
Naudascher, E., Rockwell, D., 2005, Flow-Induced Vibrations, Dover Publ., N.Y.
Erbisti, P.C.F., 2004, Design of Hydraulic Gates, Balkema Pub., Tokyo
Lewin, J., 1995, Hydraulic Gates and Valves in free surface flow and submerged outlets, Th. Telford Pub., London
Hucho, W., 2002: “Aerodynamik der stumpfen Körper”, Vieweg-Verlag, ISBN 3-528-06870-1
Holmes, J.D., 2007: “Wind Loading on Structures”, Taylor & Francis, ISBN 978-0-415-40946-9
Oertel, H., Ruck, S.: 2012: “Bioströmungsmechanik”, Vieweg - Teubner, ISBN: 978-3-8348-1765-5
Oertel, H. jr. (Hrsg.), 2008: “Prandtl - Führer durch die Strömungslehre”, Vieweg-Teubner, ISBN 978-3-8348-0430-3

Module: Technical Hydraulics [bauiM2S17-SM3]

Coordination: C. Lang
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Water and Environment

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6221804	Steady and Unsteady-state Operation of Hydraulic Systems (p. 381)	L/E	2/2	S	6	C. Lang

Learning Control / Examinations
graded:
examination Technical Hydraulics, written, 100 min., accord. ER/SPO § 4 par. 2 no. 1
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
course Hydromechanics (6200304),
module Advanced Fluid Mechanics [bauiM2P1-AFM] or Fluid Mechanics for Environmental Flows [bauiM2P4-FMENVFL]

Qualification Goals
The students have the competence to analyze, calculate and evaluate a complex fluid mechanics problem. This ability will be practiced by means of many practical applications

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercise:	60 h
independent study:	
preparation and follow-up:	60 h
examination preparation and examination:	60 h
total:	180 h

Content
Part 1: Pipe flow systems

- Dimensioning of pipe flow systems
- Calculation of pipe networks
- Unsteady flow in pipe lines

Part 2: Control structures

- Discharge characterisitcs
- Energy dissipation
- Spillway chute
- Unsteady operating

Remarks
Literature:
Vorlesungsskript Rohrhydraulik, 2009
Lang, C., Jirka, G., 2009, Einführung in die Gerinnehydraulik, Universitätsverlag Karlsruhe
Naudascher, E., 1992, Hydraulik der Gerinne und Gerinnebauwerke, Springer Verlag Berlin

Module: Experimental Techniques II: Measurement Techniques [bauiM2S18-SM4]

Coordination: B. Ruck
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Water and Environment

ECTS Credits	Cycle	Duration
6	Every 2nd term, Winter Term	2

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6221703	Flow Measuring Technique (p. 385)	L/E	1/1	W	3	B. Ruck
6221812	Signal Processing in Fluid Mechanics (p. 367)	L/E	1/1	S	3	B. Ruck

Learning Control / Examinations
graded:
partial examination Flow Measuring Technique, oral , 30 min., accord. ER/SPO § 4 par. 2 no. 2
partial examination Signal Processing in Fluid Mechanics, oral , 30 min., accord. ER/SPO § 4 par. 2 no. 2
grading:
grade of module is defined by weighted average according credit points of grades of the partial examinations

Conditions
none

Recommendations
none

Qualification Goals
Signal detection and processing in fluid mechanics: The lecture deals with the fundamentals of signal detection and processing in fluid mechanics. Both, processing in the time and frequency domain will be explained.Typical processing procedures of existing measuring systems will be demonstrated. Flow Measuring Technique: The lecture gives an introduction to existing flow measuring techniques. Measuring techniques based on electrical, acoustical and optical signal detection and processing are presented.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercise:	60 h
independent study:	
preparation and follow-up:	60 h
examination preparation and examination:	60 h
total:	180 h

Content
Flow measuring techniques (WS):

- Pressure-based and mechanical probes
- electrical measuring systems
- acoustical measuring devices
- laser-based flow measuring systens

Signal detection and processing in fluid mechanics (SS):

- Introduction to signal detection and processing
- fundamentals and definitions

- flow measuring techniques and their specific signal detection and processing
- processing in time and frequency domain
- image analysis

Remarks
Literature:
Profos, P., Pfeifer, T., 1993: “Grundlagen der Messtechnik”, Oldenburg-Verlag, ISBN 3-486-22537-5
Ruck, B., 1987: “Laser-Doppler-Anemometrie”, AT-Fachverlag Stuttgart, ISBN 3-921 681-00-6
Ruck, B. (Hrsg.), 1990: “Lasermethoden in der Strömungsmesstechnik”, AT-Fachverlag Stuttgart, ISBN 3-921681-01-4
Schlichting, H., Gersten, K., 2006: “Grenzschichttheorie”, Springer-Verlag, ISBN: 978-3-540-23004-5

Module: Environmental Fluid Mechanics [bauiM2S19-SM5]

Coordination: O. Eiff
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Water and Environment

ECTS Credits	Cycle	Duration
6	Every 2nd term, Winter Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6221907	Environmental Fluid Mechanics (p. 271)	L/E	3/1	W	6	O. Eiff

Learning Control / Examinations
graded:
examination Environmental Fluid Mechanics, written, 90 min., accord. ER/SPO § 4 par. 2 no. 1
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
modules Advanced Fluid Mechanics [bauiM2P1-AFM] or Fluid Mechanics for Environmental Flows [bauiM2P4-FMENVFL], Analyses of Turbulent Flows []

Qualification Goals
The students identify fundamental hydrodynamic processes in the natural environment in water and air applications and solve related problems. They can relate the observed phenomena to fundamental principles of hydrodynamics and to the specific nature of the flow conditions. They can critically evaluate the different models and approximations made to obtain solutions and predictions and can make first estimates.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercise:	60 h
independent study:	
preparation and follow-up:	60 h
examination preparation and examination:	60 h
total:	180 h

Content
This module covers the fundamental concepts and flow models of environmental fluid mechanics in both water and air. The topics include turbulence structure in rivers and open channels, diffusion and dispersion, atmospheric boundary layers, internal waves, instabilities and mixing, stratified turbulence, buoyant jets and plumes.

Remarks
will be offered as from winter term 2016/17, in English

Module: Turbulent Flows [bauiM2S20-NS1]

Coordination: M. Uhlmann
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Water and Environment

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	2

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6221806	Fluid Mechanics of Turbulent Flows (p. 288)	L	2	S	3	M. Uhlmann
6221913	Modelling of Turbulent Flows - RANS and LES (p. 395)	L	2	W	3	M. Uhlmann

Learning Control / Examinations
graded:
partial examination Fluid Mechanics of Turbulent Flows, oral, 30 min., accord. ER/SPO § 4 par. 2 no. 2
partial examination Modelling of Turbulent Flows, oral, 30 min., accord. ER/SPO § 4 par. 2 no. 2
grading:
grade of module is defined by weighted average according credit points of grades of the partial examinations

Conditions
none

Recommendations
courses Hydromechanics (6200304), Mathematics (0131900, 0181300, 0132200)

Qualification Goals
Introduction to the physics of turbulent flows and the problem of computing them, statistical analysis of turbulent field data, detailed description of currently used statistical turbulence models (Reynolds-averaging as well as spatial filtering), discussion of model performance and range of applicability

Workload

Content
Fluid Mechanics of Turbulent Flows:

- general introduction to turbulent flows
- equations of fluid motion
- statistical description of turbulence
- free shear flows
- the scales of turbulent motion
- wall-bounded shear flows
- DNS as numerical experiments

Turbulence Models RANS - LES:

- introduction to RANS modelling
- k-epsilon and other eddy viscosity models
- Reynolds-stress transport models
- the concept of Large-Eddy Simulation (LES)
- spatial filtering

- current Subgrid-stress models
- boundary conditions and wall treatment

Remarks
IMPORTANT:
This module will not be offered any more as from summer term 2016. It will be replaced by the new module Analysis of Turbulent Flows [bauiM2S32-NS3].

Literature:
S.B. Pope “Turbulent flows”, Cambridge University Press, 2000.
U. Frisch “Turbulence: The legacy of A.N. Kolmogorov”, Cambridge U. Press, 1995.
P.A. Durbin and P.A. Petterson Reif. “Statistical theory and modeling for turbulent flows”, Wiley, 2001.
D.C. Wilcox “Turbulence Modeling for CFD”, DCW Industries, second edition, 1998.

Module: Advanced Computational Fluid Dynamics [bauiM2S21-NS2]

Coordination: M. Uhlmann
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Water and Environment

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6221807	Parallel Programming Techniques for Engineering Problems (p. 347)	L/E	1/1	S	3	M. Uhlmann
6221809	Numerical Fluid Mechanics II (p. 345)	L/E	1/1	S	3	M. Uhlmann

Learning Control / Examinations
graded:
partial examination Parallel Programming Techniques, written, 60min., accord. ER/SPO § 4 par. 2 no. 1
partial examination Numerical Fluid Mechanics II, oral, 30 min., accord. ER/SPO § 4 par. 2 no. 2
grading:
grade of module is defined by weighted average according credit points of grades of the partial examinations

Conditions
module Advanced Fluid Mechnics [bauiM2P1-AFM] or Numerical Fluid Mechanics [bauiM2P5-NUMFLMECH]

Recommendations
numerical treatment of partial differential equations, programming skills

Qualification Goals
The students are able to solve numerically simple flow problems based on the Navier-Stokes equations by themselves. This comprises the the design of a solution method, the analysis of its properties (stability, accuracy, computational effort), the implementation of algorithms, the validation by means of appropriate test cases, and finally the dcumentation and communication of the results. Furthermore, the students are put in the position to evaluate techniques using massive parallel computer systems for solving flow problems with regard to efficiency and applicability, and to apply them to modelling problems.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercise:	60 h
independent study:	
preparation and follow-up:	60 h
examination preparation and examination:	60 h
total:	180 h

Content
Parallel programming techniques:

- architectures of parallel computers
- general considerations and limits of parallel efficiency (speedup, scaling, latency, load-balancing, Amdahl's law)
- parallel programming paradigms
- design of a parallel program
- general strategies for algorithm parallelization
- introduction to the message passing standard MPI

- parallelization of some select algorithms (hands-on sessions)

Numerical Fluid Mechanics II:

- efficient solution of the incompressible Navier-Stokes equations
- grid generation
- utilization of a commercial CFD package
- extension of the existing software package with user-defined modules

Remarks
Literature:
C. Hirsch “Numerical computation of internal and external flows” Butterworth-Heinemann, 2nd edition, 2007.
J.H. Ferziger and M. Peric “Computational Methods for Fluid Dynamics”, Springer, 3rd edition, 2001.
N. Carriero “How to Write Parallel Programs: A First Course”, MIT Press, 1990.
T.G. Mattson, B.A. Sanders, B.L. Massingill “Patterns for Parallel Programming” Addison-Wesley, 2004.
M. Snir, S. Otto, S. Huss-Lederman, D. Walker, J. Dongarra “MPI: The Complete Reference”, MIT Press, 1995.

Module: Water Treatment Technologies [bauiM2S24-SW1]

Coordination: E. Hoffmann
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Water and Environment

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6223801	Process Technologies in Storm Water Treatment (p. 406)	L/E	2	S	3	S. Fuchs, E. Hoffmann
6223803	Process Technologies in Water Supply and Wastewater Disposal (p. 407)	L/E	2	S	3	E. Hoffmann

Learning Control / Examinations
graded:
partial examination Process Technologies in Storm Water Treatment, term paper, appr. 10 pages, and presentation, accord. ER/SPO § 4 par. 2 no. 3
partial examination Process Technologies in Water Supply and Wastewater Disposal, oral, 30 min., accord. ER/SPO § 4 par. 2 no. 2
grading:
grade of module is defined by weighted average according credit points of grades of the partial examinations

Conditions
none

Recommendations
The attendance of the course Sanitary Environmental Engineering (6200603) is recommended.

Qualification Goals
The studends are familiar with different plants for waste water and storm water treatment. They can explain the functional principles of single plant components, evaluate their usability for specific cases of application, and apply basic design approaches.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercise:	60 h
independent study:	
preparation and follow-up:	40 h
preparation of term paper (partial examination):	30 h
examination preparation and examination:	50 h
total:	180 h

Content
visiting, description and evaluation of different plants for water treatment:

- storm water sedimentation tank
- storm water overflow tank
- soil retention filter
- waste water treatment plants

design principles of facilities for storm water treatment

Remarks
Literature:
Gujer, W.: “Siedlungswasserwirtschaft”, Springer, Berlin (3. Aufl., 2007)

Module: Urban Water Management [bauiM2S25-SW2]

Coordination: S. Fuchs
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Water and Environment

ECTS Credits	Cycle	Duration
6	Every 2nd term, Winter Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6220902	Urban Water Management (p. 403)	L/E	4	W	6	S. Fuchs, P. Klingel, U. Mohrlok

Learning Control / Examinations
graded:
examination Urban Water Management, oral, accord. ER/SPO § 4 par. 2 no. 2
attested:
term paper as examination prerequisite, accord. ER/SPO § 4 par. 2 no. 3
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
course Sanitary Environmental Engineering (6200603),
modules Technical Hydraulics [bauiM2S17-SM3], Water Treatment Technologies [bauiM2S24-SW1]

Qualification Goals
The students have knowledge in integrated water ressource management focusing on urban areas. That covers fundamental knowledge in water and linked substance transports on surfaces, in surface water, water distribution and sewer systems and groundwater bodies.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercise:	60 h
independent study:	
preparation and follow-up:	40 h
preparation of term paper:	30 h
examination preparation and examination:	50 h
total:	180 h

Content

- amount and quality of different runoff components
- indicators of pollution
- tools for urban water management (water distribution, urban drainage, surface and ground waters; characteristics of urban surface waters)

Remarks
IMPORTANT:
This module will not be offered any more as from winter term 2016/17.

Literature:
lecture accompanying documents and variing papers

Module: Water Quality of Surface Water and Groundwater [bauiM2S26-SW3]

Coordination: S. Fuchs
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Water and Environment

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6223813	Seminar Water Quality (p. 363)	S	2	S	3	S. Fuchs, S. Hilgert, U. Mohrlok
6223814	Field Training Water Quality (p. 293)	P	2	S	3	S. Fuchs, S. Hilgert, U. Mohrlok

Learning Control / Examinations
graded:
partial examination Seminar Water Quality, term paper, appr. 10 pages, and presentation, accord. ER/SPO § 4 par. 2 no. 3
partial examination Field Training Water Quality, report, appr. 10 pages, with presentation, accord. ER/SPO § 4 par. 2 no. 3
grading:
grade of module is defined by weighted average according credit points of grades of the partial examinations

Conditions
none

Recommendations
The attendance of the courses Sanitary Environmental Engineering (6200603) and Groundwater Management (6221801) is recommended.

Qualification Goals
Die students are able to explain and evaluate critically the interdisciplinary interrelations (fluid mechanics, chemistry, ecology) which determines the water quality in surface water and groundwater by means of presenting the theoretical basics and the legal framework. They can critically evaluate the date obtained in the fiedl by their own with respect to the uncertainty related to the collection of the data as well as the classification into the context of the river basin.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
seminar, field training:	60 h
independent study:	
preparation and follow-up:	40 h
preparation of term paper (partial examination):	30 h
preparation of report and presentation (partial examination):	50 h
total:	180 h

Content

- basics: fluid mechanics, mass balances, zonation
- legal frame work
- pollution of water bodies: inflows, substances, sediment problem
- sampling methods
- methods for the evaluation of water quality and status of water bodies

Remarks

IMPORTANT:

This module will not be offered any more as from winter term 2016/17. It will be replaced by a newly configured module.

Literatur:
Schwörbel, Einführung in die Limnologie, 7. Aufl., UTB-Verlag Gustav Fischer (1993)
Lampert und Sommer, Limnoökologie, Thieme Verlag (1993)
Schwörbel, Methoden der Hydrobiologie, Süßwasserbiologie, 3. Aufl., UTB-Verlag Gustav Fischer (1986)
DIN 38410 (2004): Deutsche Einheitsverfahren zur Wasser-, Abwasser- und Schlammuntersuchung - Biologisch-ökologische Gewässeruntersuchung . DIN Deutsches Institut für Normung e.V., Beuth Verlag Berlin
DVWK (Deutscher Verband für Wasserwirtschaft und Kulturbau), Schriften 107, "Grundwassermessgeräte", Verlag Paul Parey, 1994.
DVWK (Deutscher Verband für Wasserwirtschaft und Kulturbau), Schriften 125, "Methoden für die Beschreibung der Grundwasserbeschaffenheit", Verlag Paul Parey, 1999.
Wechselnde aktuelle Literatur

Module: Water Supply and Sanitation Systems and Plants [bauiM2S28-SW5]

Coordination: E. Hoffmann
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Water and Environment

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	2

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6223808	Water Treatment (p. 415)	L/E	2	S	3	E. Hoffmann
6222905	Water Distribution (p. 418)	L/E	2	W	3	P. Klingel

Learning Control / Examinations
graded:
partial examination Water Treatment, oral, accord. ER/SPO § 4 par. 2 no. 2
partial examination Water Distribution, oral, accord. ER/SPO § 4 par. 2 no. 2
grading:
grade of module is defined by weighted average according credit points of grades of the partial examinations

Conditions
none

Recommendations
course Santitary Enverimental Engineering (6200603)

Qualification Goals
Knowledge in operation and optimization of water distribution drainage and treatment systems

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercise:	60 h
independent study:	
preparation and follow-up:	40 h
examination preparation and examination:	80 h
total:	180 h

Content
Water infrastructure:

- operation
- design of system components
- operational planning, optimization in regard to effiziency ressources and energy consumption
- case studies

adapted concepts and design of water treatment plants:

- phase separation
- oxidation
- precipitation, flocculation
- adsorption

Remarks
IMPORTANT:

This module will not be offered any more as from winter term 2016/17. Contents and competences will be provided by newly configured modules.

Literature:
textbooks,
technical and scientific papers,
lecture notes

Module: Industrial Water Management [bauiM2S29-SW6]

Coordination: E. Hoffmann
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Water and Environment

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	2

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6223810	Cleaner Production - Closing the Loop (p. 320)	L/E	2	S	3	E. Hoffmann
6223902	Appropriate Technologies (p. 226)	L/E	2	W	3	E. Hoffmann

Learning Control / Examinations
graded:
examination Industrial Water Management, oral, 30 min., accord. ER/SPO § 4 par. 2 no. 2
attested:
report on lab work, appr. 10 pages, as examination prerequisite, accord. ER/SPO § 4 par. 2 no. 3
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
course Sanitary Environmental Engineering (6200603)

Qualification Goals
The students have available knowledge about the techniques of waste water treatment in industrial production processes and can explain the functional principles of the techniques. They are able to evaluate compounds of industrial waste water and emissions on the base of legal regulations. They can analyse problems of the treatment of industrial waste water and select appropriate techniques for emission reduction and water recycling.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up:	40 h
laboratory work (examination prerequisite):	30 h
examination preparation and examination:	50 h
total:	180 h

Content
This module will discuss different types of waste waters (e.g. leather, paper, metal industries) and appropriate physico-chemical as well as biological treatment technologies.

Remarks
Literature:
lecture accompanying documents

Module: River Basin Modeling [bauiM2S30-SW7]

Coordination: S. Fuchs
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Water and Environment

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	2

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6223812	Mass Fluxes in River Basins (p. 382)	L	2	S	3	S. Fuchs
6223904	Modelling Mass Fluxes in River Basins (p. 333)	E	2	W	3	S. Fuchs

Learning Control / Examinations
graded:
partial examination Mass Fluxes in River Basins, oral, accord. ER/SPO § 4 par. 2 no. 2
partial examination Modelling Mass Fluxes in River Basins, report, accord. ER/SPO § 4 par. 2 no. 3
grading:
grade of module is defined by weighted average according credit points of grades of the partial examinations

Conditions
none

Recommendations
course Sanitary Environmental Engineering (6200603)

Qualification Goals
Students can explain the basic relationships of water driven mass fluxes in river basins and of mass balances in waterbodies. They are able to analyse the influences of human activities on the status and quality of the waterbodies. They apply their knowledge about the transport paths of substances as well as the bio-chemical and physical phenomenons in water bodies for the formulation of mathematical modelling approaches. By means of simulation models, they are able to quantify mass emissions, to predict consequences of external impacts on the relevant quality processes in waterbodies and to conduct scenario anlyses. The students are enabled to analyse the modelling results and evaluate them with respect to their margin of uncertainty.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercise:	60 h
independent study:	
preparation and follow-up:	40 h
term paper Modelling Mass Fluxes in River Basins (partial examination):	40 h
examination preparation and examination:	40 h
total:	180 h

Content
In the lectures advanced basics about mass fluxs (N, P, pollutants) and transport paths in river basins are provided as well as their quantitative description by modelling approaches. The students get a single-user license of the programme MoRE (Modelling of Regionalized Emissions). They work in small teams on a project task and analyse the results.

Remarks
Literature:
modelling tools,
lecture accompanied literatur

Module: Analysis of Turbulent Flows [bauiM2S32-NS3]

Coordination: M. Uhlmann
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Water and Environment

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	2

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6221806	Fluid Mechanics of Turbulent Flows (p. 288)	L	2	S	3	M. Uhlmann
6221913	Modelling of Turbulent Flows - RANS and LES (p. 395)	L	2	W	3	M. Uhlmann

Learning Control / Examinations
graded:
partial examination Analysis of Turbulent Flows, oral, 45 min., accord. ER/SPO § 4 par. 2 no. 2
grading:
grade of module is defeined by grade of examination

Conditions
must not be selected together with module Turbulent Flows [bauiM2S20-NS1].

Recommendations
Hydromechanics/Fluid Mechanics (dealing with Navier-Stokes equations)
Mathematics (Analysis - partial differential equations, Fourier analysis, vektors/tensors, matrices and Eigenvalues; statistics)
preliminary knowledge in programming with Matlab is helpful; otherwise attending the course 'Introduction to Matlab' is recommended.

Qualification Goals
The students are able to describe the fundamental characteristics of turbulent flows and to quantify their influence on different balanced quantities. They can classify the difficulty of computing turbulent flows. With this knowledge, they can weigh the advantages and disadvantages of different modelling approaches against each other according to the application and make an appropriate selection for a given problem. The students can analyse critically the expected results of turbulence models with regard to prediction capability and computational effort.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercise:	60 h
independent study:	
preparation and follow-up:	60 h
examination preparation and examination:	60 h
total:	180 h

Content
Fluid Mechanics of Turbulent Flows:

- general introduction to turbulent flows
- equations of fluid motion
- statistical description of turbulence
- free shear flows
- the scales of turbulent motion

- wall-bounded shear flows
- DNS as numerical experiments

Turbulence Models RANS - LES:

- introduction to RANS modelling
- k-epsilon and other eddy viscosity models
- Reynolds-stress transport models
- the concept of Large-Eddy Simulation (LES)
- spatial filtering
- current Subgrid-stress models
- boundary conditions and wall treatment

Remarks
newly offered as from summer term 2016, replaces the module Turbulent Flows [bauiM2S20-NS1]

4.3 Modules Study Focus 3: Mobility and Infrastructure

Module: Urban and Regional Planning [bauiM3P1-PLSTAREG]

Coordination: P. Vortisch
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Mobililty and Infrastructure

ECTS Credits	Cycle	Duration
6	Every 2nd term, Winter Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6231701	Urban Planning (p. 375)	L/E	1/1	W	3	C. Minster
6231703	Regional Planning (p. 358)	L	2	W	3	S. Wilske

Learning Control / Examinations
graded:
examination Urban and Regional Planning, oral, accord. ER/SPO § 4 par. 2 no. 2
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
module Mobility and Infrastructure [bauiBFP5-MOBIN]

Qualification Goals
The aim is to provide an overview of important tasks for spatial planning, of the legal principles, methods and strategies for solving spatial problems on urban and regional level. The students shall be able to develop planning strategies, particularly in the field of planning on a supra-local level.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up, examination preparation:	120 h
total:	180 h

Content
In the lectures basic goals and tasks of planning of different levels, procedures and instruments, the relationship between governmental and private planning are taught. The scientific contexts are developed systematically to strengthen the various methodological approaches to understand and evaluate them. Particular attention will be paid inter alia to changing conditions, such as demographic and economic developments.

Remarks
Literature:
list of literature for module

Module: Models and Methods in Traffic Engineering and Transportation Planning [bauiM3P2-VERMODELL]

Coordination: P. Vortisch
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Mobililty and Infrastructure

ECTS Credits	Cycle	Duration
6	Every 2nd term, Winter Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6232701	Methods and Models in Transportation Planning (p. 247)	L/E	1/1	W	3	P. Vortisch, M. Kagerbauer
6232703	Traffic Engineering (p. 383)	L/E	1/1	W	3	P. Vortisch

Learning Control / Examinations
graded:
examination Models and Methods in Traffic Engineering and Transportation Planning, oral, accord. ER/SPO § 4 par. 2 no. 2
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
none

Qualification Goals
knowledge about methods and approaches in transport planning and traffic engineering

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up, examination preparation:	120 h
total:	180 h

Content
Methods and models in transport planning as well as the relevant tools and methods for the traffic engineer.
Transport Planning:

- four-Step-Algorithm
- aggregate versus indivdiual models
- choice modeling

Traffic Engineering:

- measuring traffic flow data
- description of traffic conditions / fundamental diagram
- capacity of roads and intersections with and without traffic signals

Remarks
Literature:
lecture notes with additional references / exercise sheets

Module: Infrastructure Management [bauiM3P3-STRINFRA]

Coordination: R. Roos
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Mobililty and Infrastructure

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6233801	Design and Construction of Highways (p. 270)	L/E	2	S	3	R. Roos
6233802	Operation and Maintenance of Highways (p. 251)	L	2	S	3	R. Roos

Learning Control / Examinations
graded:
examination Infrastructure Management, oral, accord. ER/SPO § 4 par. 2 no. 2
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
none

Qualification Goals
The graduates are able to apply and develop respectively methods and techniques for different tasks related to the life cycle of a road (design, construction, operation and maintenance) and to examine these with regard to their technical suitability and economic feasibility. Futher, they have the competence to be able to apply these methods to other problems and in different fields and modify them respectively.

Workload
contact hours (1 HpW = 1 h x 15 weeks):
lectures, exercises: 60 h
independent study:
preparation and follow-up: 60 h
examination preparation and examination: 60 h

total: 180 h

Content
The module addresses further topics about design and construction of roads such as aspects of safety, junctions, construction materials, way of construction and drainage. In the phase of operation of a road after release for traffic logistical and technical aspects of the operation service (raod control, snow and ice control, green belt care etc.) as well as the maintenance of roads (status recognition and evaluation, surface and structure properties, pavement management a.o.) come to the fore which are important for smooth and safe traffic flow. These are discussed in the classes fundamentally.

Module: Track Guided Transport Systems - Technical Design and Components [bauiM3P4-EBTECHNIK]

Coordination: E. Hohnecker
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Mobililty and Infrastructure

ECTS Credits	Cycle	Duration
6	Every 2nd term, Winter Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6234701	Track Guided Transport Systems - Technical Design and Components (p. 372)	L/E	3/1	W	6	E. Hohnecker

Learning Control / Examinations
graded:
examination Track Guided Transport Systems - Technical Design & Components, written, 90 min., accord. ER/SPO § 4 par. 2 no. 1
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
none

Qualification Goals
to know the complexity of the profession “track guided systems”

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up, examination preparation:	120 h
total:	180 h

Content
basics in all fields; layout and dimensioning of lines

Remarks
Literature:
Zilch, Diederichs, Katzenbach: Handbuch f. Bauingenieure, Springer-Verlag

Module: Laws and Proceedings concerning Traffic and Roads [bauiM3P5-VERFRECHT]

Coordination: R. Roos
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Mobililty and Infrastructure

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6233803	Laws concerning Traffic and Roads (p. 409)	L	2	S	3	D. Hönig
6233804	Environmental Impact Assessment (p. 400)	L	1	S	1,5	R. Roos
6232801	Assessment and Evaluation Techniques (p. 253)	L	1	S	1,5	P. Vortisch, B. Chlond

Learning Control / Examinations
graded:
partial examination Laws concerning Traffic and Roads, oral, accord. ER/SPO § 4 par. 2 no. 2
partial examination Environmental Impact Assessment, oral, accord. ER/SPO § 4 par. 2 no. 2
partial examination Assessment and Evaluation Techniques, oral, accord. ER/SPO § 4 par. 2 no. 2
grading:
grade of module is defined by weighted average according credit points of grades of the partial examinations

Conditions
none

Recommendations
none

Qualification Goals
The graduates know the legal framework concerning construction and operating of roads and can justify and question decisions. Furthermore, they understand methods concerning environmental impact analysis of infrastructure, they can technically argue and classify evaluations of variants. In addition, they are able to apply assessment and evaluation techniques for the planning of infrastructure projects, to modify them with respect to specific applications and to analyse their results.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up:	60 h
examination preparation and examination:	60 h
total:	180 h

Content
Constitutional framework, envirnmental impact of roads, changeing topics concerning mainly proceedures in highway engineering Methodologies and application of standardized assessment and decisison techniques (Cost-Benefit-Analyses, Value Benefit Analyis etc.) in transport planning

Module: Urban Renewal [bauiM3S01-PLSTUMB]

Coordination: N. N.
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Mobililty and Infrastructure

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6231801	Urban Management (p. 374)	L/E	1/1	S	3	A. Karmann-Woessner
6231803	History of Urban Planning and the Built Environment (p. 376)	L	1	S	1,5	J. Vogt
6231804	Building Theory (p. 290)	L	1	S	1,5	N. N.

Learning Control / Examinations
graded:
examination Urban Renewal, oral, accord. ER/SPO § 4 par. 2 no. 2
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
none

Qualification Goals
The aim is to convey the principles and methods of urban renewal. In the module adaptation strategies are taught, by which cities and city regions react to changing conditions. These changes -such as climate change, demographics or changing economic practices- are encountered by urban concepts city-wide, on the level of city quarters or on the building level. In addition to the urban redevelopment in Germany selected references from Europe are examinated.

Workload
contact hours (1 HpW = 1 h x 15 weeks):
lectures, exercises: 60 h
independent study:
preparation and follow-up, examination preparation: 120 h

total: 180 h

Content
Based on the core module “Urban and Regional Planning” this lecture is focused on adaptation strategies of cities and urban regions. In addition to a classification in the current discussions on urban redevelopment basic methods and tools are taught. The students of the module Urban Renewal shall be able to elaborate strategies of urban renewal and redevelopment. The basic methodological framework is the discussion of projects as examples for good practice. The module will be supplemented by courses such as “History of Urban Planning and the Built Environment” to consider the historical development and cultural heritage. In addition, in the course “Building Theory” urban qualities and implementation on the building level are taught.

Remarks
Literature:
list of literature for module

Module: Space and Infrastructure [bauiM3S02-PLRAUMINF]

Coordination: M. Kagerbauer
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Mobililty and Infrastructure

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6231805	Logistics, Supply and Disposal (p. 276)	L/E	1/1	S	3	M. Kagerbauer
6072201	Fundamentals of Geographic Information Systems for Modelling and Planning (p. 306)	L	2	S	3	S. Keller

Learning Control / Examinations
graded:
examination Space and Infrastructure, oral, accord. ER/SPO § 4 par. 2 no. 2
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
none

Qualification Goals
Transport infrastructure, water and energy, and telecommunications are fundamental prerequisites for the development of an area. However, the conditions of the area, its topography, resources, environment, population and characteristics have to be considered in order to design not only an effective, but also a sustainable plan. This relationship between spatial planning and infrastructure development are mediated. This content will be supplemented by learning the skills to analyse and display spatial data. The aim is to show the importance of coupling between planning task and use of computer-based tools in spatial planning. A link between theoretical background and reality on the one hand and instruments on the other is necessary.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up:	60 h
examination preparation and examination:	60 h
total:	180 h

Content
Logistics, Supply and Disposal:
After a introduction to the terms infrastructure and development the lecture examines the most important infrastructures in detail:

- traffic systems
- railway planning
- air traffic
- watercourses

- water supply and drainage
- power supply
- telecommunications
- recycling and waste management systems
- calculation and distribution of development costs

Fundamentals of Geographic Information Systems for Modelling and Planning:

- foundations of information and communication theory
- spatial information on the Internet
- project presentation
- planning information systems
- technical information systems
- cartographic principles

Remarks
Literature:
list of literature for module

Module: Traffic Management and Simulation Methods [bauiM3S03-VERMANAGE]

Coordination: P. Vortisch
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Mobililty and Infrastructure

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6232802	Traffic Management and Transport Telematics (p. 410)	L/E	1/1	S	3	P. Vortisch
6232804	Traffic Flow Simulation (p. 368)	L/E	1/1	S	3	P. Vortisch

Learning Control / Examinations
graded:
examination Traffic Management und Simulation Methods, oral, accord. ER/SPO § 4 par. 2 no. 2
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
none

Qualification Goals
Acquisition of the specific and advanced knowledge and the relevant methodologies in the field of traffic engineering. Basic considerations in the development and the application of simulation models in transport planning and traffic engineering.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up, examination preparation:	120 h
total:	180 h

Content
In excess of the basic module “Model approaches and methods in transportation” more advanced methods of traffic engineering will be dealt with (advanced signalisation, control of routes and networks). Furthermore methods for the development of simulation models as well as their application will be in the focus (application of professional software tools for transport planning and traffic engineering). Another issue are transport telemtics and intelligent transportation system.

Remarks
Literature:
lecture notes,
guidelines (manual for highway design, guidelines for light signals),
software manuals

Module: Planning of Transportation Systems [bauiM3S04-VERPLAN]

Coordination: P. Vortisch
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Mobililty and Infrastructure

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6232806	Characteristics of Transportation Systems (p. 266)	L	2	S	3	P. Vortisch
6232808	Strategic Transport Planning (p. 384)	L	2	S	3	V. Waßmuth

Learning Control / Examinations
graded:
examination Planning of Transportation Systems, oral, 30 min., accord. ER/SPO § 4 par. 2 no. 2
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
course Transportation (6200405)

Qualification Goals
The students know all common means of transport and their properties. They can assess advantages and disadvantages of the means of transport from the perspective of users, operators and the environment, and they can make decisions about the system adapted to the situation. They understand the systemic interrelation of means of transport, infrastructure and mobility behaviour. The students know the methods of transportation planning common in practise and can these critically evaluate and develop further.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up:	60 h
examination preparation and examination:	60 h
total:	180 h

Content

- means of transport and their properties: capacity, velocity and energy consumption;
- environmental impacts: pollutant emission, noise and traffic safety;
- origin and evolution of traffic demand;
- examples of transport systems: bicyle traffic as system, planning procedures in paublic transport,
- boundary conditions of strategic planning: target systems, civic participation, policy influence;
- application of models;
- activity development;
- impact investigation and evaluation;
- examples: federal road plan, international master plans;

- transport development plans

Remarks
Literature:
Lecture notes and lecture materials are available for download.

Module: Highway Design [bauiM3S05-STRENTW]

Coordination: M. Zimmermann
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Mobililty and Infrastructure

ECTS Credits	Cycle	Duration
6	Every 2nd term, Winter Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6233901	IT-based Road Design (p. 265)	L/E	2	W	3	M. Zimmermann
6233903	Highway Design Project Study (p. 354)	L/E	2	W	3	M. Zimmermann, R. Roos

Learning Control / Examinations
graded:
examination Highway Design, oral, accord. ER/SPO § 4 par. 2 no. 2
attested:
attestation of study project design of a rural road as internal prerequisite, accord. ER/SPO § 4 par. 2 no. 3
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
preliminary attendance of compulsory module Infrastructure Management [bauiM3P3-STRINFRA]

Qualification Goals
The graduates can apply methods as well as manual and computer aided procedures for the design of a road in position elevation and cross section and design new roads. Furthermore, they are able to develop and evaluate variants of new roads considering traffic, topographic, ecologic and economic requirements as well as to assess road designs in compliance with the technical regulations.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up:	60 h
preparation of study project:	30 h
examination preparation and examination:	30 h
total:	180 h

Content
In this module the procedure of finding the route of a bypass road will be discussed and applied to a specific planning example. After defining the boundary conditions für the draft of this bypass road design solutions are developed in the map, in the gradient diagramm and in the cross-section manually by small teams. The results are discussed. Here also, tests are made whether the standards are satisfied and related to requirements of the spatial route planning. In parallel to this manual route planning of the road, the procedure of a computer aided road design is addressed in theory as well as pratically at basic design examples. The exercises are conducted by use of the both most popular design codes.

Module: Road Construction [bauiM3S06-STRBAUT]

Coordination: R. Roos
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Mobililty and Infrastructure

ECTS Credits	Cycle	Duration
6	Every 2nd term, Winter Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6233904	Practical Laboratory Training in Road Construction (p. 321)	L/E	2	W	3	P. Plachkova-Dzhurova
6233905	Pavement Structural Design and Failure Analysis (p. 246)	L	2	W	3	P. Plachkova-Dzhurova

Learning Control / Examinations
graded:
examination Road Construction, oral, accord. ER/SPO § 4 par. 2 no. 2
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
preliminary attendance of compulsory module Infrastructure Management [bauiM3P3-STRINFRA]

Qualification Goals
The graduates are able to dimension and to test roadway constructions build of asphalt and concrete empirically and by calculation and to assess the impact of internal and external influencing factors on roadway constructions. Furthermore, they are able to explain mechanisms of failure, to question and to evaluate failures as well as to test material parameters by experimental techniques in the lab.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up:	60 h
examination preparation and examination:	60 h
total:	180 h

Content
In this module material models, influencing factors on roadway constructions as well as basics and patrameters for an empirical and calculatory dimensioning of transportation routes are addressed deeply. Furtermore, deficiencies and failures of roadway constructions are presented and failure mechanisms are explained. In the practical training experiments on the determination of material parameters of unconsolidated meterials, bitumen and asphalt are conducted, analysed and evaluated as well as the applicaton of dimensioning methods are examined at real-world examples.

Module: Project Integrated Planning [bauiM3S09-PROJEKTIP]

Coordination: R. Roos
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Mobililty and Infrastructure

ECTS Credits	Cycle	Duration
6	Every 2nd term, Winter Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6230901	Project Integrated Planning (p. 351)	Pj	4	W	6	R. Roos, M. Zimmermann, B. Chlond, M. Weigel, Assistenten

Learning Control / Examinations
graded:
examination Project Integrated Planning, in 2 of 4 subjects, oral, accord. ER/SPO § 4 par. 2 no. 2
attested:
integrated term paper of the whole group and 2 presentations of the results as examination prerequisite, accord. ER/SPO § 4 par. 2 no. 3
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
preliminary attendance of at least 2 compulsory modules in the Focus Mobility and Infrastructure

Qualification Goals
The graduates are able to analyze the planning requirements of the different subject areas in the field mobility and infrastructure and to apply them to a specific example. They identify the weak points, develop realizable solutions and discuss them in the framework of a multi-disciplinary weighing process. Furthermore, they can work self-organized and have organisational and didactic competences with respect to team work and presentation.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
on-site meeting, technical group meetings, präsentations:	15 h
independent study:	
preparation and follow-up:	15 h
team exercise (per person): 135 h	
examination preparation and examination:	15 h
total:	180 h

Content
A typical practical task in the field of spatial and infarastructure planning has to be elaborated (e.g. ideas contest in town planning). The students have to take charge of certain planning tasks from the fields town planning, transport studies, highway engineering and track guided transport systems and develop different solution concepts baseed on a conflict and deficiency analysis. In order to obtain an integrated planning concept the requirements of the involved subject areas have to be considered. Susequent to a weighing process, they select well-founded a acceptable and sustainable concept which they develop further and present in 3 phases to a realizable solution on different levels of detail.

Module: Intermodality in Freight, Long-distance and Air Transport [bauiM3S11-VERINTER]

Coordination: B. Chlond
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Mobililty and Infrastructure

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	2

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6232809	Freight Transport (p. 307)	L/E	1/1	S	3	B. Chlond
6232904	Long-distance and Air Traffic (p. 284)	L	2	W	3	B. Chlond, N.N., Wilko Manz

Learning Control / Examinations
graded:
partial examination Freight Transport, oral, accord. ER/SPO § 4 par. 2 no. 2
partial examination Long-distance and Air Transport, oral, accord. ER/SPO § 4 par. 2 no. 2
grading:
grade of module is defined by weighted average according credit points of grades of the partial examinations

Conditions
none

Recommendations
none

Qualification Goals
Knowledges about the characteristics of freight transportation, long distance travel and air travel against the background of the globalization and and EU-integration Knowledge about the challenges and the design and of intermodal transport services.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up, examination preparation:	120 h
total:	180 h

Content

- relevant factors for the demand in freight transport
- methods for demand forecasts and planning in freight transport
- measures for influencing the demand in freight transport as well as their efficiency
- particularities of the airline industry in a global market shown in case studies
- organisation of the airline industry
- particularities of Long Distance Travel
- methodology of the Federal Transport Master Plan
- evolution of Long Distance Transport Systems

Remarks
Literature:
lecture accompanying documents

Module: Road Safety [bauiM3S12-STRVSICH]

Coordination: M. Zimmermann
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Mobililty and Infrastructure

ECTS Credits	Cycle	Duration
6	Every 2nd term, Winter Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6233906	Safety Management in Highway Engineering (p. 366)	L/E	2	W	3	M. Zimmermann
6233908	Seminar in Highway Engineering (p. 364)	S	2	W	3	M. Zimmermann

Learning Control / Examinations
graded:
examination Road Safety, oral,accord. ER/SPO § 4 par. 2 no. 2
attested:
integrated term paper and presentation of the results as internal examination prerequisite, accord. ER/SPO § 4 par. 2 no. 3
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
none

Qualification Goals
The graduates are able to apply methods and techniques for the improvement of road safety, to evaluate the safety of road networks, road sections and junctions, to identify accident black spots, to analyse accidents and their causes as well as to develop measures to improve road safety and evaluatre them in their effect. Furthermore, they are able to self-organized and have organisational and didactic competences available related to team work and presentations.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, seminar:	60 h
independent study:	
preparation and follow-up:	30 h
preparation of term paper:	60 h
examination preparation and examination:	30 h
total:	180 h

Content
In this course the theoretical basics of road safety are repeated and fundamental improvements are discussed.
During the following seminar in highway engineering changing regional accident black spots are analysed and improvements for the road authorities are worked out and will be presented.

Module: Special Topics in Highway Engineering [bauiM3S13-STRSPEZ]

Coordination: R. Roos
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Mobililty and Infrastructure

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6233805	Technical and Economic Management Tools in Highway Engineering (p. 387)	L	2	S	3	H. Rethage
6233806	Simulations and Analysis Methods in Highway Engineering (p. 369)	L	1	S	1,5	R. Roos, staff
6233807	Special Topics in Highway Engineering (p. 248)	L	1	S	1,5	R. Roos

Learning Control / Examinations
graded:
partial examination Technical and economical management tools in Highway Engineering, oral, accord. ER/SPO § 4 par. 2 no. 2
partial examination Special Chapters in Highway Engineering, oral, accord. ER/SPO § 4 par. 2 no. 2
grading:
grade of module is defined by arithmetic average of grades of the partial examinations

Conditions
none

Recommendations
preliminary attendance of compulsory module Infrastructure Management [bauiM3P3-STRINFRA]

Qualification Goals
Learning the methodology of organisation and carrying out the road operation and maintenance
The graduates are able to apply methods and techniques for specific aspects in the life cycle of a road, to modify them for the application case and to analyse the obtained knowledge. They are able to investigate the organisation and implementation of the operation and maintenance of a road, for instance, to reveal the weak points and to develop improvement possibilities.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up:	60 h
examination preparation and examination:	60 h
total:	180 h

Content
In this module the duties of the management of existing roads are aquiered and the technical and commercial control from the point of view of the road authorities are explained. Further, different methods for the simulation, analysis and evaluation of additional problems and special aspects in highway engineering are presented and discussed by means of varying topics of design, construction, operation and maintenance of roads (e.g. statistical analysis of large data sets, simulation of traffic flow under particular boundary conditions, construction material analysis in lab experiments, innovative contractual forms for construction and operation of roads, econ. privatization).

Module: Dimensioning and Construction of Railway Tracks [bauiM3S14-EBBAU]

Coordination: E. Hohnecker
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Mobililty and Infrastructure

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6234806	Infrastructure Dimensioning and Running Dynamics of Railway Tracks (p. 312)	L/E	1/1	S	3	E. Hohnecker, staff
6234808	Infrastructure Equipment of Railway Tracks (p. 311)	L	1	S	1,5	E. Hohnecker, staff
6234809	Construction and Maintenance of Track Infrastructure (p. 232)	L	1	S	1,5	E. Hohnecker, staff

Learning Control / Examinations
graded:
examination Dimensioning and construction of railway lines, oral, accord. ER/SPO § 4 par. 2 no. 2
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
preliminary attedance of compulsory module Track Guided Transport Systems - Technical Design & Components [bauiM3P4-EBTECHNIK]

Qualification Goals
to know the methods of planning, dimensioning, construction and maintenance of railway lines

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up, examination preparation:	120 h
total:	180 h

Content

- dimensioning of railway tracks
- planning and construction of railway lines
- operation and maintenance
- mechanic and planing models
- power supply
- electric elements in signalling/operation

Remarks
Literature:
Fiedler: Grundlagen der Bahntechnik, Werner-Verlag, Düsseldorf

Module: Economics, Law and Environmental Aspects in Railway Transportation [bauiM3S15-EBUMWELT]

Coordination: E. Hohnecker
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Mobililty and Infrastructure

ECTS Credits	Cycle	Duration
6	Every 2nd term, Winter Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6234901	Environmental Aspects of Guided Transport Systems (p. 398)	L	2	W	3	E. Hohnecker
6234902	Economic Efficiency of Track Guided Transport Systems (p. 423)	L	1	W	1,5	E. Hohnecker, staff
6234903	Law Aspects of Guided Transport Systems (p. 357)	L	1	W	1,5	E. Hohnecker, staff

Learning Control / Examinations
graded:
examination Economics, Law and Environmental Aspects in Railway Transportation, oral, accord. ER/SPO § 4 par. 2 no. 2
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
none

Qualification Goals
to know the economic, judicial and environmental problems of track guided transport systems

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up, examination preparation:	120 h
total:	180 h

Content

- basics of economy
- evalutation of planing
- economic and law in public transport
- noise and vibration
- ecology

Remarks
Literature:
Aberle: Transportwirtschaft, Oldenbourg-Verlag Kunz: Eisenbahnrecht, Nomos, Baden-Baden

Module: Traffic Infrastructure [bauiM3S16-EBVERKEHR]

Coordination: E. Hohnecker
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Mobililty and Infrastructure

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	2

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6234810	Determination of Demand, Timetable Construction and Alignment (p. 241)	L/E	1/2	S	4,5	E. Hohnecker
6234904	Standard Valuation in Public Transport - Using an Example (p. 380)	E	1	W	1,5	E. Hohnecker

Learning Control / Examinations
graded:
examination Traffic Infrastructure, oral, accord. ER/SPO § 4 par. 2 no. 2
ungraded:
term paper and presentation as internal examination prerequisite in each course, accord. ER/SPO § 4 par. 2 no. 3
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
modules Track Guided Transport Systems - Basics of Operating Systems [bauiM3S07-EBBETRIEB], Track Guided Transport Systems - Operational Logistics & Management [bauiM3S08-EBLOGISTIK]
resp. as from summer term 2015:
Track Guided Transport Systems - Operation and Capacity [bauiM3S18-EBBETRKAP], Track Guided Transport Systems - Management, Facilities and Vehicles of Public Transport [bauiM3S19-EBOEV]

Qualification Goals
to know how to plan and evaluate a public transport project

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up, examination preparation:	75 h
preparation of term papers:	45 h
total:	180 h

Content
determination of demand, alignment, construction of timetable, cost estimate, evaluation of track guided public transport projects

Module: City Transport Facilities [bauiM3S17-STRIVA]

Coordination: R. Roos
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Mobililty and Infrastructure

ECTS Credits	Cycle	Duration
6	Every 2nd term, Winter Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6233909	City Transport Facilities (p. 313)	L/E	4	W	6	R. Roos, M. Zimmermann

Learning Control / Examinations
graded:
examination Infrastructure Management, oral, accord. ER/SPO § 4 par. 2 no. 2
attested:
elaborated exercises and student research project, accord. ER/SPO § 4 par. 2 no. 3
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
none

Qualification Goals
The graduates are able to plan and design city transport facilities related to car, bicycle, pedestrian and public traffic as well as to test, evaluate and optimize existing infrastructure. Further, they are able to assess the different usage requirements of diefferent types of transportation and to consider them appropriately in design planning.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	45 h
independent study:	
preparation and follow-up:	30 h
preparation of exercises and student research project:	70 h
examination preparation and examination:	40 h
total:	185 h

Content
Manifold requirements are put on city transport facilities in contrast to overland roads: usage from transit to access traffic, usage for stationary traffic, weak road users such as bicyclist and pedestrians, the demand of moving traffic, for stay and recreation activities up to the designing of the tranmsport facilities considering the cityscape. Contemporarily, a variety of carriers of traffic are found within urban areas which have to be taken into consideration for designing roads and junctions as well as the network of transportation routes. All aspects are covered, discussed and their handling is practised at practically relevant case stsudies within this module.

Module: Track Guided Transport Systems - Operation and Capacity [bauiM3S18-EBBETRKAP]

Coordination: E. Hohnecker
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Mobililty and Infrastructure

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6234801	Operation track guided systems (p. 250)	L	2	S	3	E. Hohnecker
6234804	Operation Systems and Track Guided Infrastructure Capacity (p. 252)	L	2	S	3	E. Hohnecker, staff

Learning Control / Examinations
graded:
examination Track Guided Transport Systems - Operation and Capacity, oral, 45 min., accord. ER/SPO § 4 par. 2 no. 2
grading:
grade of module is defined by grade of examination

Conditions
This module must not be selected together with one of the modules Track Guided Transport Systems - Basics of Operating Systems [bauiM3S07-EBBETRIEB] and Track Guided Transport Systems - Operational Logistics and Management [bauiM3S08-EBLOGISTIK] not offered any more.

Recommendations
preliminary attedance of compulsory module Track Guided Transport Systems - Technical Design & Components [bauiM3P4-EBTECHNIK]

Qualification Goals
The Students can analyse, structure and describe formally problems in the field of operation of track guided transport systems. They are able to process methodically questions of security and capacitiy of railway tracks and to propose solutions.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up, examination preparation:	120 h
total:	180 h

Content

- operatoin and signal systems
- safety and signalbox technologies
- time table compilation
- performance and capacity of railway lines
- proof of safety
- operation and dimensioning of marshalling yards

Remarks
Literature:
Fiedler, Grundlagen der Bahntechnik, Werner-Verlag, Düsseldorf
Hausmann, Enders, Grundlagen des Bahnbetriebs, Bahn-Fachverlag, Heidelberg
Pachl, Systemtechnik des Schienenverkehrs, Teubner-Verlag, Stuttgart

Module: Track Guided Transport Systems - Management, Facilities and Vehicles of Public Transport [bauiM3S19-EBOEV]

Coordination: E. Hohnecker
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Mobililty and Infrastructure

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6234802	Facilities and Rolling Stock of Public Transport (p. 229)	L/E	1/1	S	3	E. Hohnecker
6234805	Management in Public Transport (p. 324)	L	2	S	3	E. Hohnecker

Learning Control / Examinations
graded:
examination Track Guided Transport Systems - Management, Facilities and Vehicles of Public Transport, oral, 45 min., accord. ER/SPO § 4 par. 2 no. 2
grading:
grade of module is defined by grade of examination

Conditions
This module must not be selected together with one of the modules Track Guided Transport Systems - Basics of Operating Systems [bauiM3S07-EBBETRIEB] and Track Guided Transport Systems - Operational Logistics and Management [bauiM3S08-EBLOGISTIK] not offered any more.

Recommendations
preliminary attedance of compulsory module Track Guided Transport Systems - Technical Design & Components [bauiM3P4-EBTECHNIK]

Qualification Goals
The Students can analyse, structure and describe formally problems in the field of management, facilities and vehicles of long-distance and local public transport. They are able to develop suggestions for the management of transport companies, for the design of railway stations and for the operation- and safety-related equipement of railway vehicles.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up, examination preparation:	120 h
total:	180 h

Content

- network planning of public transport
- stations and stops of public transport
- vehicles of public transport
- traction / eletric railway facilities
- construction and operation of track guided local public transport
- cooperation and linked transport system of public transport

- special railways in public transport

Remarks
Literature:
Fiedler, Grundlagen der Bahntechnik, Werner-Verlag, Düsseldorf
Pachl, Systemtechnik des Schienenverkehrs, Teubner-Verlag, Stuttgart
Janicki, Fahrzeugtechnik, Eisenbahn-Fachverlag, Heidelberg

Module: Analysis and Evolution of Mobility [bauiM3S20-VERANAMOB]

Coordination: M. Kagerbauer
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Mobililty and Infrastructure

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	2

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6232901	Transportation Data Analysis (p. 267)	L/E	2	W	3	M. Kagerbauer
6232811	Mobility Services and new Forms of Mobility (p. 330)	L/E	2	S	3	M. Kagerbauer

Learning Control / Examinations
graded:
examination Analysis and Evolution of Mobility, oral, 30 min., accord. ER/SPO § 4 par. 2 no. 2
grading:
grade of module is defined by grade of examination

Conditions
This module must not be selected together with the module Data Analysis and Transportation Modelling [bauiM3S10-VERDATAMOD] not offered any more.

Recommendations
course Transportation (6200405)

Qualification Goals
The students master the methods to capture and to analyse the mobility behaviour of the people and recognise trends in the behaviour. They know up to date mobility offers and are able to evaluate these from the point of view of users and operators.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up:	60 h
examination preparation and examination:	60 h
total:	180 h

Content

- capturing mobility: measurements and surveys, data preparation
- analysis: statistical methods and software tools therefore (SAS, R), also practical exercises at PC
- new forms of mobility, e.g. sharing systems for cars and bicycles
- mobility services: rideshare services, intermodal information systems etc.
- analysis of functionality, interrelatoins and backgrounds of these mobility forms

Module: Special Topics in Transportation [bauiM3S21-VERSPEZ]

Coordination: P. Vortisch
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Mobililty and Infrastructure

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6232807	Tendering, Planning and Financing in Public Transport (p. 422)	L	2	S	3	A. Pischon
6232903	Seminar in Transportation (p. 365)	S	2	W/S	3	P. Vortisch, B. Chlond

Learning Control / Examinations
graded:
partial examination Tendering, Planning and Financing in Public Transport, oral, 20 min., accord. ER/SPO § 4 par. 2 no. 2,
partial examination Seminar Transportation, term paper and presentation, accord. ER/SPO § 4 par. 2 no. 3
grading:
grade of module is defined by weighted average of grade of oral examination (50 %) and grade of term paper (50 %)

Conditions
This module must not be selected together with the module Data Analysis and Transportation Modelling [bauiM3S10-VERDATAMOD] not offered any more or the version of the module Planning of Transportation Systems [bauiM3S04-VERPLAN] valid until WS 2014/15.

Recommendations
course Transportation (6200405)

Qualification Goals
The students are able to get themselves familiar in deep with special topics of transportation. They can learn efficiently the important expert knowledge, and they can understand and question critically the methods common in practise. They can state complex facts in transportation in a transparent way in written form and by oral presentation.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, seminar:	60 h
independent study:	
preparation and follow-up:	30 h
preparation of term paper and oral presentation:	60 h
examination preparation and examination:	30 h
total:	180 h

Content
lecture:

- legal framework for the organization of public transport in Germany;
- planning procedures in public transport: local transport plan, investment planning, cooperations;
- financing: Local Authority Traffic Financing Act etc.

In the seminar current topics from transport engineering or transport planning changing each semester are addressed.

4.4 Modules Study Focus 4: Technology and Management in Construction

Module: Economics and Management in Construction [bauiM4P3-]

Coordination: S. Haghsheno
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Technology and Management in Construction

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6241801	Cost Estimation (p. 314)	L/E	1/1	S	3	S. Haghsheno
6241804	Building Laws (p. 237)	L	2	S	3	S. Haghsheno, R. Kohlhammer, H. Miernik

Learning Control / Examinations
graded:
examination Economics and Management in Construction, written, 90 min., accord. ER/SPO § 4 par. 2 no. 1
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
none

Qualification Goals
Students can define the term accounting and can explain the various components and tasks. They gain the ability to apply the various types of depreciation. The students can explain the different methods of calculation and the structure of a calculation. They have the knowledge to create tenders and unit prices independently. Furthermore, students can apply current software for the calculation.
Students have the ability to assign the different stakeholders to partnerships and corporate enterprises and to explain the construction contract laws as well as the difference between BGB and VOB. Furthermore, students can explain the different types of procuration. Students can explain legal bases of construction law and are able to assess and evaluate the contents of a construction contract. Moreover, students develop legal thinking regarding contract and employment law and can apply the basic to construction projects.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up, examination preparation:	120 h
total:	180 h

Content
The module consists of two courses containing the following content:
Lecture Cost Estimation:
This course exemplifies the calculation of average wages, product cost, and overhead (average wage, EKT, BGK, AGK, W&G). Furthermore, the calculated tender will be transferred to current software.
Lecture Building Laws:
This course first clarifies basic issues of the building law. Based on these, legal principles are explained in detail in context to the construction contract (scope, rights and obligations of the parties, compensation, construction period, risk, acceptance, defects, penalty, and termination of an agreement). In addition to the general training of

legal thinking, topics are explained in detail on contract law. The various topics legal bases, general terms and conditions, conclusion on a contract, procuration, as well as the contents of a construction contract are exemplified using case studies and current jurisdiction.
In addition, students need to develop two exercises within the scope of their seminar paper as part of this module.

Remarks
Literature:
1) Bronner, Albert: Angebots- und Projektkalkulation - Leitfaden für Praktiker, Springer, 3., aktualisierte Aufl., Berlin, Heidelberg, 2008.
2) Drees, Gerhard u. Paul, Wolfgang: Kalkulation von Baupreisen - Hochbau, Tiefbau, Schlüsselfertiges Bauen, Bauwerk, 10., erw. und aktualisierte Aufl., Berlin, 2008.
3) Leimböck, Egon; Klaus, Ulf Rüdiger u. Hölkermann Oliver: Baukalkulation und Projektcontrolling unter Berücksichtigung der KLR Bau und der VOB, Vieweg, 11., überarb. Aufl., Wiesbaden, 2007.
4) Girmscheid, Gerhard, Motzko, Christoph: Kalkulation und Preisbildung in Bauunternehmen - Grundlagen, Methodik und Organisation, Springer, Berlin, Heidelberg, 2007.
5) Handwörterbuch der Betriebswirtschaft (HWB), Herausgegeben von: Prof. Dr. Dr. h.c. Richard Köhler, Prof. Dr. Dr. h.c. Hans-Ulrich Küpper, Prof. Dr. Andreas Pfingsten, Schäffer Pöeschel, 6. Auflage, 2007
Weitere Literatur wird zu Beginn der Vorlesung bekannt gegeben. Lernmaterialien bzw. Unterlagen zur Veranstaltung werden zu Beginn des Semesters über einen virtuellen Projektraum zur Verfügung gestellt.

Module: Sustainability in Real Estate Management [bauiM4P4-]

Coordination: K. Lennerts
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Technology and Management in Construction

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6241805	Sustainability in Real Estate Management (p. 336)	L/E	1/1	S	3	K. Lennerts
6241807	Real Estate Life Cycle Management (p. 323)	L	1	S	1,5	K. Lennerts, staff
6241808	Facility and Real Estate Management II (p. 280)	L	1	S	1,5	K. Lennerts

Learning Control / Examinations
graded:
examination Sustainability in Real Estate Management, written, 90 min., accord. ER/SPO § 4 par. 2 no. 1
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
courses Facility und Real Estate Management I (6200513), Life Cycle Management (6200613)

Qualification Goals
Students understand issues an economic-ecological evaluation of the entire life cycle of buildings and can independently carry out life cycle analyzes and assess the sustainability of buildings.
Students can represent the essential relationships within the sustainable construction. You can explain the focal points of international certification process and the evaluation process can DGNB apply. Students can describe technical and economic concepts and know their areas of application.
In addition, students know the procedure of procurement procedures and can discuss them in connection with the procurement law. You can explain and understand the Infrastructural FM and the FM Technical the essential contents of the procurement law for the FM and their effects.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up, examination preparation:	120 h
total:	180 h

Content
Sustainability in Real Estate Management:

- Sustainable architecture
- Location factors
- Stability of value
- LCC - Life Cycle Cost
- Comfort and convenience

- Health and pollutants
- Resource-Efficient Building
- Energy-efficient building envelope
- Energy-Efficient Building
- Energy Concepts
- PM - Project Management
- FM - Facilities Management

Life cycle management of real estate:

- Basics of Life Cycle Management
- Methods of calculating life-cycle costs
- Life Cycle Assessment
- Practical Application

Real Estate and Facility Management II:

- Infrastructural Facility Management
- Data collection / CAFM
- Technical Facility Management
- Procurement procedures / procurement law

Module: Project Management in Construction and Real Estate Industry [bauiM4P5-]

Coordination: S. Haghsheno
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Technology and Management in Construction

ECTS Credits	Cycle	Duration
6	Every 2nd term, Winter Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6241706	Project Management in Construction and Real Estate Industry (p. 353)	L/E	3/1	W	6	S. Haghsheno

Learning Control / Examinations
graded:
examination Project Management in Construction and Real Estate Industry, written, 90 min.,accord. ER/SPO § 4 par. 2 no. 1;
attested examination prerequisite: team exercise with attestation, accord. ER/SPO § 4 par. 2 no. 3
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
none

Qualification Goals
Students have advanced knowledge in the area of project management, particularly in the planning and management of the construction and real estate projects. They are able to name and analyze the different project parties, structures and types of contracts. Furthermore, they are able to apply methods and tools in construction projects.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up, team exercise, examination preparation:	120 h
total:	180 h

Content
In the area of project management the topics project organization, awards and types of contracts, quality management, production planning and construction logistics, schedule management, cost management and conflict management are discussed.
In addition, skills for technical project development will be imparted. Complex issues are clarified using practical examples. In case of process planning, basic principles (terms, definitions, basic variables, current trends), methods of process comparison, methods of construction scheduling (classification and structuring of projects, structure, time and cost analyzes), optimization techniques, and basic knowledge of site facilities and formwork are explained. In addition, accident prevention regulations, active and passive protection measures as well as the organization of the labor protection during operation and on site are discussed.
In addition, students need to develop two exercises within the scope of their seminar paper as part of this module.

Remarks
Literature:
DIETHELM, G.: Projektmanagement, Band 1: Grundlagen, Verlag Neue Wirtschafts-Briefe, Herne, 2000
DIETHELM, G.: Projektmanagement, Band 2: Sonderfragen, Verlag Neue Wirtschafts-Briefe, Herne, 2001
ESCHENBRUCH, K.: Recht der Projektsteuerung, Werner Verlag, München, 2003

HAHN, R.: Projektmanagement für Ingenieure, Wiley-VCH Verlag, Weinheim, 2002
KERZNER, H.: Project Management - A Systems Approach to Planning, Scheduling and Controlling, Wiley & Sons, 2006
KOCHENDÖRFER, B., LIEBCHEN, J.: Bau-Projekt-Management, Verlag B. G. Teubner, Stuttgart, 2001
Project Management Institute: A Guide to the Project Management Body of Knowledge: PMBOK Guide, 2008
ROSENAU, M:, W.: Succesful Project Management, Van Norstrand Reinhold, New York, 1992
VOLKMANN, W.: Projektabwicklung, Verlag für Wirtschaft und Verwaltung Hubert Wingen, Essen, 2002

Module: Machinery and Process Engineering [bauiM4P6-]

Coordination: S. Gentes
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Technology and Management in Construction

ECTS Credits	Cycle	Duration
6	Every 2nd term, Winter Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6241703	Construction Equipment (p. 325)	L	2	W	3	S. Gentes
6241704	Process Engineering (p. 404)	L	2	W	3	H. Schneider, H. Schlick

Learning Control / Examinations
graded:
examination Machinery and Process Engineering, written, 90 min., accord. ER/SPO § 4 par. 2 no. 1
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
none

Qualification Goals
The students hear about the basic principles and concepts of machine technology and understand the built and function of construction machinery and equipment. They can appropriately name the equipment and select the suitable machines depending on their building tasks.
They understand the BGL system (list of construction equipment) and are able to rank and classify machines and equipment as needed. They will realize optimization potentials using suitable process technology and equipment alternatives. Finally, they will be able plan and size various construction machines and transport devices with respect to static and dynamic effects and impacts.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up, examination preparation:	120 h
total:	180 h

Content
This module provides machine technology basics to better understand a broad variety of construction equipment and machinery. Further, static and dynamic effects and impacts of construction equipment application will be discussed, various construction machines introduced, their respective applications compared, and basics for their dimensioning provided.
Different construction machines and their variations will be presented with the help of the BGL system. In addition, the functions, variations, effectiveness, and applications for diverse construction and productions procedures used in processing technology, earthworks, underground engineering, and hydraulic engineering will be presented and discussed. The curriculum also includes the necessary technical basics for drive systems, power transmission components (mechanic and hydraulic), undercarriages, as well as steering controls, and safety facilities. In addition to a building site visit for practical insight, a practical course on the institute's own test site will be offered to try out construction machinery. Finally, students need to develop two exercises within the scope of their seminar paper as part of this module.

Remarks
Literatur:
1) Baugeräteliste, Band 2007, 1. Aufl., 2007.
2) Hüster, Felix, Leistungsberechnung der Baumaschinen, Shaker, 5. Aufl., Aachen, 2005.
3) Girmscheid, Gerhard: Leistungsermittlungshandbuch für Baumaschinen und Bauprozesse, Springer, 3., überarb. Aufl., Berlin, Heidelberg, Zürich, 2005.
4) Drees, Gerhard; Krauß, Siri: Baumaschinen und Bauverfahren - Einsatzgebiete und Einsatzplanung, expert-Verlag, 3., völlig neu bearb. Aufl., Renningen, 2002.

Module: Business and Human Resource Management [bauiM4S01-]

Coordination: S. Haghsheno
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Technology and Management in Construction

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6241830	Business and Human Resources (p. 401)	L/E	2/1	S	4,5	S. Haghsheno, E. Eschen
6241832	Site Management (p. 236)	L	1	S	1,5	S. Haghsheno, P. Steffek

Learning Control / Examinations
graded:
examination Business and Human Resource Management, oral, 40 min., accord. ER/SPO § 4 par. 2 no. 2
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
none

Qualification Goals
Students are able to explain principles of business and human resource management as well as key corporate functions in construction companies. They are able to name and describe the different forms of organizations and can distinguish between these forms. Furthermore, students achieve knowledge to identify and analyze different types of strategies in construction companies. In the area of communication and motivation, students gain basic knowledge and are able to implement methods of human resources management.
In the course site management, students know about technical, business and organizational tasks and are able to analyze and evaluate the individual process steps.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up, examination preparation:	120 h
total:	180 h

Content
In the area of operational management generic strategies for contractors and their implementation in the context of organizational structures and legal forms are discussed. Moreover, procedures and processes to develop and implement a corporate strategy are explained. Basic principles and methods of human resource management are exemplified, implying the topics determination of personnel requirements, development, acquisition, and motivation. In addition, communication and motivation are highlighted in context to human resources management.
The course site management presents the work of foreman, site manager, and project manager and contains significant aspects of management processes of the construction site.

Module: Environmentally-friendly Recycling and Disassembly of Buildings [bauiM4S06-]

Coordination: S. Gentes
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Technology and Management in Construction

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6241826	Project Studies (p. 355)	L/E	1/1	S	3	S. Gentes
6241828	Disassembly Process Engineering (p. 405)	L/E	1/1	S	3	S. Gentes

Learning Control / Examinations
graded:
examination Environmentally-friendly Recycling and Disassembly of Buildings, oral, 40 min., accord. ER/SPO § 4 par. 2 no. 2
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
none

Qualification Goals
On completion of this course, the students know how to independently plan, apply for and realize demolition, disassembly, and disposal projects for buildings and technical structures. This involves legal, technical, and practical aspects from the criteria of suitable procedures, applications for disassembly and approval, up to the applicable recycling and disposal options. Furthermore, the students gain an overview of possible harmful substances (e.g. asbestos, artificial mineral fibers, etc.) and protective measures.
The students can

- evaluate and characterize waste of construction and demolition according to current legal framework,
- plan and implement demolition work for constructional and technical facilities and select processes,
- evaluate demolition objects acording to the current legal basis and make respective calculations,
- plan the required resources for the demolition work by themselves (personal, machinary, processes),
- recognize, evaluate and implement recycling potentials,
- evaluate tenders for demolition work,
- implement safety requirements for demolition work and prepare evaluations of threats.

The students recognize the necessity and the meaning of the qualified demolition and the associated recycling with respect to the entire construction management. They know several methodes and procedures for implementation and realization.
The students have

- trained their capacity for teamwork by several groupworks,
- practised self-reliant working and deciding,
- become acquainted with different option for the implementation of recycling by excursions to neighbouring foreign countries.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up, examination preparation:	120 h
total:	180 h

Content

Information about the state of research and technology with respect to machined disassembly, transport, conditioning, dumping, and disposal of demolition waste, as well as the latest developments in machine technology. The entire approval process from the demolition license application to machine deployment plans will be discussed in addition to technical aspects. This also involves occupational safety, immission control, as well as handling pollutants in buildings to be demolished. Specific tasks, e.g. the partial demolition of existing buildings, will be explained and calculated using existing examples. VDI (The Association of German Engineers) guidelines pertaining to demolition projects will be introduced and an excursion to a recycling facility will provide the opportunity to discuss landfill directives.

Remarks

Literature:

1) Seemann, Axel: Entwicklung integrierter Rückbau- und Recyclingkonzepte für Gebäude - ein Ansatz zur Kopplung von Demontage, Sortierung und Aufbereitung, Shaker, Aachen, 2003.
2) RAL, Deutsches Institut für Gütesicherung und Kennzeichnung e.V.: Ausbau und Entsorgung von Gefahrstoffen in Bauwerken - Gütesicherung, Beuth, Ausg. Juni 2004, Berlin, 2004.
3) Lippok, Jürgen [Red.]: Abbrucharbeiten - Grundlagen, Vorbereitung, Durchführung, Müller, 2., aktualisierte und erw. Aufl., Köln, 2007.
4) VDI 6202 „Schadstoffsanierung“
5) VDI 6210 „Abbruch“

Module: Upgrading of Existing Buildings and Energetic Refurbishment [bauiM4S07-]

Coordination: K. Lennerts
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Technology and Management in Construction

ECTS Credits	Cycle	Duration
6	Every 2nd term, Winter Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6241901	Upgrading of Existing Buildings (p. 234)	L/E	2/1	W	4,5	K. Lennerts, H. Schneider
6241903	Energetic Refurbishment (p. 268)	L	1	W	1,5	K. Lennerts, J. Megdenberg

Learning Control / Examinations
graded:
partial examination Upgrading of Existing Buildings and Energetic Refurbishment, oral, 30 min., accord. ER/SPO § 4 par. 2 no. 2,
partial examination Term Paper Upgrading of Existing Buildings and Energetic Refurbishment, written report and presentation, accord. ER/SPO § 4 par. 2 no. 3
grading:
grade of module is weighted average of grade of oral examination (75 %) and grade of term paper with presentation (25 %)

Conditions
none

Recommendations
none

Qualification Goals
Students understand the economic, ecological and cultural significance of the building stock and to describe the specific tasks for a civil engineer in this field of activity. You can explain the advantages and disadvantages of different maintenance strategies and maintenance budgets can be calculated for real estate stocks. You know the basics of a technical due diligence and the basics of building information modeling.
In addition, students may constitute the legal framework for energy rehabilitation measures and can use the methods of the energy performance of buildings apply.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up, preparation of term paper, examination preparation:	120 h
total:	180 h

Content
Refurbishment:

- maintenance / definitions & Strategies
- durability and wear of components
- determination of component lifetimes
- budgeting of maintenance costs
- the PABI method

- condition assessment & action planning
- damage to buildings
- due diligence
- monument and Historic Monuments
- demolition and construction vs. rehabilitation
- building Information Modeling (BIM)

Energy efficiency refurbishment

- policy development to energy savings
- historical development of the Energy Saving Ordinance
- forms of energy
- building physical characteristics
- calculation of energy use
- renewables
- energy efficiency of buildings by Energy Saving Ordinance

Module: Real Estate Management [bauiM4S08-]

Coordination: K. Lennerts
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Technology and Management in Construction

ECTS Credits	Cycle	Duration
6	Every 2nd term, Winter Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6241924	Controlling in Real Estate Management (p. 260)	L	1	W	1,5	K. Lennerts
6241904	Public Real Estate Management and Public Private Partnership (p. 356)	L	1	W	1,5	K. Lennerts
6241906	Project Development (p. 352)	L	1	W	1,5	K. Lennerts, staff
6241907	Corporate Real Estate Management and Human Resources in Real Estate (p. 261)	L	1	W	1,5	S. Beretitsch

Learning Control / Examinations
graded:
examination Real Estate Management, oral, 40 min., accord. ER/SPO § 4 par. 2 no. 2
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
none

Qualification Goals
see German version

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up, examination preparation:	120 h
total:	180 h

Content
see German version

Module: Lean Construction [bauiM4S09-]

Coordination: S. Haghsheno
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Technology and Management in Construction

ECTS Credits	Cycle	Duration
6	Every 2nd term, Winter Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6241908	Lean Construction (p. 322)	L/E	2/2	W	6	S. Haghsheno, staff

Learning Control / Examinations
graded:
examination prerequisite project paper Lean Construction, lecture accompanying with presentation, accord. ER/SPO § 4 par. 2 no. 3
examination Lean Construction, oral, 30 min., accord. ER/SPO § 4 par. 2 no. 2
grading:
grade of module is defined by weighted average of grades for examination (75 %) and examination prerequisite (25 %)

Conditions
none

Recommendations
none

Qualification Goals
see German version

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up, preparation of project paper, examination preparation:	120 h
total:	180 h

Content
see German version

Remarks
Literatur:
Gehbauer, F. (2013) *Lean Management Im Bauwesen*. Skript des Instituts für Technologie und Management im Baubetrieb, Karlsruher Institut für Technologie (KIT)
Liker, J. & Meier, D. (2007) Praxisbuch, der Toyota Weg: für jedes Unternehmen. Finanzbuch Verlag
Rother, M., Shook, J., & Wiegand, B. (2006). Sehen lernen: mit Wertstromdesign die Wertschöpfung erhöhen und Verschwendung beseitigen. Lean Management Institut

Module: Advanced Studies in Construction Engineering [bauiM4S10-]

Coordination: S. Haghsheno
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Technology and Management in Construction

ECTS Credits	Cycle	Duration
6	Every 2nd term, Winter Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6241910	Tunnel Construction and Blasting Engineering (p. 394)	L	2	W	3	S. Haghsheno, L. Scheuble, U. Matz
6241911	Operation Methods for Foundation and Marine Construction (p. 390)	L	1	W	1,5	H. Schneider
6241913	Operation Methods for Earthmoving (p. 272)	L	1	W	1,5	H. Schlick

Learning Control / Examinations
graded:
examination Advanced Studies in Construction Engineering, oral, 40 min., accord. ER/SPO § 4 par. 2 no. 2
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
none

Qualification Goals
see German version

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up, examination preparation:	120 h
total:	180 h

Content
see German version

Module: Decommissioning of Nuclear Facilities [bauiM4S12-]

Coordination: S. Gentes
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Technology and Management in Construction

ECTS Credits	Cycle	Duration
6	Every 2nd term, Winter Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6241917	Removal and Decontamination of Nuclear Facilities (p. 263)	L/E	1/1	W	3	S. Gentes, staff
6241919	New Development and Optimization of Decommissioning Machine Technology (p. 338)	L/E	1/1	W	3	S. Gentes, staff

Learning Control / Examinations
graded:
examination Decommissioning of Nuclear Facilities, oral, accord. ER/SPO § 4 par. 2 no. 2
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
none

Qualification Goals
The students are able

- to develop decommissioning concepts and to select and apply the required technologies and processes,
- to implement the principles of concession and to formulate respective applications,
- to consider and implement the requirements of the respective laws.

The students can

- derive and apply the necessary precautions,
- analyse, work on and implement self-reliantly decommissioning projects of nuclear facilities,
- entitle and select the required processes, equipements und machines for that purpose.

The students have

- developed analytical methods for the procedures in decommissioning and are able to make project specific decisions,
- trained their capacity for teamwork in several groupworks.

The students recognize and understand the implications of decommissioning projects on local, municipal, regional and federal scale.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up, examination preparation:	120 h
total:	180 h

Content

This course provides an overview about the state of research and technology in mechanical process engineering for the decommissioning of nuclear facilities. This involves decontamination procedures, remote-handled procedures, and procedures for the separation of reinforced concrete, etc.
The required approvals and licenses and the involved authorities will be introduced and discussed using examples and legal sources, e.g. the German Atomic Energy Act (Atomgesetz). The basics of radiation protection together with the pertaining measurement technology will be explained in step with actual practice. Furthermore, a suitable system to successfully manage decommissioning projects will be presented as well as the numerous stakeholders involved.
A visit to a nuclear facility currently under decommissioning is part of the course. The new findings will be further discussed in conjunction with existing decommissioning projects which will also be presented by the involved industry partners.

Remarks

Literature:

Kohli, Rajiv [Hrsg.]: Developments in surface contamination and cleaning - fundamentals and applied aspects, Knovel library, USA, 2008.
Rahman, A.: Decommissioning and radioactive waste management, Whittles, Dunbeath, 2008.
Thierfeldt, Stefan: Stillegung und Rückbau kerntechnischer Anlagen - Erfahrungen und Perspektiven, Tönnes, Düsseldorf, 1993.
Zeiher, Marco: Ein Entscheidungsunterstützungsmodell für den Rückbau massiver Betonstrukturen in kerntechnischen Anlagen, Karlsruhe, Univ., Diss., 2009.
5) Fortschrittsbericht über den Stand der BMBF – Stilllegungsprojekte und der vom BMBF geförderten FuE-Arbeiten zu „Stilllegung / Rückbau kerntechnischer Anlagen“

Module: Facility Management in Hospitals and Hospital Management [bauiM4S13-]

Coordination: K. Lennerts
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Technology and Management in Construction

ECTS Credits	Cycle	Duration
6	Every 2nd term, Winter Term	2

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6241921	Facility Management in Hospitals (p. 279)	L/E	3	W	4,5	K. Lennerts, staff
6241923	Hospital Management (p. 319)	L	1	W	1,5	K. Lennerts

Learning Control / Examinations
graded:
partial examination Facility Management in Hospitals, term paper and presentation, accord. ER/SPO § 4 par. 2 no. 3
partial examination Hospital Management, oral, accord. ER/SPO § 4 par. 2 no. 2
grading:
grade of module is defined by weighted average according credit points of grades of the partial examinations

Conditions
none

Recommendations
course Facility and Real Estate Management (6200513)

Qualification Goals
Students are able to describe and understand the principle of funding hospitals the basics of the German health care system. You know the cost structures in a hospital and are able to understand the basis of the hospital accounting.
Students are able to distinguish primary and secondary processes in a hospital each other. For selected facility management processes (secondary) processes, students can carry out strategic planning. Students understand the basic principles of hospital planning with a focus on master planning, space and function program and layout planning.
Furthermore, students can give an overview over a wide range of hospital management.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up, examination preparation:	120 h
total:	180 h

Content

- Hospital Financing
- Cost structures of a hospital
- Facility management processes in hospitals
- Strategic planning of selected facility management services
- Sustainable Hospitals
- Master planning, space and function program and layout planning of hospitals

- Introduction to Hospital Management
- Internal organizational structures, working conditions and working environment in the hospital

Module: Turnkey Construction [bauiM4S15-]

Coordination: S. Haghsheno
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Technology and Management in Construction

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6241833	Turnkey Construction I - Processes and Methods (p. 360)	L	1	S	1,5	S. Haghsheno, K. Teizer
6241834	Turnkey Construction II - Trades and Technology (p. 361)	L/E	1/1	S	3	S. Haghsheno, M. Denzer, K. Teizer
6241822	Supplementary Claim Management (p. 337)	L	1	S	1,5	S. Haghsheno, R. Bartsch

Learning Control / Examinations
graded:
examination Turnkey Construction, oral, 40 min., accord. ER/SPO § 4 par. 2 no. 2
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
none

Qualification Goals
Students are able to describe the basic technologies and design techniques in shell and finishes as well as in building services. Furthermore, they are able to apply technologies and techniques under project-specific conditions. They know the basic processes in turnkey construction.
Students know the eligibility requirements for the calculation of additional or reduced cost based on VOB/B. They are able to created, examine and avoid claims.

Workload
contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up, examination preparation:	120 h
total:	180 h

Content
In the area of turnkey projects the detailed design and basic construction services for various construction trades (e.g. drywall construction, floating screed, Facing) are discussed. Furthermore, processes of turnkey construction are explained from the beginning of the design phase till the acceptance of the work and the beginning of warranty. In terms of claim management the course clarifies, how to create, justify, and calculate claims based on the VOB by using practical examples.

Remarks
Literature:
ELWERT, Ulrich, Flassak, Alexander: Nachtragsmanagement in der Baupraxis - Grundlagen, Beispiele, Anwendung, Vieweg, 2., erw. und aktualisierte Aufl., Wiesbaden, 2008.
WÜRFELE, Falk [Hrsg.]: Nachtragsmanagement - Leistungsbeschreibung, Leistungsabweichung, Bauzeitverzögerung, Werner, Neuwied, 2006.

SCHERER, Holger: Integriertes Nachtragsmanagement - Verfahrenshandbuch für die Dokumentation von Behinderungen, Störungen und Nachtragssachverhalten auf der Grundlage der VOB, Zeittechnik-Verlag, Neu-Isenburg, 2001.
HELLER, Jörg: Sicherung der Nachtragsvergütung nach VOB und BGB, Zeittechnik-Verlag, Neu-Isenburg, 2000.

Module: Building Information Modeling (BIM) [bauiM4S16-]

Coordination: S. Haghsheno
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Technology and Management in Construction

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6241836	Building Information Modeling (BIM) (p. 258)	L/E	4	S	6	S. Haghsheno

Learning Control / Examinations
graded:
examination Building Information Modeling, project work with report (partial examination) and presentation (partial examination), accord. ER/SPO § 4 par. 2 no. 3
grading:
grade of module is defined by the weighted average of the grade of the report (75%) and the grade of the presentation (25%)

Conditions
none

Recommendations
course Cost Estimation (6241801) from the module Economics and Management in Construction [bauiM4P3-], basic knowledge in CAD

Qualification Goals
see German version

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up, project work, preparation of report and presentation:	120 h
total:	180 h

Content
see German verison

Remarks
newly offered as from summer term 2016

Literature:
1) Borrmann, André; König, Markus; Koch, Christian; Beetz, Jakob (Hrsg.) Building Information Modeling – Technologische Grundlagen und industrielle Praxis, Wiesbaden 2015, Springer Verlag.
2) Egger, Martin; Hausknecht, Kerstin; Liebich, Thomas, Przybylo, Jakob: BIM-Leitfaden für Deutschland. Abschlussbericht Bundesinstitut für Bau-, Stadt- und Raumforschung (BBSR), \protect\T1\textbraceleft http://www.bbsr.bund.de/BBSR/DE/FP/ZB/Auftragsforschung/3Rahmenbedingungen/2013/BIMLeitfaden/01_
Zugriff: 31.08.2015.

4.5 Modules Study Focus 5: Geotechnical Engineering

Module: Theoretical Soil Mechanics [bauiM5P1-THEOBM]

Coordination: T. Triantafyllidis
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Geotechnical Engineering

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6251801	Theoretical Soil Mechanics (p. 388)	L/E	4	S	6	A. Niemunis

Learning Control / Examinations
graded:
examination Theoretical Soil Mechanics, written, 90 min., accord. ER/SPO § 4 par. 2 no. 1
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
basics in soil mechanics and continuum mechanics,
module Basics of Numerical Modelling [bauiM5P4-NUMGRUND]

Qualification Goals
The students obtained a scientific based understanding of the essential behaviour of soil under monotonic and cyclic load with and without effects of time regarding large and small deformations. They are able to describe relations in soil mechanics mathematically and physically correctly. They can understand the tensorial terminology of modern geotechnical literature and can apply computing programs to comprehend element tests. They recognize self-reliantly relevant mechnisms of boundary value problems and can specify the limitations of simple engineering models.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up, consultation hours, working with available software:	60 h
examination preparation and examination:	60 h
total:	180 h

Content
advanced theoretical basics of soil behaviour:

- geotechnical invariants of stress and strain
- failure criteria according to Coulomb, Matsuoka-Nakai etc.
- contractancy and dilatancy
- critical density
- failure criteria according to Krey-Tiedemann
- soil behaviour under partial saturation
- collapse theorems and their application (Kinematic Element Analysis)

- elasticity in soil mechanics (isotropic and anisotropic)
- elastoplasticity with volumetric hardening using the example of the Cam-Clay-Model
- soil behaviour under cyclic loading
- one-dimensional viscoplasticity

Remarks
Literature:
Niemunis (2009): Über die Anwendung der Kontinuumstheorie auf bodenmechanische Probleme (download)
Additional study material is supplied for participants: homework, programs (download)
Accompagnying to the lectures, a tutorial to Stress, Strain and Limit States in Soils (19182) is offered, which is recommended.

Module: Earthworks and Foundation Engineering [bauiM5P2-ERDGB]

Coordination: T. Triantafyllidis
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Geotechnical Engineering

ECTS Credits	Cycle	Duration
6	Every 2nd term, Winter Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6251701	Foundation Types (p. 300)	L/E	2	W	3	T. Triantafyllidis
6251703	Basics in Earthworks and Embankment Dams (p. 302)	L/E	2	W	3	A. Bieberstein

Learning Control / Examinations
graded:
examination Earthworks and Foundation Engineering, written, 90 min., accord. ER/SPO § 4 par. 2 no. 1
attested:
approved term paper "Earth Dams and Foundation Engineering", accord. ER/SPO § 4 par. 2 no. 3, definition of a project available from lecturer
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
Basic knowledge of Soil Mechanics and Foundation Engineering

Qualification Goals
With regard to geotechnical constructions the students are able to select and apply appropriate methods for exploration, modelling, dimensioning, realization and control in the case of complex requirements on average. They can apply this knowledge to earthworks and embankment engineering, can identify all geotechnically relevant problems occuring with dams and can apply self-reliantly design and dimensioning rules in outline. They gained geotechnical competence in solving problems for all kind of constructions in and with unconsolidated rocks, also with respect to the managerial organization, expense budgeting, use of documents and presentation of results.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up, consultation hours:	15 h
preparation of term paper:	45 h
examination preparation and examination:	60 h
total:	180 h

Content
Foundation Types:

- safety concepts in earthworks and foundation engineering
- project design for foundation problems
- frame constructions on partially soft soil, bridge abutment and embankments on soft soil
- types of retaining constructions for a cut-and-cover metro tunnel
- ground anchors

- quay wall structures with sheetpiles
- stabilization and drainage of embankments
- retaining constructions with structural slope stabilisation
- underpinning and supporting
- observation method

Basics of Earthworks and Embankment Dams:

- cross section and longitudinal section of filled dams
- requirements for zonation
- sealing
- combined effects dam/subsoil
- construction methods for seepage cuttoff
- building materials for dams with requirements and characteristics
- construction of dams
- seepage and flow nets
- flow cases with known and unknown boundaries
- erosion, suffosion, piping, colmatation and joint erosion
- dam stability

Remarks
Literature:
[1] Witt. K.J. (2008), Grundbau-Taschenbuch, Teil 1,
[2] Ernst & S. Smoltczyk, U. (2001), Grundbau-Taschenbuch, Teil 2-3,
[3] Ernst & S. Schmidt, H.G. & Seitz, J. (1998), Grundbau , Bilfinger & Berger
[4] Striegler (1998), Dammbau in Theorie und Praxis, Verlag für Bauwesen Berlin
[5] Kutzner (1996), Erd- und Steinschüttdämme für Stauanlagen, Enke Verlag Stuttgart

Module: Rock Mechanics and Tunnelling [bauiM5P3-FMTUB]

Coordination: T. Triantafyllidis
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Geotechnical Engineering

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6251804	Basics in Rock Mechanics (p. 301)	L/E	2	S	3	E. Gerolymatou
6251806	Basics in Tunnel Construction (p. 304)	L/E	2	S	3	B. Fröhlich

Learning Control / Examinations
graded:
examination Basics of Rock Mechanics and Tunnelling, written, 90 min., accord. ER/SPO § 4 par. 2 no. 1
attested:
approved term paper Rock Engineering, accord. ER/SPO § 4 par. 2 no.3, definition of a project available from lecturer
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
Basic knowledge of Engineering Geology

Qualification Goals
The students understand the essential strength and deformation properties of rock and master the basic analytical methods to solve boundary value problems of surface and underground rock excavation. They can select basic construction methods and constructions in underground tunnel construction and apply sel-reliantly the methods of rock mechanics and static calculation and safety assessments. With regard to the assessment of variants, costs, construction operation and safety aspects they gained geotechnical competence in solving problems for all kind of constructions in and with solid rocks.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up, consultation hours:	15 h
preparation of term paper:	45 h
examination preparation and examination:	60 h
total:	180 h

Content
Basics in Rock Mechanics:

- basics of petroprahy
- rocks and rock mass classification
- rock pressure
- genity and tropy
- stress-strain-behaviour
- shear strength, compressive strength and tensile strength of compact and jointed rock

- shear resistance of discontinuities
- basics and methods to determine compressibility parameters for rocks and rock mass
- in situ and laboratory testing
- circular tunnels in isotrope and biaxial primary stress fields (elastic)
- circular tunnels in elastoplastic ground
- elliptical cross sections
- shaft problem

Rock Mechanics and Tunnelling:

- tunneling by drilling and blasting, driving by TBM
- measuring technologies in tunnel construction
- rock exploration and classification
- rock pressure and in-situ stress measurement
- introduction to tunnel constructions (types and purposes)
- tunnel construction methods
- safety measures
- collaps mechanisms of bedrock
- stresses and deformations around a tunnel: plastification, ground reaction line method

Remarks
Literature:
[1] Brady, B. H. G. and Brown, E. T., (2004): Rock Mechanics for Underground Mining, 3rd. Edition, Kluwer Academic Publishers.
[2] Kolymbas, D. (1998), Geotechnik - Tunnelbau und Tunnelmechanik, Springer.
[3] Goodmann, R.E., (1989): Introduction to Rock Mechanics, John Wiley & Sons.
[4] Hoek, E., 2007: Practical Rock Engineering, free download at:
http://www.rocscience.com/hoek/PracticalRockEngineering.asp.
[5] Jäger, J.C., Cook, N.G.W. and Zimmerman, R.W., 2007: Fundamentals of Rock Mechanics, Blackwell Publishing.
[6] Wittke, W., 1982: Felsmechanik, Springer-Verlag.
[7] Maidl, B. 1997: Tunnelbau im Sprengvortrieb
[8] Müller, L. 1978: Der Felsbau, Bd. 3 Tunnelbau

Module: Basics in Numerical Modelling [bauiM5P4-NUMGRUND]

Coordination: T. Triantafyllidis
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Geotechnical Engineering

ECTS Credits	Cycle	Duration
6	Every 2nd term, Winter Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6215702	Continuum Mechanics (p. 317)	L	2	W	3	C. Hesch
6251707	Numerics in Geotechnics (p. 342)	L	2	W	3	A. Niemunis

Learning Control / Examinations
graded:
examination Basics of Numeric Modelling, oral, 60 min., accord. ER/SPO § 4 par. 2 no. 2
grading:
grade of module is defined by grade of examination

Conditions
This module must not be selected together with the module Continuum Mechanics of Heterogeneous Solids [bauiM1S32-KONTIMECH].

Recommendations
basic knowledge in continuum mechanics

Qualification Goals
The students are familiar wit hthe general concepts of continuum mechanics and their application to engineering, specifically geotechnical, problems. They know operational methods for the discretization of the typical differential equations. They are able to comprehend the modelling of geomechnical boundary value problems using Finte Difference and Finite Element Methods and to work independently on standrad problems. They can assess the failure potential of numerical calculations, select commercial FE-codes reasonably and test and evaluate Fe results crtically.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up, consultation hours, exercises with available software:	60 h
examination preparation and examination:	60 h
total:	180 h

Content
Continuum Mechanics:

- kinematics of continuum deformation: general strain measures, geometrical linearization
- balance relations for mass, linear momentum, angular momentum and energy
- elasticity, isotropic and anisotropic constitutive laws
- thermoelasticity
- linear-elastic wave propagation: d'Alembert's solution, harmonic waves, compression waves, shear waves, surface waves
- basic fracture mechanics
- inelastic material behaviour: plasticity, viscoelasticity

Numerics in Geotechnics:

- time dependent and time-independent numerical problems in soil mechanics
- finite difference method: implicit and explicit solution of time-dependent differential equations, stability of the FD-scheme
- partial differential equations (consolidation, waves): numerical methods, stability, errors
- finite elements: weak form, discretization, boundary conditions according to Neumann and Dirichlet
- sample finite element computation for stationary two dimensional seepage flow
- finite element computation for static equilibrium (2D)
- locking, reduced integration, static condensation
- weak form of the consolidation equation and GN-time integration
- material non-linearity
- return-mapping and equilibrium iteration
- geometrical non-linearity, follower loads, simplified integration schemes
- introduction to the boundary-element-method.

Remarks
Literature:
[1] E. Becker, W. Bürger: Kontinuumsmechanik. Teubner, 1975
[2] J. Bonet, R.D., Wood: Nonlinear continuum mechanics for finite element analysis. Cambridge, 1997
[3] R. Greve: Kontinuumsmechanik. Springer, 2003
[4] L. Malvern: Introduction to the Mechanics of a Continuous Medium. Prentice Hall, 1969
[5] Th. Seelig: Kontinuumsmechanik. Skript zur Vorlesung
[6] Presss, W., e.a. (1992), Numerical Recipies, Cambridge Univ. Press
[7] Hughes, T.J.R. (2000): The FEM, Linear Static and Dynamic FE Analysis. Dover
[8] Bathe, K.-J. (200): Finite-Elemente-Methoden. Springer
[9] Smith, I.M.; Griffith, D.V. (2004): Programming the Finite Element Method. JWS
[10] Potts, D.M. Zdravkovic, L. (1999): Finite element analysis in geotechnical engineering. Thomas Telford Ltd
[11] Zienkewicz O.C. et.al. (2005): The Finite Element Method, Vol. 1, Wiley
[12] Hartmann, F. (1987): Methode der Randelemente, Springer
additional study material is placed at students disposal (mathematica scripts for download)

Module: Special Issues of Soil Mechanics [bauiM5S01-SPEZBM]

Coordination: T. Triantafyllidis
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Geotechnical Engineering

ECTS Credits	Cycle	Duration
6	Every 2nd term, Winter Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6251901	Unsaturated, Viscous and Cyclic Soil Behaviour - Theory and Element Tests (p. 413)	L/E	2	W	3	A. Niemunis, T. Wichtmann
6251903	Soil Dynamics (p. 235)	L/E	2	W	3	G. Huber

Learning Control / Examinations
graded:
examination Special Issues of Soil Mechanics, oral, 40 min., accord. ER/SPO § 4 par. 2 no. 2
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
module Theoretical Soil Mechanics [bauiM5P1-THEOBM]

Qualification Goals
The students master a wide range of mechanical, hydraulic and numerical tools for the processing of specific soil mechanical problems. They can comprehend the cross-linking of hydraulic, mechanical and chemical processes under partial saturation. They can use the dynamic and cyclic laboratory techniques and apply material laws operationally for the calculation and calibration of experiments. They can describe and evaluate constructionally vibrations and waves in elastic continua and real soils in the range of strains from small shakes up to earthquakes.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up, consultation hours, exercises with available software:	60 h
examination preparation and examination:	60 h
total:	180 h

Content
Unsaturated, Viscous and Cyclic Soil Behaviour – Theory and Element Tests:

- Hypoplastic constitutive laws (1D, 3D): advantages, limitations, identification of parameters, intergranular strain, visco-hypoplasticity
- application: creeping embankments with shead dowelling
- natural soils in comparison to idealized models
- phenomena of shear localization
- sounding, soil penetration and contact problems
- typical stress-strain-relations for various soils (sand, gravel, silt, clay) for monotonous drained and undrained loading

- soils under high-cycle-loading, strain accumulation, accumulation model
- soils under undrained cyclic loading, soil liquefaction, debris flow
- hydraulic and mechanic properties of partly saturated soils
- recalculations of different element tests

Soil Dynamics:

- vibrations of systems with one degree of freedom, linear and non linear (time and frequency domain)
- wave propagation in full and half space, also layered
- vibrations of rigid foundations (linear elastic, substructure method)
- wave propagation: linear and linearised using adapted stiffness, numerical methods
- behaviour of soils under cyclic and dynamic loading: particle models, continuum models
- laboratory tests: resonant column test (RC), cyclic triaxial test
- wave propagation in real soils (influence of hysteretic material damping and increase of stiffness with depth)
- effects related to saturated soil (cyclic mobility, liquefaction)
- 1D-wave propagation for earthquake loading: linearised model using program Shake including adapted stiffness, nonlinear using Hypoplasticity
- settlements caused by dynamic loading and transient loss of stiffness

Remarks
Literature:
study material is placed at students disposal (download)

Module: Ground Investigation [bauiM5S02-BERKUND]

Coordination: T. Triantafyllidis
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Geotechnical Engineering

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6251808	Soil Mechanical Laboratory Exercises (p. 255)	E	2	S	3	G. Huber
6251809	Geomechanical Field Exercise (p. 294)	E	2	S	3	G. Huber

Learning Control / Examinations
graded:
examination Ground Investigation, oral, 40 min., accord. ER/SPO § 4 par. 2 no. 2
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
none

Qualification Goals
The students can conduct the standard experiments common in soil mechanics by themself, define appropriate experimental conditions, analyse and control the experiments purposefully and derive constructionally conclusions. They are familiar with the common field experiments in unconsolidated and solid rocks, they can plan, control, analyse and interpret these. They conducted experiments exemplarily by themselves.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up, consultation hours, experiments in laboratory:	60 h
examination preparation and examination:	60 h
total:	180 h

Content
Explanation, demonstration and execution of standard tests in soil mechanics:

- particle size distribution
- state limits
- water content
- density evaluation: limit densities, specific density, proctor test

Further lab tests and field tests:

- oedometer (compressibility)
- simple shear
- triaxial tests (drained, undrained)

- permeability
- in-situ determination of density
- dynamic probing
- cone penetration and vane shear test
- plate loading test
- inclinometer measurements
- exploratory drilling and sampling
- sample handling and special samples
- survey of interface structures in rock (field exercise)
- evaluation and illustration of interface data
- choice of necessary laboratory tests according to the type, required sample quality and the testing boundary conditions
- subsoil and foundation report, expertise

Module: Applied Geotechnics [bauiM5S03-ANGEOTEC]

Coordination: T. Triantafyllidis
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Geotechnical Engineering

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6251810	Foundations and Retaining Structures (p. 299)	L/E	2	S	3	P. Kudella
6251812	Special Foundation Engineering and Design (p. 371)	L/E	2	S	3	P. Kudella

Learning Control / Examinations
graded:
examination Applied Geotechnics, written, 90 min., accord. ER/SPO § 4 par. 2 no. 1
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
module Earthworks and Foundation Engineering [bauiM5P2-ERDGB]

Qualification Goals
The students make a self-dependent reasonable design decisions for pile foundations and excavations with regard to geological engineering, site managing and economical boundary conditions. They have a deepend understanding for the interaction of building, foundation and subsoil and can establish simple mechanical models by themself and use numerical tools customary in practice as well. They know and use relevant guidelines and link constructional experience, dimensioning rules and standardization to theoretical knowledge about soil mechanical laws.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
field trips:	10 h
independent study:	
preparation and follow-up, consultation hours:	50 h
examination preparation and examination:	60 h
total:	180 h

Content

- pile types
- load bearing resistance and deformations of individual piles in axial and lateral direction
- negative skin friction
- elastic subgrade reaction and plastic flow resistance
- load bearing resistance and settlement of pile groups
- recommendations EA-Pfähle and pile tests
- pile test
- pile raft design

- stress trapezoid
- ground reaction and elastic halfspace method for slab foundations
- gravity walls, cantilever retaining walls, stone cages, space lattice walls, underpinning
- trench sheeting, timber sheeting
- soldier pile walls, sheetpile walls, diaphragm walls
- anchoring and struts
- dig-and-cast construction method
- bottom sealing and immersed troughs
- grouted slabs, jetgrout slabs
- underwater concrete
- uplift piles and anchors
- combined pile-raft foundations
- caisson foundations
- soil reinforcement, geosynthetics and EBGEO recommendations
- soil nailing
- recommendations EAB: load approaches, special shapes of excavations, excavations next to buildings, excavations in rock and soft soils
- buried structures
- numerical design and deformation prediction using elastic-beam models
- numerical design and deformation prediction using elastioplastic FE-models, recommendations for modeling, 3D-FEM in examples
- recommendations EAU

Remarks
Literature:
[1] Seitz, J. & Schmidt, H.-G. (2000), Bohrpfähle, Ernst & S.
[2] Triantafyllidis, Th. (1990), Planung und Bauausführung im Spezialtiefbau, Teil 1, Ernst & S.
[3] Weißenbach, A. (2001), Baugruben, Teil 1-3, Wiley
[4] EA Pfähle (2012), Deutsche Ges. f. Geotechnik, 2. Aufl. Ernst & S.
[5] EAB (2012), Deutsche Ges. f. Geotechnik, 5. Aufl., Ernst & S.
[6] EAU (2012), HTG und Deutsche Ges. f. Geotechnik, 11. Aufl., Ernst & S.
[7] EBGEO (2010), Deutsche Ges. f. Geotechnik, 2. Aufl. Ernst & S.
[8] Witt, J. Grundbau-Taschenbuch Teil 1-3, 7. Aufl. (2009), Ernst & S.

Module: Ground Water and Earth Dams [bauiM5S04-GWDAMM]

Coordination: T. Triantafyllidis
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Geotechnical Engineering

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6251814	Geotechnical Ground Water Problems (p. 295)	L/E	2	S	3	A. Bieberstein
6251816	Embankment Dams (Advanced) (p. 274)	L/E	2	S	3	A. Bieberstein

Learning Control / Examinations
graded:
examination Ground Water and Earth Dams, oral, 40 min., accord. ER/SPO § 4 par. 2 no. 2
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
module Earthworks and Foundation Engineering [bauiM5P2-ERDGB]

Qualification Goals
The students have deepend knowledge about different geotechnical groundwater problems. They can dimension dewatering unter very different boundary conditions and demonstrate geohydraulic relationships by example calculations. They are able to develop own solution approaches for dam construction problems, to evaluate construction techniques and to conduct the requested geotechnical proofs.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
field trips:	10 h
independent study:	
preparation and follow-up, consultation hours:	50 h
examination preparation and examination:	60 h
total:	180 h

Content
Geotechnical Ground Water Problems:

- investigation of the groundwater conditions
- geophysical exploration procedures
- overview of laboratory and field tests
- types and application possibilities of sounding equipment and measuring procedures
- permeability tests in the laboratory and in-situ
- air permeability of soils
- saturation and propagation of saturation fronts
- permeability anisotropy

- dewatering technologies, time scale of dewatering
- dewatering along rivers
- dewatering effects
- seepage through dams and flow nets, load cases, underseepage of dams.

Embankment Dams (Advanced):

- hydrologic and hydraulic design of dams
- regulations for dams and embankments
- design of freeboard
- slope stability concepts
- proof of sliding stability
- uplift stability
- stress distribution in the dam base
- spread stability
- settlements
- hydraulic stability
- seepage and flow nets
- determination of the phreatic line
- erosion criteria, methods to prove inner erosion stability
- filters and drains
- subsoil sealing
- deformation of embankments
- safety against flaws
- earthquake design
- monitoring of dams
- buried auxiliary structures
- artificial sealings
- asphalt concrete
- dams and embankments designed for overtopping

Remarks
Literature:
[1] Cedergren, H.R. (1989), Seepage, Drainage, and Flow Nets, 3. Aufl. Wiley
[2] Herdt, W. & Arndts, E. (1985), Theorie und Praxis der Grundwasserabsenkung, 2. Aufl. Ernst & S.

Module: Rock Engineering and Underground Construction [bauiM5S05-FELSHOHL]

Coordination: T. Triantafyllidis
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Geotechnical Engineering

ECTS Credits	Cycle	Duration
6	Every 2nd term, Winter Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6251905	Aboveground Rock Engineering (p. 282)	L/E	2	W	3	P. Kudella
6251907	Tunnel Construction in Soils and in Existence (p. 393)	L/E	2	W	3	B. Fröhlich, P. Kudella

Learning Control / Examinations
graded:
examination Rock Engineering and Underground Construction, written, 90 min., accord. ER/SPO § 4 par. 2 no. 1
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
module Rock Engineering and Tunneling [bauiM5P3-FMTUB]

Qualification Goals
The students are familiar with planning, construction and design of safety systems for embankments and hillsides in bedrock. They can identify critical failure mechanisms, conduct respective stability analyses and design anchoring. They know setup and function of tunnel boring machines and tunneling techniques by own perception and can select appropriate tunnel boring technologies. They can transfer deepend knowledge about strength and deformation properties of bedrock and the precursory and accompanied exploration to the rehabilitation of existing tunnels.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
field trips:	10 h
independent study:	
preparation and follow-up, consultation hours:	50 h
examination preparation and examination:	60 h
total:	180 h

Content
Aboveground Rock Engineering:

- types of rock slopes and failure mechanisms
- survey, analysis and interpretation of structural interface data (stereonet projection, rose diagram)
- computational procedures for sliding of rock embankments: grafical (stereonet projection) and analytical computational procedures, block overturning
- embankment construction: dismantling procedures, protection methods, retaining walls, anchors
- slope reinforcement: clearing, barrier fences, nets, monitoring systems

Tunnel Construction in Soils and in Existence:

- tunnel sealing
- tunnel lining
- tunnel security (fire protection, escape concept)
- rehabilitation of existing tunnels, safety analysis of existing tunnels (exploration, rehabilitation, restoration, renewal)
- open-face tunneling (cut-and-cover, sink tunnels, caisson tunnels)
- mechanical tunnelling: shield machines, compressed air, hydro and earth pressure support, pipe and frame jacking, microtunneling and steered horizontal borings
- earth static analysis and deformation prediction for surface-near tunneling in loose ground
- settlement compensation

Remarks
Literature:
[1] Brady, B. H. G. and Brown, E. T., (2004): Rock Mechanics for Underground Mining, 3rd. Edition, Kluwer Academic Publishers.
[2] Maidl B., Herrenknecht M., Maidl U., Wehrmeyer G. Maschineller Tunnelbau im Schildvortrieb, 2. Auflage 2011, Ernst & Sohn
[3] Kolymbas, D. (1998), Geotechnik - Tunnelbau und Tunnelmechanik, Springer.

Module: Numerical Modelling in Geotechnics [bauiM5S06-NUMMOD]

Coordination: T. Triantafyllidis
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Geotechnical Engineering

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6251818	Exercises in Numerical Modelling (p. 397)	E	2	S	3	A. Niemunis
6251819	FEM Applications in Geotechnical Modelling (p. 283)	L	2	S	3	A. Niemunis

Learning Control / Examinations
graded:
examination Numeric Modelling in Geotechnics, oral, 40 min., accord. ER/SPO § 4 par. 2 no. 2, on base of a programming project worked at during the semseter
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
basic knowledge in programming (any language),
module Basics of Numeric Modelling [bauiM5P4-NUMGRUND]

Qualification Goals
The students can develop numerical solutions for typical geotechnical boundary value problems by themself and implement them by programming with FORTRAN95. They got to know FE applications in several fields of geotechnics (foundation, rock and tunnel construction, dam construction), got practical experience with the FE code ABAQUS (TM) and applied this for the modelling of example problems. They are able to interpret and evaluate crtically results of numerical simulations.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up, consultation hours, exercises with available software:	60 h
examination preparation and examination:	60 h
total:	180 h

Content

- beam on elastic half-space
- slope stability with layer procedure according to Bishop
- 2D and 3D pile rafts with lateral bedding
- FE-modeling of spatially correlated fluctuations of soil parameters
- FE settlement prediction with nonlinearity for small strains
- introduction to the FE-program ABAQUS: definition of joints and elements, assignment of material laws, definition of initial and boundary conditions

- examples of FE-applications in tunnel engineering
- numerical FE-modeling of a deep pit excavation under consideration of the construction sequence
- numerical FE-modeling of seepage through a zoned dam with partial saturation (different load cases)
- linear dynamics using ABAQUS

Remarks
Literature:
[1] Smith, I.M.; Griffith, D.V. (2004): Programming the Finite Element Method. JWS
[2] Hibbit, Karlsson, Sorensen: ABAQUS for geotechnical problems
[3] Helwany, S. (2007) Applied Soil Mechanics with ABAQUS Applications, Wiley
[4] Hibbit, Karlsson, Sorensen (1997): Contact in ABAQUS/Standard
[5] FORTRAN 95 HP Manual
additional study material is placed at students disposal (software for download)

Module: Geotechnical Testing and Measuring Technology [bauiM5S07-VERSMESS]

Coordination: T. Triantafyllidis
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Geotechnical Engineering

ECTS Credits	Cycle	Duration
6	Every 2nd term, Winter Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6251909	Rock Testing (p. 412)	L	1	W	1,5	E. Gerolymatou
6251910	Testing in Dam and Wastefill Engineering (p. 275)	L	1	W	1,5	A. Bieberstein
6251911	Geotechnical Measuring Technology (p. 254)	L/E	2	W	3	G. Huber

Learning Control / Examinations
graded:
examination Geotechnical Testing and Measuring Technology, oral, 40 min., accord. ER/SPO § 4 par. 2 no. 2
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
none

Qualification Goals
The students overview masterfully the procedures and methods for subsoil exploration and testing techniques even those surpassing standard procedures. They are familiar with their specific application conditions and prerequisites and can select reasonably appropriate combinations of techniques. They have basic knowledge in geophysics, measurement technologies and the functioning principles of sensors and data acquisition. As a result of this they can select equipement reasonably with respect to resolution, accuracy, long term stability and interpretation. They have own experiences with the handling of sensor application, wiring, data acquisition, control elements, measuring and analysis precedures.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up, consultation hours, laboratory experiments and their analyses:	60 h
examination preparation and examination:	60 h
total:	180 h

Content
Rock Testing:

- presentation of national and international standards for testing procedures
- basic measuring techniques in rock
- structure and function of testing devices
- selection and preparation of samples
- test execution: uniaxial and triaxial compression test, uniaxial and triaxial creep test, relaxation test, direct shear test, Brazilian test, swelling test, point load test, large-scale triaxial test, further index tests

Testing in Dam and Wastefill Engineering:

- investigation of groundwater situation
- geophysical exploration
- overview of lab and field tests for compressibility, shear resistance, permeability, filter tests
- rheological properties of suspensions
- testing of densification and deformability

Geotechnical Measuring Technology:

- measurement of physical quantities: displacement, strain, velocity, acceleration, force, pressure, stress tensor, time, temperature, flow, moisture
- introduction to their measuring methods, sensors and limitations
- measuring electrical quantities: methods and devices, signal filtering
- optical measurements and correlation techniques using the example of the Particle-Image-Velocimetry (PIV)
- development and analysis of a measurement chain from a physical quantity to a final reading
- influence of measurement on observed processes, influences of errors, noise e.g.
- comparison of direct and compensating methods
- transmission of analogue and digital data, smart sensors
- methods of characterisation: time domain, frequency domain, state space
- description of dynamic measurement categories: time domain, frequency domain, state space,
- control technology: concepts and application
- examples of measurements on construction site and in situ: anchor tests, measurement of settlement and inclination, stress measurement and borehole measurements in rock
- measurements in relation to the observational method (DIN1054)
- training: electrical measuring, data acquisition, influence of noise, mounting of DMS to strain gauges, setup and test of a measurement chain for field measurements (anchor test or cone penetration test), density measurement

Module: Special Underground Engineering [bauiM5S08-SPEZTIEF]

Coordination: T. Triantafyllidis
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Geotechnical Engineering

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6251820	Ground Improvement, Grouting and Soil Freezing (p. 256)	L/E	2	S	3	W. Orth
6251822	Anchoring, Piling and Slurry Wall Technology (p. 228)	L/E	2	S	3	T. Triantafyllidis

Learning Control / Examinations
graded:
partial examination Ground Improvement, Grouting and Soil Freezing, oral, 20 min., accord. ER/SPO § 4 par. 2 no. 2
partial examination Anchoring, Piling and Slurry Wall Technology, oral, 20 min., accord. ER/SPO § 4 par. 2 no. 2
grading:
grade of module is defined by weighted average according credit points of grades of the partial examinations

Conditions
none

Recommendations
none

Qualification Goals
The students know performance, ranges of application, necessary preliminary investigations and accompanying controls (monitoring) for special underground engineering technologies and gain specific knowledge about special underground engineering technologies. They can select self-reliantly appropriate technologies for certain construction problems, describe and dimensioning the steps of the procedure, motivate required preinvestigations, specify parameters for the realization and define the type of controls of execution. They are familiar with the principles of the observation method and the construction measurment technology and the controls for quality assurance.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
field trips:	10 h
independent study:	
preparation and follow-up, consultation hours:	50 h
examination preparations and examinations:	60 h
total:	180 h

Content
Ground Improvement, Grouting and Soil Freezing:

- soil freezing: brine and nitrogen cooling, frost spreading under artificial and natural influence, frost heave and thaw settlement, mechanical behaviour of frozen soils, mechanical and thermal calculation of simple frost bodies (underpinning and tunnel ring), monitoring
- grouting technology: execution and application boundaries of injections, monitoring, pore and gap injection, soil fracturing, jet grouting, theory of the injections, characteristics of suspensions and solutions, permeability and strength of injected soils

- soil improvement: application areas, obtainable effects, monitoring, deep vibro compaction, vibro replacement compaction, dynamic (heavy) compaction

Anchoring, Piling and Slurry Wall Technology:

- Slurry walls: Application rangs of diaphragm and slurry walls, guide walls, trench excavation, internal and external stability of open slurry trenches, support fluids, joints and joint constructions, reinforcement and concreteing diaphragm walls, FE simulation of construction.
- Anchoring: Ground anchor types, standards, cetrifications, recommendations, function and constructions, corrosion protection, anchor drilling and mounting, dimensioning and load capacity, checks due to DIN 1537, supervision, use in aggressive environment
- Piling: cast concrete caissons, borehole support, drilling technology and tools, distinctive features, pile reinforcement and concreting

Remarks
Literature:
[1] Triantafyllidis, Th. (1990), Planung und Bauausführung im Spezialtiefbau, Teil 1, Ernst & S.
[2] Seitz, J. & Schmidt, H.-G. (2000), Bohrpfähle Ernst & S.
[3] Witt, J. (Hrsg.), Grundbau-Taschenbuch Teil 1-3, 7. Aufl. (2009), Ernst & Sohn
[4] Kutzner, Ch. (1991), Injektionen im Baugrund, F.Enke

Module: Environmental Geotechnics [bauiM5S09-UMGEOTEC]

Coordination: T. Triantafyllidis
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Geotechnical Engineering

ECTS Credits	Cycle	Duration
6	Every 2nd term, Winter Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6251913	Landfills (p. 396)	L/E	2	W	3	A. Bieberstein
6251915	Brownfield Sites - Investigation, Evaluation, Rehabilitation (p. 224)	L	2	W	3	A. Bieberstein, T. Neumann, H. Würdemann, S. Norra, U. Mohrlok, M. Reinhard, H. Dörr

Learning Control / Examinations
graded:
partial examination Landfills, oral, 20 min., accord. ER/SPO § 4 par. 2 no. 2
partial examination Brownfield Sites, oral, 20 min., accord. ER/SPO § 4 par. 2 no. 2
grading:
grade of module is defined by weighted average according credit points of grades of the partial examinations

Conditions
none

Recommendations
none

Qualification Goals
The students know the legal guidelines regarding the disposal of wastes and the permitted threshold value for brownfields. They overview the geotechnical concerns in the construction of landfill sites depending on the particular landfill classification, landfill elements, their relevant requirements and necessary certifications. They are able to interlink interdisciplinarily the chemical, mineralogical, biological, hydraulic and geotechnical aspects dealing with brownfileds. They can choose reasonably between the relevant remediation technologies and assess their limits of applications and risks.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
field trips:	10 h
independent study:	
preparation and follow-up, consultation hours:	50 h
examination preparations and examinations:	60 h
total:	180 h

Content
Landfills:

- waste-situation and waste catalogue
- requirements from the authorities, legal basis
- planning landfill sites
- multi-barrier system
- construction elements

- hydraulic analysis
- technical equipment for gas treatment of landfills
- static analysis
- serviceability analysis
- construction
- special design solutions
- strengthening of landfills

Brownfield Sites:

- introduction to the problematic of brownfields
- investigation and location assessment of brownfields
- harmful substances and their behavior in the environment
- environmental-chemical and mineralogical aspects of the accumulation of harmful substances in soil
- natural attenuation and active microbiological decontamination procedures
- reactive walls and electro-kinetic decontamination procedures
- soil washing, combustion, pyrolysis
- immobilization and compression, geotechnical aspects of the containment of industrial waste landfills
- hydraulic and pneumatic decontamination procedures
- case-studies, excursion

Remarks
Literature:
[1] DGGT, GDA-Empfehlungen – Geotechnik der Deponien und Altlasten, Ernst und Sohn, Berlin
[2] Drescher (1997), Deponiebau, Ernst und Sohn, Berlin
[3] Reiersloh, D und Reinhard, M. (2010): Altlastenratgeber für die Praxis, Vulkan-V. Essen

Module: Coupled Geomechanical Processes [bauiM5S10-GEKOPPRO]

Coordination: T. Triantafyllidis
Degree programme: Bauingenieurwesen (M.Sc.)
Subject: Focus Geotechnical Engineering

ECTS Credits	Cycle	Duration
6	Every 2nd term, Winter Term	1

Courses in module

ID	Course	Course type	Hours per week	Term	CP	Responsible Lecturer(s)
6251916	Special Issues in Rock Mechanics (p. 370)	L/E	2	W	3	E. Gerolymatou
6251918	Coupled Phenomena in Geomechanics (p. 292)	L/E	2	W	3	T. Wichtmann

Learning Control / Examinations
graded:
examination Coupled Geomechanical Processes, oral, 40 min., accord. ER/SPO § 4 par. 2 no. 2
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
module Rock Engineering and Tunnelling [bauiM5P3-FMTUB]

Qualification Goals
The students have deepend and supplementary knowledge about time-varying strength and deformation properties of rocks as well as of rock testing in-situ and in laboratory. They recognize and evaluate the basic physical and chemical alteration parameters of geomaterials. They are able to describe the involved hydromechanical, chemo-mechanical, thermomechanical and biomechanical processes and to express mathematically their interdependence with mechanical properties.

Workload

contact hours (1 HpW = 1 h x 15 weeks):	
lectures, exercises:	60 h
independent study:	
preparation and follow-up, consultation hours:	60 h
examination preparations and examinations:	60 h
total:	180 h

Content
Extended material properties of rock:

- time-dependent material phenomena: swelling, creep
- scale effects
- rock as multi-phase system (Biot theory)
- rock and fissure hydraulics, permeability,
- rock dynamics and basics of blasting techniques,
- rock drilling, cutting performance and bit consumption
- numerical methods in rock mechanics

Coupled physical procedures in geomaterials:

- hydromechanical phenomena: effect of wetting, internal erosion, liquefaction, hydraulic fracturing
- chemomechanical phenomena: dissolution, precipitation, swelling, solute transport
- thermomechanical phenomena: heat production and transport, effect on mechanical properties, coupling to hydraulic effects
- biomechanical phenomena: effect of bacteria and flora

Remarks
Literature:
[1] Brady, B.H.G. & Brown, E.T. (2004), Rock Mechanics for Underground Mining, 3rd Ed., Kluwer.
[2] Fecker, Edwin, 1997: Geotechnische Messgeräte und Feldversuche im Fels, Ferdinand Enke Verlag Stuttgart.
[3] Hoek, Evert, 2007: Practical Rock Engineering (free download at
http://www.rocscience.com/education/hoeks_corner)

4.6 Module Key Competences

Module: Key Competences [bauiMW0-SQUAL]

Coordination: Studiendekan Bauingenieurwesen
Degree programme: Bauingenieurwesen (M.Sc.)
Subject:

ECTS Credits	Cycle	Duration
6	Every term	

Learning Control / Examinations
according to elected courses, freely be chosen from the course catalogue for Key Competences of HoC and ZAK
grading:
n. a.
(marks can be requested in agreement with lecturer, but do not contribute to overall grade)

Conditions
none

Recommendations
none

Qualification Goals
Learning outcomes can be divided into three main complementary categories:
1. Contextual Knowledge

- Students are aware of the cultural context of their position and are in a position to consider the views and interests of others (beyond the boundaries of subject, culture, and language).
- They have enhanced their ability to participate properly and appropriately in academic or public discussions.

2. Practical Focus

- Students have gained an insight into the routines of professional life.
- They have further developed their capability to learn.
- They have improved their scope of action by extending their knowledge of foreign languages.
- They are able to relate their field of experience to basic aspects of business administration and law.

3. Basic Competences

- The students autonomously acquire new knowledge in a planned, specific, and methodologically founded manner and use it for solving tasks and problems.
- They can evaluate own work.
- They possess efficient work techniques, can set priorities, take decisions, and assume responsibility.

Workload
see module handbook of HoC, and lecture descriptions of ZAK

Content
With the key competences, the House of Competence (HoC) and the Centre for Cultural and General Studies (ZAK) offer a wide range of courses, which are bundled thematically for better orientation. The contents are explained in detail in the descriptions of the courses on the internet pages of HoC (http://www.hoc.kit.edu/lehrangebot.php) and ZAK (http://www.zak.kit.edu/english/general_studies.php).

Remarks
The Examination Committee can recognize further suitable courses as key competences which are not listed in the offers of Hoc and ZAK as mentioned above.

4.7 Module Master Thesis

Module: Master Thesis [bauiMSC-THESIS]

Coordination: Studiendekan Bauingenieurwesen
Degree programme: Bauingenieurwesen (M.Sc.)
Subject:

ECTS Credits	Cycle	Duration
30	Once	

Learning Control / Examinations
Thesis and final presentation, duration of 6 months
grading:
The mark results from the grading of the Master Thesis and the final presentation.

Conditions
Modules in extent of minimum 42 CP has to be passed in order to be admitted to the Master Thesis according to ER/SPO § 11 par. 1. Results obtained in the module Key Competences [bauiMW0-SQUAL] cannot be counted for this purpose.
In case of selection of Focus IV, Technology and Management in Construction, the two student research projects have to be got attested.

Recommendations
All technical skills and soft skills required for working on the selected topic and the preparation of the thesis should be attained.

Qualification Goals
The student is able to investigate independently a complex problem within a particular research field of his choice in limited time, following scientific methods. He can search autonomously for literature, can find own approaches, can evaluate his results and can classify them according to the state of the art. He is further able to present clearly the essential matter and results in his master thesis and in a comprehensive presentation.

Workload
6 months time for preparation,
can also be distributed over a longer period

Content
The Master Thesis is an independent written report and comprises the theoretical or experimental work on a complex problem within a particular field of civil engineering with scientific methods. The topic of the master thesis derives from the students choice of a particular field. The student and can make proposals for the topic.

5 Courses

(listed according to course ID)

Course: Brownfield Sites - Investigation, Evaluation, Rehabilitation [6251915]

Coordinators: A. Bieberstein, T. Neumann, H. Würdemann, S. Norra, U. Mohrlok, M. Reinhard, H. Dörr
Part of the modules: Environmental Geotechnics (p. 218)[bauiM5S09-UMGEOTEC]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture	2	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Analytic Methods [6211908]

Coordinators: J. Eckhardt, M. Vogel
Part of the modules: Durability and Service Life Design (p. 75)[bauiM1S25-DAUERLEB]

ECTS Credits	Course type	Hours per week	Term	Instruction language
1,5	lecture	1	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Appropriate Technologies [6223902]

Coordinators: E. Hoffmann
Part of the modules: Industrial Water Management (p. 140)[bauiM2S29-SW6]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	2	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Applied Building Physics [6211909]

Coordinators: E. Kotan, H. Müller
Part of the modules: Building Physics I (p. 78)[bauiM1S27-BAUPH-I]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture	2	Winter term	

Learning Control / Examinations

Conditions

None.

Learning Outcomes

Content

Course: Anchoring, Piling and Slurry Wall Technology [6251822]

Coordinators: T. Triantafyllidis
Part of the modules: Special Underground Engineering (p. 216)[bauiM5S08-SPEZTIEF]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	2	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Facilities and Rolling Stock of Public Transport [6234802]

Coordinators: E. Hohnecker
Part of the modules: Track Guided Transport Systems - Management, Facilities and Vehicles of Public Transport (p. 167)[bauiM3S19-EBOEV]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	1/1	Summer term	de

Learning Control / Examinations
See German version.

Conditions
See module description.

Learning Outcomes
See German version.

Content
stations and terminals for passengers and freight, basics of rolling stock and electrical drive

Remarks
See German version.

Course: Material Models in Solid Mechanics [6215801]

Coordinators: T. Seelig, C. Hesch
Part of the modules: Material Models in Solid Mechanics (p. 72)[bauiM1S22-MATTHEO]

ECTS Credits	Course type	Hours per week	Term	Instruction language
6	lecture + exercise	2/2	Summer term	

Learning Control / Examinations

Conditions

None.

Learning Outcomes

Content

Course: Bracing and Stability in Reinforced Concrete [6211801]

Coordinators: L. Stempniewski
Part of the modules: Bracing and Stability in Reinforced Concrete (p. 42)[bauiM1S01-STABISTB]

ECTS Credits	Course type	Hours per week	Term	Instruction language
6	lecture + exercise	2/2	Summer term	

Learning Control / Examinations

Conditions

None.

Learning Outcomes

Content

Course: Construction and Maintenance of Track Infrastructure [6234809]

Coordinators: E. Hohnecker, staff
Part of the modules: Dimensioning and Construction of Railway Tracks (p. 161)[bauiM3S14-EBBAU]

ECTS Credits	Course type	Hours per week	Term	Instruction language
1,5	lecture	1	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Dynamics of Structures [6215701]

Coordinators: P. Betsch, T. Seelig
Part of the modules: Surface Structures and Dynamics of Structures (p. 40)[bauiM1P3-FTW-BD]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture	2	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Upgrading of Existing Buildings [6241901]

Coordinators: K. Lennerts, H. Schneider
Part of the modules: Upgrading of Existing Buildings and Energetic Refurbishment (p. 182)[bauiM4S07-]

ECTS Credits	Course type	Hours per week	Term	Instruction language
4,5	lecture + exercise	2/1	Winter term	

Learning Control / Examinations

Conditions

None.

Learning Outcomes

Content

Course: Soil Dynamics [6251903]

Coordinators: G. Huber
Part of the modules: Special Issues of Soil Mechanics (p. 202)[bauiM5S01-SPEZBM]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	2	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Site Management [6241832]

Coordinators: S. Haghsheno, P. Steffek
Part of the modules: Business and Human Resource Management (p. 179)[bauiM4S01-]

ECTS Credits	Course type	Hours per week	Term	Instruction language
1,5	lecture	1	Summer term	

Learning Control / Examinations

Conditions

None.

Learning Outcomes

Content

Course: Building Laws [6241804]

Coordinators: S. Haghsheno, R. Kohlhammer, H. Miernik
Part of the modules: Economics and Management in Construction (p. 171)[bauiM4P3-]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture	2	Summer term	

Learning Control / Examinations

Conditions

None.

Learning Outcomes

Content

Course: Building Analysis [6211813]

Coordinators: E. Kotan, M. Vogel
Part of the modules: Building Preservation of Concrete and Masonry Constructions (p. 76)[bauiM1S26-BBM]

ECTS Credits	Course type	Hours per week	Term	Instruction language
1,5	lecture	1	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Preservation of Timber Structures [6213903]

Coordinators: R. Görlacher
Part of the modules: Preservation of Steel and Timber Structures (p. 57)[bauiM1S11-BAUING-BSH]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	2	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Preservation of Steel Structures [6212909]

Coordinators: T. Ummenhofer
Part of the modules: Preservation of Steel and Timber Structures (p. 57)[bauiM1S11-BAUING-BSH]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture	2	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Determination of Demand, Timetable Construction and Alignment [6234810]

Coordinators: E. Hohnecker
Part of the modules: Traffic Infrastructure (p. 163)[bauiM3S16-EBVERKEHR]

ECTS Credits	Course type	Hours per week	Term	Instruction language
4,5	lecture + exercise	1/2	Summer term	de

Learning Control / Examinations
The conjoined assessment of the lectures *Determination of demand, Timetable construction and Alignment* [6234810; 6234811] and *“Standardisierte Bewertung” in public transport using an example* [6234904] consists of an oral presentation and a written paper according §4(2), 3 of the examination regulation.
The mark consist of both parts of the assessment (66% of the mark of the presentation and 34% of the written paper).
The exam is offered each semester. The re-examination is offered upon prior agreement with the interested participants and not later than the next regular examination date.

Conditions
See module description.
The lecture is obligatory in the module *Project in Public Transportation*.

Recommendations
See module description.

Learning Outcomes
See German version.

Content
practise: urban traffic project: Planning and line-layouting

Remarks
See German version.

Course: Anchorage in Concrete I [6211807]

Coordinators: W. Fuchs
Part of the modules: Anchorage in Concrete (p. 47)[bauiM1S05-BEFTECH]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	1/1	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Anchorage in Concrete II [6211905]

Coordinators: W. Fuchs
Part of the modules: Anchorage in Concrete (p. 47)[bauiM1S05-BEFTECH]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	1/1	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Tank Construction [6212910]

Coordinators: P. Knödel
Part of the modules: Tank Construction (p. 88)[bauiM1S39-BEHBAU]

ECTS Credits	Course type	Hours per week	Term	Instruction language
6	lecture + exercise	3/1	Winter term	de

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Literature
Literature:
lecture notes
DIN EN 1993-1-6: Bemessung und Konstruktion von Stahlbauten - Teil 1-6: Festigkeit und Stabilität von Schalen
DIN EN 1993-4-1: Bemessung und Konstruktion von Stahlbauten - Teil 4-1: Silos
DIN EN 1993-4-2: Bemessung und Konstruktion von Stahlbauten - Teil 4-2: Tankbauwerke
Knödel, P.; Heß, A.; Ummenhofer, T.: Stählerne Tankbauwerke nach DIN EN 1993-4-2. In: Stahlbau-Kalender 2013, S. 523-563.

Course: Design and Construction of Components in Reinforced Concrete [6211701]

Coordinators: L. Stempniewski
Part of the modules: Design and Construction of Components in Reinforced Concrete (p. 37)[bauiM1P1-BEMISTB]

ECTS Credits	Course type	Hours per week	Term	Instruction language
6	lecture + exercise	2/2	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Pavement Structural Design and Failure Analysis [6233905]

Coordinators: P. Plachkova-Dzhurova
Part of the modules: Road Construction (p. 156)[bauiM3S06-STRBAUT]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture	2	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Methods and Models in Transportation Planning [6232701]

Coordinators: P. Vortisch, M. Kagerbauer
Part of the modules: Models and Methods in Traffic Engineering and Transportation Planning (p. 145)[bauiM3P2-VERMODELL]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	1/1	Winter term	de

Learning Control / Examinations
The assessment consists of an oral exam according to §4(2), 2 of the examination regulation.

Conditions
See module description.

Learning Outcomes

Content

Course: Special Topics in Highway Engineering [6233807]

Coordinators: R. Roos
Part of the modules: Special Topics in Highway Engineering (p. 160)[bauiM3S13-STRSPEZ]

ECTS Credits	Course type	Hours per week	Term	Instruction language
1,5	lecture	1	Summer term	

Learning Control / Examinations
See module description.

Conditions
See corresponding module information.

Learning Outcomes

Content

Course: Concrete Technology [6211809]

Coordinators: M. Haist, V. Kvitsel, H. Müller
Part of the modules: Concrete Construction Technology (p. 74)[bauiM1S24-BETONTECH]

ECTS Credits	Course type	Hours per week	Term	Instruction language
4,5	lecture + exercise	3	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Operation track guided systems [6234801]

Coordinators: E. Hohnecker
Part of the modules: Track Guided Transport Systems - Operation and Capacity (p. 165)[bauiM3S18-EBBETRKAP]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture	2	Summer term	de

Learning Control / Examinations
See German version.

Conditions
See module description.

Learning Outcomes
See German version.

Content
Operation systems, signalling systems, operation schedule and timetable construction

Literature
Elective literature:
Fiedler: Grundlagen der Bahntechnik, Werner Verlag Düsseldorf
Pachl: Systemtechnik des Schienenverkehrs, Teubner-Verlag, Stuttgart

Remarks
See German version.

Course: Operation and Maintenance of Highways [6233802]

Coordinators: R. Roos
Part of the modules: Infrastructure Management (p. 146)[bauiM3P3-STRINFRA]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture	2	Summer term	de

Learning Control / Examinations
See module description.

Conditions
See corresponding module information.

Learning Outcomes

Content

Course: Operation Systems and Track Guided Infrastructure Capacity [6234804]

Coordinators: E. Hohnecker, staff
Part of the modules: Track Guided Transport Systems - Operation and Capacity (p. 165)[bauiM3S18-EBBETRKAP]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture	2	Summer term	de

Learning Control / Examinations
See module description.

Conditions
See module description.

Learning Outcomes
See German version.

Content
Special signalling equipments, automatic driving, safety case, capacity of railway equipments, dimensioning of marshaling yards.

Literature
Elective literature:
Fiedler: Grundlagen der Bahntechnik, Werner Verlag Düsseldorf
Pachl: Systemtechnik des Schienenverkehrs, Teubner-Verlag, Stuttgart

Remarks
See German version.

Course: Assessment and Evaluation Techniques [6232801]

Coordinators: P. Vortisch, B. Chlond
Part of the modules: Laws and Proceedings concerning Traffic and Roads (p. 148)[bauiM3P5-VERFRECHT]

ECTS Credits	Course type	Hours per week	Term	Instruction language
1,5	lecture	1	Summer term	de

Learning Control / Examinations
The assessment consists of an oral exam according to §4(2), 2 of the examination regulation.

Conditions
None.

Learning Outcomes

Content

Course: Geotechnical Measuring Technology [6251911]

Coordinators: G. Huber
Part of the modules: Geotechnical Testing and Measuring Technology (p. 214)[bauiM5S07-VERSMESS]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	2	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Soil Mechanical Laboratory Exercises [6251808]

Coordinators: G. Huber
Part of the modules: Ground Investigation (p. 204)[bauiM5S02-BERKUND]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	exercise	2	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Ground Improvement, Grouting and Soil Freezing [6251820]

Coordinators: W. Orth
Part of the modules: Special Underground Engineering (p. 216)[bauiM5S08-SPEZTIEF]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	2	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Fracture and Damage Mechanics [6215903]

Coordinators: T. Seelig
Part of the modules: Fracture and Damage Mechanics (p. 70)[bauiM1S21-BRUCHMECH]

ECTS Credits	Course type	Hours per week	Term	Instruction language
6	lecture + exercise	2/2	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Building Information Modeling (BIM) [6241836]

Coordinators: S. Haghsheno
Part of the modules: Building Information Modeling (BIM) (p. 193)[bauiM4S16-]

ECTS Credits	Course type	Hours per week	Term	Instruction language
6	lecture + exercise	4	Summer term	de

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Computational Analysis of Structures [6214801]

Coordinators: W. Wagner
Part of the modules: Computational Analysis of Structures (p. 63)[bauiM1S15-CTWM]

ECTS Credits	Course type	Hours per week	Term	Instruction language
6	lecture + exercise	2/2	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Controlling in Real Estate Management [6241924]

Coordinators: K. Lennerts
Part of the modules: Real Estate Management (p. 184)[bauiM4S08-]

ECTS Credits	Course type	Hours per week	Term	Instruction language
1,5	lecture	1	Winter term	de

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Corporate Real Estate Management and Human Resources in Real Estate [6241907]

Coordinators: S. Beretitsch
Part of the modules: Real Estate Management (p. 184)[bauiM4S08-]

ECTS Credits	Course type	Hours per week	Term	Instruction language
1,5	lecture	1	Winter term	de

Learning Control / Examinations

Conditions

None.

Learning Outcomes

Content

Course: Data Analysis and Environmental Monitoring [6224805]

Coordinators: E. Zehe
Part of the modules: Data Analysis and Environmental Monitoring (p. 106)[bauiM2S04-HY4]

ECTS Credits	Course type	Hours per week	Term	Instruction language
6	lecture + exercise	4	Summer term	

Learning Control / Examinations

Conditions

None.

Learning Outcomes

Content

Course: Removal and Decontamination of Nuclear Facilities [6241917]

Coordinators: S. Gentes, staff
Part of the modules: Decommissioning of Nuclear Facilities (p. 187)[bauiM4S12-]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	1/1	Winter term	

Learning Control / Examinations

Conditions

None.

Learning Outcomes

Content

Course: Design of Hydraulic Structures [6222703]

Coordinators: F. Nestmann
Part of the modules: Hydraulic Engineering (p. 95)[bauiM2P6-ADVHYENG]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	1/1	Summer term	en

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: IT-based Road Design [6233901]

Coordinators: M. Zimmermann
Part of the modules: Highway Design (p. 155)[bauiM3S05-STRENTW]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	2	Winter term	de

Learning Control / Examinations
See module description.

Conditions
See corresponding module information.

Learning Outcomes

Content

Course: Characteristics of Transportation Systems [6232806]

Coordinators: P. Vortisch
Part of the modules: Planning of Transportation Systems (p. 153)[bauiM3S04-VERPLAN]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture	2	Summer term	de

Learning Control / Examinations
The assessment consists of an oral exam according to §4(2), 2 of the examination regulation.

Conditions
See module description.

Learning Outcomes

Content

Course: Transportation Data Analysis [6232901]

Coordinators: M. Kagerbauer
Part of the modules: Analysis and Evolution of Mobility (p. 169)[bauiM3S20-VERANAMOB]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	2	Winter term	de

Learning Control / Examinations
The assessment consists of an oral exam according to §4(2), 2 of the examination regulation.

Conditions
See module description.

Learning Outcomes

Content

Course: Energetic Refurbishment [6241903]

Coordinators: K. Lennerts, J. Megdenberg
Part of the modules: Upgrading of Existing Buildings and Energetic Refurbishment (p. 182)[bauiM4S07-]

ECTS Credits	Course type	Hours per week	Term	Instruction language
1,5	lecture	1	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Hydro Power Engineering [6222801]

Coordinators: P. Oberle
Part of the modules: Hydro Power Engineering (p. 117)[bauiM2S11-WB3]

ECTS Credits	Course type	Hours per week	Term	Instruction language
6	lecture + exercise	4	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Design and Construction of Highways [6233801]

Coordinators: R. Roos
Part of the modules: Infrastructure Management (p. 146)[bauiM3P3-STRINFRA]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	2	Summer term	de

Learning Control / Examinations
See module description.

Conditions
See corresponding module information.

Learning Outcomes

Content

Course: Environmental Fluid Mechanics [6221907]

Coordinators: O. Eiff
Part of the modules: Environmental Fluid Mechanics (p. 128)[bauiM2S19-SM5]

ECTS Credits	Course type	Hours per week	Term	Instruction language
6	lecture + exercise	3/1	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Operation Methods for Earthmoving [6241913]

Coordinators: H. Schlick
Part of the modules: Advanced Studies in Construction Engineering (p. 186)[bauiM4S10-]

ECTS Credits	Course type	Hours per week	Term	Instruction language
1,5	lecture	1	Winter term	de

Learning Control / Examinations
The assessment consists of an oral exam (15 min.) taking place in the recess period (according to §4 (2), 2 of the examination regulation).

Conditions
None.

Learning Outcomes
Students

- Gain specific knowledge regarding construction methods and equipment
- Can determine appropriate equipment and they can plan construction methods
- Can evaluate different construction methods and construction equipment based on context of use.

Content
The lecture comprises

- Operational characteristics of equipment and driving dynamics of construction equipment
- Impact of boundary conditions on operational characteristics
- Mode of operation of construction equipment and systems of construction equipment.

Media
Lecture slides.

Course: Earthquake Engineering [6211903]

Coordinators: L. Stempniewski
Part of the modules: Applied Dynamics of Structures (p. 45)[bauiM1S04-BAUDYN]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	1/1	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Embankment Dams (Advanced) [6251816]

Coordinators: A. Bieberstein
Part of the modules: Ground Water and Earth Dams (p. 208)[bauiM5S04-GWDAMM]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	2	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Testing in Dam and Wastefill Engineering [6251910]

Coordinators: A. Bieberstein
Part of the modules: Geotechnical Testing and Measuring Technology (p. 214)[bauiM5S07-VERSMESS]

ECTS Credits	Course type	Hours per week	Term	Instruction language
1,5	lecture	1	Winter term	

Learning Control / Examinations

Conditions

None.

Learning Outcomes

Content

Course: Logistics, Supply and Disposal [6231805]

Coordinators: M. Kagerbauer
Part of the modules: Space and Infrastructure (p. 150)[bauiM3S02-PLRAUMINF]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	1/1	Summer term	

Learning Control / Examinations

Conditions

None.

Learning Outcomes

Content

Course: Experimental Hydrology and Process Monitoring in Environmental Systems [6224807]

Coordinators: J. Wienhöfer, U. Ehret
Part of the modules: Experimental Hydrology and Process Monitoring in Environmental Systems (p. 108)[bauiM2S05-HY5]

ECTS Credits	Course type	Hours per week	Term	Instruction language
6	exercise	4	Summer term	

Learning Control / Examinations

Conditions

None.

Learning Outcomes

Content

Course: Experimental Methods [6221802]

Coordinators: C. Lang
Part of the modules: Experimental Techniques I: Small Scale Experiments (p. 120)[bauiM2S15-SM1]

ECTS Credits	Course type	Hours per week	Term	Instruction language
4,5	lecture + exercise	1/2	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Facility Management in Hospitals [6241921]

Coordinators: K. Lennerts, staff
Part of the modules: Facility Management in Hospitals and Hospital Management (p. 189)[bauiM4S13-]

ECTS Credits	Course type	Hours per week	Term	Instruction language
4,5	lecture + exercise	3	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Facility and Real Estate Management II [6241808]

Coordinators: K. Lennerts
Part of the modules: Sustainability in Real Estate Management (p. 173)[bauiM4P4-]

ECTS Credits	Course type	Hours per week	Term	Instruction language
1,5	lecture	1	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: FE-Applications in Practical Engineering [6214803]

Coordinators: W. Wagner
Part of the modules: FE-Applications in Practical Engineering (p. 64)[bauiM1S16-FE-PRAXIS]

ECTS Credits	Course type	Hours per week	Term	Instruction language
6	lecture + exercise	2/2	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Aboveground Rock Engineering [6251905]

Coordinators: P. Kudella
Part of the modules: Rock Engineering and Underground Construction (p. 210)[bauiM5S05-FELSHOHL]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	2	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: FEM Applications in Geotechnical Modelling [6251819]

Coordinators: A. Niemunis
Part of the modules: Numerical Modelling in Geotechnics (p. 212)[bauiM5S06-NUMMOD]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture	2	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Long-distance and Air Traffic [6232904]

Coordinators: B. Chlond, N.N., Wilko Manz
Part of the modules: Intermodality in Freight, Long-distance and Air Transport (p. 158)[bauiM3S11-VERINTER]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture	2	Winter term	de

Learning Control / Examinations
The assessment consists of an oral exam according to §4(2), 2 of the examination regulation.

Conditions
None.

Learning Outcomes

Content

Course: Finite Elements in Solid Mechanics [6215808]

Coordinators: P. Betsch
Part of the modules: Finite Elements in Solid Mechanics (p. 86)[bauiM1S37-FEFKM]

ECTS Credits	Course type	Hours per week	Term	Instruction language
6	lecture + exercise	2/2	Summer term	de

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Surface Structures [6214701]

Coordinators: W. Wagner
Part of the modules: Surface Structures and Dynamics of Structures (p. 40)[bauiM1P3-FTW-BD]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture	2	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Fluid Mechanics for Environmental Flows [6221704]

Coordinators: O. Eiff
Part of the modules: Fluid Mechanics for Environmental Flows (p. 92)[bauiM2P4-FMENVFL]

ECTS Credits	Course type	Hours per week	Term	Instruction language
6	lecture + exercise	4	Summer term	en

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Literature
I.G. Currie, Fundamental Mechanics of Fluids, Fourth Edition 2012.

Course: Fluid Mechanics of Turbulent Flows [6221806]

Coordinators: M. Uhlmann
Part of the modules: Analysis of Turbulent Flows (p. 142)[bauiM2S32-NS3], Turbulent Flows (p. 129)[bauiM2S20-NS1]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture	2	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes
Introduction to the physics of turbulent flows and the problem of computing them, statistical analysis of turbulent field data, detailed description of currently used statistical turbulence models (Reynolds-averaging as well as spatial filtering), discussion of model performance and range of applicability

Content
Fluid Mechanics of Turbulent Flows: General introduction to turbulent flows, Equations of fluid motion, Statistical description of turbulence, Free shear flows, The scales of turbulent motion, Wall-bounded shear flows, DNS as numerical experiments

Literature
Literature: S.B. Pope “Turbulent flows”, Cambridge University Press, 2000. U. Frisch “Turbulence: The legacy of A.N. Kolmogorov”, Cambridge U. Press, 1995. P.A. Durbin and P.A. Petterson Reif. “Statistical theory and modeling for turbulent flows”, Wiley, 2001. D.C. Wilcox “Turbulence Modeling for CFD”, DCW Industries, second edition, 1998.

Course: Building and Environmental Aerodynamics [6221905]

Coordinators: B. Ruck
Part of the modules: Interaction Flow - Building Structure (p. 122)[bauiM2S16-SM2]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	1/1	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Building Theory [6231804]

Coordinators: N. N.
Part of the modules: Urban Renewal (p. 149)[bauiM3S01-PLSTUMB]

ECTS Credits	Course type	Hours per week	Term	Instruction language
1,5	lecture	1	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Building Technology [6211910]

Coordinators: S. Wirth
Part of the modules: Building Physics I (p. 78)[bauiM1S27-BAUPH-I]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture	2	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Coupled Phenomena in Geomechanics [6251918]

Coordinators: T. Wichtmann
Part of the modules: Coupled Geomechanical Processes (p. 220)[bauiM5S10-GEKOPPRO]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	2	Winter term	de

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Field Training Water Quality [6223814]

Coordinators: S. Fuchs, S. Hilgert, U. Mohrlok
Part of the modules: Water Quality of Surface Water and Groundwater (p. 136)[bauiM2S26-SW3]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	practical course	2	Summer term	de

Learning Control / Examinations
graded report on field training with presentation

Conditions
attendance of the course Seminar Water Quality

Recommendations
none

Learning Outcomes
The students can critically evaluate the date obtained in the fiedl by their own with respect to the uncertainty related to the collection of the data as well as the classification into the context of the river basin.

Content

- water sampling methods
- sampling of water qaulity of surface water and groundwater
- structural quality mapping of streams
- determination of oxigen loss in water and sediment
- determination of Ermittlung des saprobic index

Remarks
The course Seminar Water Quality (6223813) together with the course Field Training Water Quality (6223814) replaces the combination of the courses Surface Water Quality (6223805)/Groundwater Quality (6221811).
The field training takes place at four days by the end of the semester.

Course: Geomechanical Field Exercise [6251809]

Coordinators: G. Huber
Part of the modules: Ground Investigation (p. 204)[bauiM5S02-BERKUND]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	exercise	2	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Geotechnical Ground Water Problems [6251814]

Coordinators: A. Bieberstein
Part of the modules: Ground Water and Earth Dams (p. 208)[bauiM5S04-GWDAMM]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	2	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Aquatic Ecosystems [6224903]

Coordinators: C. Kämpf
Part of the modules: Aquatic Ecosystems (p. 110)[bauiM2S06-HY6]

ECTS Credits	Course type	Hours per week	Term	Instruction language
6	lecture + exercise	2/1	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Glass, Plastic and Cable Structures [6212905]

Coordinators: D. Ruff
Part of the modules: Glass, Plastic and Cable Structures (p. 53)[bauiM1S09- GlaKunSe]

ECTS Credits	Course type	Hours per week	Term	Instruction language
6	lecture + exercise	3/1	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Groundwater Management [6221801]

Coordinators: U. Mohrlok
Part of the modules: Groundwater Management (p. 113)[bauiM2S08-HY8]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	2	Summer term	en

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Foundations and Retaining Structures [6251810]

Coordinators: P. Kudella
Part of the modules: Applied Geotechnics (p. 206)[bauiM5S03-ANGEOTEC]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	2	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Foundation Types [6251701]

Coordinators: T. Triantafyllidis
Part of the modules: Earthworks and Foundation Engineering (p. 196)[bauiM5P2-ERDGB]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	2	Winter term	

Learning Control / Examinations

Conditions

None.

Learning Outcomes

Content

Course: Basics in Rock Mechanics [6251804]

Coordinators: E. Gerolymatou
Part of the modules: Rock Mechanics and Tunnelling (p. 198)[bauiM5P3-FMTUB]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	2	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Basics in Earthworks and Embankment Dams [6251703]

Coordinators: A. Bieberstein
Part of the modules: Earthworks and Foundation Engineering (p. 196)[bauiM5P2-ERDGB]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	2	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Basics of Prestressed Concrete [6211803]

Coordinators: L. Stempniewski
Part of the modules: Basics of Prestressed Concrete (p. 43)[bauiM1S02-GDLSPANNB]

ECTS Credits	Course type	Hours per week	Term	Instruction language
6	lecture + exercise	2/2	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Basics in Tunnel Construction [6251806]

Coordinators: B. Fröhlich
Part of the modules: Rock Mechanics and Tunnelling (p. 198)[bauiM5P3-FMTUB]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	2	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Basics of Finite Elements [6215901]

Coordinators: C. Hesch
Part of the modules: Basics of Finite Elements (p. 69)[bauiM1S20-GRUNDFE]

ECTS Credits	Course type	Hours per week	Term	Instruction language
6	lecture + exercise	2/2	Winter term	

Learning Control / Examinations

Conditions

None.

Learning Outcomes

Content

Course: Fundamentals of Geographic Information Systems for Modelling and Planning [6072201]

Coordinators: S. Keller
Part of the modules: Space and Infrastructure (p. 150)[bauiM3S02-PLRAUMINF]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture	2	Summer term	de

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Freight Transport [6232809]

Coordinators: B. Chlond
Part of the modules: Intermodality in Freight, Long-distance and Air Transport (p. 158)[bauiM3S11-VERINTER]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	1/1	Summer term	de

Learning Control / Examinations
The assessment consists of an oral exam according to §4(2), 2 of the examination regulation.

Conditions
See module description.

Learning Outcomes

Content

Course: Hollow Section Structures [6212903]

Coordinators: S. Herion
Part of the modules: Hollow Section Structures (p. 52)[bauiM1S08-HOHLPROFIL]

ECTS Credits	Course type	Hours per week	Term	Instruction language
6	lecture + exercise	2/2	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Timber and Wood-based Materials [6213803]

Coordinators: C. Sandhaas
Part of the modules: Timber and Wood-based Materials (p. 60)[bauiM1S13-BAUING-HHW]

ECTS Credits	Course type	Hours per week	Term	Instruction language
6	lecture + exercise	2/2	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Timber Structures [6213801]

Coordinators: H. Blaß
Part of the modules: Timber Structures (p. 59)[bauiM1S12-BAUING-HB]

ECTS Credits	Course type	Hours per week	Term	Instruction language
6	lecture + exercise	2/2	Summer term	

Learning Control / Examinations

Conditions

None.

Learning Outcomes

Content

Course: Infrastructure Equipment of Railway Tracks [6234808]

Coordinators: E. Hohnecker, staff
Part of the modules: Dimensioning and Construction of Railway Tracks (p. 161)[bauiM3S14-EBBAU]

ECTS Credits	Course type	Hours per week	Term	Instruction language
1,5	lecture	1	Summer term	de

Learning Control / Examinations
The assessment will consist of a oral exam (20 min) according to §4 (2), 1 of the examination regulation.
The exam is offered each semester. The re-examination is offered upon prior agreement with the interested participants and not later than the next regular examination date.

Conditions
See module description.

Learning Outcomes
See German version.

Content
electrical infrastructure; signalling and telecommunication equipment, track systems

Remarks
See German version.

Course: Infrastructure Dimensioning and Running Dynamics of Railway Tracks [6234806]

Coordinators: E. Hohnecker, staff
Part of the modules: Dimensioning and Construction of Railway Tracks (p. 161)[bauiM3S14-EBBAU]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	1/1	Summer term	de

Learning Control / Examinations
See German version.

Conditions
See module description.

Learning Outcomes
See German version.

Content
calculation of Zimmermann; wheelset-running, graph theory, Max-Plus Algebra

Remarks
See German version.

Course: City Transport Facilities [6233909]

Coordinators: R. Roos, M. Zimmermann
Part of the modules: City Transport Facilities (p. 164)[bauiM3S17-STRIVA]

ECTS Credits	Course type	Hours per week	Term	Instruction language
6	lecture + exercise	4	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Cost Estimation [6241801]

Coordinators: S. Haghsheno
Part of the modules: Economics and Management in Construction (p. 171)[bauiM4P3-]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	1/1	Summer term	

Learning Control / Examinations

Conditions

None.

Learning Outcomes

Content

Course: Contact Mechanics - Fundamentals and Basics [6215803]

Coordinators: C. Hesch
Part of the modules: Contact Mechanics - Fundamentals and Basics (p. 83)[bauiM1S35-KONTMECH-BASICS]

ECTS Credits	Course type	Hours per week	Term	Instruction language
6	lecture + exercise	2/2	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Contact Mechanics - Computational Algorithms in a geometrically exact Form [6215907]

Coordinators: A. Konyukhov
Part of the modules: Contact Mechanics - Computational Algorithms in a geometrically exact Form (p. 84)[bauiM1S36-KONTMECH-ALGOR]

ECTS Credits	Course type	Hours per week	Term	Instruction language
6	lecture + exercise	2/2	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Continuum Mechanics [6215702]

Coordinators: C. Hesch
Part of the modules: Continuum Mechanics of Heterogeneous Solids (p. 82)[bauiM1S32-KONTIMECH], Basics in Numerical Modelling (p. 200)[bauiM5P4-NUMGRUND]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture	2	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Corrosion Processes and Life Time [6211907]

Coordinators: J. Eckhardt, M. Haist
Part of the modules: Durability and Service Life Design (p. 75)[bauiM1S25-DAUERLEB]

ECTS Credits	Course type	Hours per week	Term	Instruction language
4,5	lecture + exercise	3	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Hospital Management [6241923]

Coordinators: K. Lennerts
Part of the modules: Facility Management in Hospitals and Hospital Management (p. 189)[bauiM4S13-]

ECTS Credits	Course type	Hours per week	Term	Instruction language
1,5	lecture	1	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Cleaner Production - Closing the Loop [6223810]

Coordinators: E. Hoffmann
Part of the modules: Industrial Water Management (p. 140)[bauiM2S29-SW6]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	2	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Practical Laboratory Training in Road Construction [6233904]

Coordinators: P. Plachkova-Dzhurova
Part of the modules: Road Construction (p. 156)[bauiM3S06-STRBAUT]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	2	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Lean Construction [6241908]

Coordinators: S. Haghsheno, staff
Part of the modules: Lean Construction (p. 185)[bauiM4S09-]

ECTS Credits	Course type	Hours per week	Term	Instruction language
6	lecture + exercise	2/2	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Real Estate Life Cycle Management [6241807]

Coordinators: K. Lennerts, staff
Part of the modules: Sustainability in Real Estate Management (p. 173)[bauiM4P4-]

ECTS Credits	Course type	Hours per week	Term	Instruction language
1,5	lecture	1	Summer term	

Learning Control / Examinations

Conditions

None.

Learning Outcomes

Content

Course: Management in Public Transport [6234805]

Coordinators: E. Hohnecker
Part of the modules: Track Guided Transport Systems - Management, Facilities and Vehicles of Public Transport (p. 167)[bauiM3S19-EBOEV]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture	2	Summer term	de

Learning Control / Examinations
The assessment will consist of a oral exam (20 min) according to §4 (2), 1 of the examination regulation.
The exam is offered each semester. The re-examination is offered upon prior agreement with the interested participants and not later than the next regular examination date.

Conditions
See module description.

Learning Outcomes
See German version.

Content
See German version.

Remarks
See German version.

Course: Construction Equipment [6241703]

Coordinators: S. Gentes
Part of the modules: Machinery and Process Engineering (p. 177)[bauiM4P6-]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture	2	Winter term	de

Learning Control / Examinations
The assessement consists of a written exam (30 minutes) (following §4(2), 1 of the examination regulation).

Conditions
None.

Learning Outcomes
Students

- gain fundamental knowledge about modes of operation of several drive technologies with a focus on construction equipment
- understand foundations of hydraulic systems in construction equipment
- gain the ability to determine and size transmission elements of construction equipment and machinery.

Content
The lecture comprises

- drive technology (basics,performance improvement, energy utilization)
- transmission elements (coupler, rope, chain, axle, gear technology, automatic gear box)
- Basics of hydraulic systems

Media
Lecture slides.

Course: Solid Construction Bridges [6211901]

Coordinators: L. Stempniewski
Part of the modules: Solid Construction Bridges (p. 44)[bauiM1S03-MASSBRUE]

ECTS Credits	Course type	Hours per week	Term	Instruction language
6	lecture + exercise	2/2	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Materials Testing in the Field of Concrete [6211913]

Coordinators: N. Herrmann
Part of the modules: Materials Testing and Measuring Techniques (p. 80)[bauiM1S29-MATPRÜF]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture	2	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Micromechanics of Heterogeneous Solids [6215805]

Coordinators: T. Seelig
Part of the modules: Continuum Mechanics of Heterogeneous Solids (p. 82)[bauiM1S32-KONTIMECH]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture	2	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Measuring Techniques in Civil Engineering [6211911]

Coordinators: N. Herrmann
Part of the modules: Materials Testing and Measuring Techniques (p. 80)[bauiM1S29-MATPRÜF]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	1/1	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Mobility Services and new Forms of Mobility [6232811]

Coordinators: M. Kagerbauer
Part of the modules: Analysis and Evolution of Mobility (p. 169)[bauiM3S20-VERANAMOB]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	2	Summer term	de

Learning Control / Examinations
see module description

Conditions
See module description.

Learning Outcomes

Content

Course: Practical Use of Numerical Methods in Fluid Mechanics [6222903]

Coordinators: P. Oberle, M. Musall
Part of the modules: Practical Use of Numerical Methods in Fluid Mechanics (p. 116)[bauiM2S10-WB2]

ECTS Credits	Course type	Hours per week	Term	Instruction language
6	lecture + exercise	2/2	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Modeling in Solid Mechanics [6215807]

Coordinators: A. Konyukhov
Part of the modules: Modeling in Solid Mechanics (p. 90)[bauiM1S40-MODFEST]

ECTS Credits	Course type	Hours per week	Term	Instruction language
6	lecture + exercise	2/2	Summer term	en

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Modelling Mass Fluxes in River Basins [6223904]

Coordinators: S. Fuchs
Part of the modules: River Basin Modeling (p. 141)[bauiM2S30-SW7]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	exercise	2	Winter term	

Learning Control / Examinations

Conditions

None.

Learning Outcomes

Content

Course: Morphodynamics [6222805]

Coordinators: F. Nestmann
Part of the modules: River Dynamics (p. 119)[bauiM2S13-WB5]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	2	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Multiphase Flow in Hydraulic Engineering [6222701]

Coordinators: F. Nestmann
Part of the modules: Hydraulic Engineering (p. 95)[bauiM2P6-ADVHYENG]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	1/1	Summer term	en

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Sustainability in Real Estate Management [6241805]

Coordinators: K. Lennerts
Part of the modules: Sustainability in Real Estate Management (p. 173)[bauiM4P4-]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	1/1	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Supplementary Claim Management [6241822]

Coordinators: S. Haghsheno, R. Bartsch
Part of the modules: Turnkey Construction (p. 191)[bauiM4S15-]

ECTS Credits	Course type	Hours per week	Term	Instruction language
1,5	lecture	1	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: New Development and Optimization of Decommissioning Machine Technology [6241919]

Coordinators: S. Gentes, staff
Part of the modules: Decommissioning of Nuclear Facilities (p. 187)[bauiM4S12-]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	1/1	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Non-linear Analysis of Surface Structures [6214903]

Coordinators: W. Wagner
Part of the modules: Non-linear Analysis of Surface Structures (p. 68)[bauiM1S19-NILI-FTW]

ECTS Credits	Course type	Hours per week	Term	Instruction language
6	lecture + exercise	2/2	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Non-linear Analysis of Beam Structures [6214702]

Coordinators: I. Münch
Part of the modules: Non-linear Analysis of Beam Structures (p. 62)[bauiM1S14-NILI-STAB]

ECTS Credits	Course type	Hours per week	Term	Instruction language
6	lecture + exercise	2/2	Winter term	

Learning Control / Examinations

Conditions

None.

Learning Outcomes

Content

Course: Numerical Fluid Mechanics I [6221702]

Coordinators: M. Uhlmann
Part of the modules: Numerical Fluid Mechanics (p. 94)[bauiM2P5-NUMFLMECH]

ECTS Credits	Course type	Hours per week	Term	Instruction language
6	lecture + exercise	2/2	Winter term	en

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Numerics in Geotechnics [6251707]

Coordinators: A. Niemunis
Part of the modules: Basics in Numerical Modelling (p. 200)[bauiM5P4-NUMGRUND]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture	2	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Numerical Groundwater Modelling [6221901]

Coordinators: U. Mohrlok
Part of the modules: Groundwater Management (p. 113)[bauiM2S08-HY8]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	project	2	Winter term	de

Learning Control / Examinations

Conditions

None.

Learning Outcomes

Content

Course: Numerical Methods in Structural Analysis [6214901]

Coordinators: I. Münch
Part of the modules: Numerical Methods in Structural Analysis (p. 67)[bauiM1S18-FEM-BS]

ECTS Credits	Course type	Hours per week	Term	Instruction language
6	lecture + exercise	2/2	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Numerical Fluid Mechanics II [6221809]

Coordinators: M. Uhlmann
Part of the modules: Advanced Computational Fluid Dynamics (p. 131)[bauiM2S21-NS2]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	1/1	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Numerical Structural Dynamics [6215810]

Coordinators: P. Betsch
Part of the modules: Numerical Structural Dynamics (p. 87)[bauiM1S38-NUMSTRDYN]

ECTS Credits	Course type	Hours per week	Term	Instruction language
6	lecture + exercise	2/2	Summer term	de

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Parallel Programming Techniques for Engineering Problems [6221807]

Coordinators: M. Uhlmann
Part of the modules: Advanced Computational Fluid Dynamics (p. 131)[bauiM2S21-NS2]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	1/1	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Applied Dynamics of Structures [6211805]

Coordinators: L. Stempniewski
Part of the modules: Applied Dynamics of Structures (p. 45)[bauiM1S04-BAUDYN]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	1/1	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Practical Fire Protection [6211815]

Coordinators: H. Schröder
Part of the modules: Building Physics II (p. 79)[bauiM1S28-BAUPH-II]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture	2	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Practical Noise Control [6211814]

Coordinators: R. Grigo
Part of the modules: Building Physics II (p. 79)[bauiM1S28-BAUPH-II]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture	2	Summer term	

Learning Control / Examinations

Conditions

None.

Learning Outcomes

Content

Course: Project Integrated Planning [6230901]

Coordinators: R. Roos, M. Zimmermann, B. Chlond, M. Weigel, Assistenten
Part of the modules: Project Integrated Planning (p. 157)[bauiM3S09-PROJEKTIP]

ECTS Credits	Course type	Hours per week	Term	Instruction language
6	project	4	Winter term	

Learning Control / Examinations

Conditions

None.

Learning Outcomes

Content

Course: Project Development [6241906]

Coordinators: K. Lennerts, staff
Part of the modules: Real Estate Management (p. 184)[bauiM4S08-]

ECTS Credits	Course type	Hours per week	Term	Instruction language
1,5	lecture	1	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Project Management in Construction and Real Estate Industry [6241706]

Coordinators: S. Haghsheno
Part of the modules: Project Management in Construction and Real Estate Industry (p. 175)[bauiM4P5-]

ECTS Credits	Course type	Hours per week	Term	Instruction language
6	lecture + exercise	3/1	Winter term	de

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Highway Design Project Study [6233903]

Coordinators: M. Zimmermann, R. Roos
Part of the modules: Highway Design (p. 155)[bauiM3S05-STRENTW]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	2	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Project Studies [6241826]

Coordinators: S. Gentes
Part of the modules: Environmentally-friendly Recycling and Disassembly of Buildings (p. 180)[bauiM4S06-]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	1/1	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Public Real Estate Management and Public Private Partnership [6241904]

Coordinators: K. Lennerts
Part of the modules: Real Estate Management (p. 184)[bauiM4S08-]

ECTS Credits	Course type	Hours per week	Term	Instruction language
1,5	lecture	1	Winter term	de

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Law Aspects of Guided Transport Systems [6234903]

Coordinators: E. Hohnecker, staff
Part of the modules: Economics, Law and Environmental Aspects in Railway Transportation (p. 162)[bauiM3S15-EBUMWELT]

ECTS Credits	Course type	Hours per week	Term	Instruction language
1,5	lecture	1	Winter term	de

Learning Control / Examinations
The assessment will consist of a oral exam (20 min) according to §4 (2), 1 of the examination regulation.
The exam is offered each semester. The re-examination is offered upon prior agreement with the interested participants and not later than the next regular examination date.

Conditions
See module description.

Learning Outcomes
See German version.

Content
Judical basics, law in european and national rail transportation, federal state law in public transport

Literature
Elective literature:
Kunz (Hrsg): Eisenbahnrecht, Nomos-Verlag, Baden-Baden

Remarks
See German version.

Course: Regional Planning [6231703]

Coordinators: S. Wilske
Part of the modules: Urban and Regional Planning (p. 144)[bauiM3P1-PLSTAREG]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture	2	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Shell Structures [6214805]

Coordinators: I. Münch
Part of the modules: Shell Structures and Stability of Structures (p. 65)[bauiM1S17-STABISHELL]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	1/1	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Turnkey Construction I - Processes and Methods [6241833]

Coordinators: S. Haghsheno, K. Teizer
Part of the modules: Turnkey Construction (p. 191)[bauiM4S15-]

ECTS Credits	Course type	Hours per week	Term	Instruction language
1,5	lecture	1	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Turnkey Construction II - Trades and Technology [6241834]

Coordinators: S. Haghsheno, M. Denzer, K. Teizer
Part of the modules: Turnkey Construction (p. 191)[bauiM4S15-]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	1/1	Summer term	

Learning Control / Examinations

Conditions

None.

Learning Outcomes

Content

Course: Protection, Rehabilitation and Reinforcement of Concrete and Masonry Constructions [6211811]

Coordinators: E. Kotan, H. Müller
Part of the modules: Building Preservation of Concrete and Masonry Constructions (p. 76)[bauiM1S26-BBM]

ECTS Credits	Course type	Hours per week	Term	Instruction language
4,5	lecture + exercise	2/1	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Seminar Water Quality [6223813]

Coordinators: S. Fuchs, S. Hilgert, U. Mohrlok
Part of the modules: Water Quality of Surface Water and Groundwater (p. 136)[bauiM2S26-SW3]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	seminar	2	Summer term	de

Learning Control / Examinations
graded study paper: Vortrag und schriftliche Ausarbeitung

Conditions
none

Recommendations
Attendance to the course Siedlungswasserwirtschaft [6200603] is recommended.

Learning Outcomes
Die students are able to explain and evaluate critically the interdisciplinary interrelations (fluid mechanics, chemistry, ecology) which determines the water quality in surface water and groundwater by means of presenting the theoretical basics and the legal framework.

Content

- Basics: fluid mechanics, mass balances, zonation
- Water Framework Directive, Water Management Act, Soil Protection Act
- pollution of water bodies: inflows, contaminant pollution (geogenic, anthropogenic)
- sediment problems in large regulated rivers: sediment transport, contaminant load of river sediments, formation of green house gases
- methods for the evaluation of water quality and sate of water body: biological, chemical, structural

Literature
Schwörbel, J. & Brendelberger, H. (2005): Einführung in die Limnologie. 9. Auflage, Spektrum Akademischer Verlag.
Lampert, W. & Sommer, U. (1999): Limnoökologie. 2. Auflage, Georg Thieme Verlag, Stuttgart.
Schwörbel, J. (1994): Methoden der Hydrobiologie: Süßwasserökologie. 4. Auflage, UTB-Verlag Gustav Fischer, Stuttgart.
DIN 38410 (2004): Deutsche Einheitsverfahren zur Wasser-, Abwasser- und Schlammuntersuchung – Biologisch-ökologisch Gewässeruntersuchung. DIN Deutsches Institut für Normung e.V., Beuth Verlag, Berlin.
DVWK (Deutscher Verband für Wasserwirtschaft und Kulturbau), Schriften 107, „Grundwassermessgeräte", Verlag Paul Parey, 1994.
DVWK (Deutscher Verband für Wasserwirtschaft und Kulturbau), Schriften 125, "Methoden für die Beschreibung der Grundwasserbeschaffenheit", Verlag Paul Parey, 1999.
Wechselnde aktuelle Literatur.

Remarks
The course Seminar Water Quality (6223813) together with the course Field Training Water Quality (6223814) replaces the combination of the courses Surface Water Quality (6223805)/Groundwater Quality (6221811).

Course: Seminar in Highway Engineering [6233908]

Coordinators: M. Zimmermann
Part of the modules: Road Safety (p. 159)[bauiM3S12-STRVSICH]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	seminar	2	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Seminar in Transportation [6232903]

Coordinators: P. Vortisch, B. Chlond
Part of the modules: Special Topics in Transportation (p. 170)[bauiM3S21-VERSPEZ]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	seminar	2	Winter / Summer Term	de

Learning Control / Examinations
Non exam assessment (following §4(2), 3 of the examination regulation).

Conditions
See module description.

Learning Outcomes

Content

Course: Safety Management in Highway Engineering [6233906]

Coordinators: M. Zimmermann
Part of the modules: Road Safety (p. 159)[bauiM3S12-STRVSICH]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	2	Winter term	de

Learning Control / Examinations
See module description.

Conditions
See corresponding module information.

Learning Outcomes

Content

Remarks
For further information, see http://www.ise.uni-karlsruhe.de/16.php

Course: Signal Processing in Fluid Mechanics [6221812]

Coordinators: B. Ruck
Part of the modules: Experimental Techniques II: Measurement Techniques (p. 126)[bauiM2S18-SM4]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	1/1	Summer term	

Learning Control / Examinations

Conditions

None.

Learning Outcomes

Content

Course: Traffic Flow Simulation [6232804]

Coordinators: P. Vortisch
Part of the modules: Traffic Management and Simulation Methods (p. 152)[bauiM3S03-VERMANAGE]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	1/1	Summer term	de

Learning Control / Examinations
The assessment consists of an oral exam according to §4(2), 2 of the examination regulation.

Conditions
See module description.

Learning Outcomes

Content

Course: Simulations and Analysis Methods in Highway Engineering [6233806]

Coordinators: R. Roos, staff
Part of the modules: Special Topics in Highway Engineering (p. 160)[bauiM3S13-STRSPEZ]

ECTS Credits	Course type	Hours per week	Term	Instruction language
1,5	lecture	1	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Special Issues in Rock Mechanics [6251916]

Coordinators: E. Gerolymatou
Part of the modules: Coupled Geomechanical Processes (p. 220)[bauiM5S10-GEKOPPRO]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	2	Winter term	de

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Special Foundation Engineering and Design [6251812]

Coordinators: P. Kudella
Part of the modules: Applied Geotechnics (p. 206)[bauiM5S03-ANGEOTEC]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	2	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Track Guided Transport Systems - Technical Design and Components [6234701]

Coordinators: E. Hohnecker
Part of the modules: Track Guided Transport Systems - Technical Design and Components (p. 147)[bauiM3P4-EBTECHNIK]

ECTS Credits	Course type	Hours per week	Term	Instruction language
6	lecture + exercise	3/1	Winter term	de

Learning Control / Examinations
See German Version.

Conditions
See module description.

Learning Outcomes
See German Version.

Content
Law and Organisation of track guided transport systems, basics of driving dynamics, dimensioning and construction of railway tracks, basics of railway facilities, basics of signalling

Literature
Zilch, Diederichs, Katzenbach, Beckmann (Hrsg): Handbuch für Bauingenieure, Springer-Verlag 2012

Course: Stability of Structures [6214807]

Coordinators: I. Münch
Part of the modules: Shell Structures and Stability of Structures (p. 65)[bauiM1S17-STABISHELL]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	1/1	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Urban Management [6231801]

Coordinators: A. Karmann-Woessner
Part of the modules: Urban Renewal (p. 149)[bauiM3S01-PLSTUMB]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	1/1	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Urban Planning [6231701]

Coordinators: C. Minster
Part of the modules: Urban and Regional Planning (p. 144)[bauiM3P1-PLSTAREG]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	1/1	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: History of Urban Planning and the Built Environment [6231803]

Coordinators: J. Vogt
Part of the modules: Urban Renewal (p. 149)[bauiM3S01-PLSTUMB]

ECTS Credits	Course type	Hours per week	Term	Instruction language
1,5	lecture	1	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Steel and Composite Structures [6212801]

Coordinators: T. Ummenhofer
Part of the modules: Steel and Composite Structures (p. 39)[bauiM1P2-STAHLBAU]

ECTS Credits	Course type	Hours per week	Term	Instruction language
6	lecture + exercise	2/2	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Construction of Steel and Composite Bridges [6212901]

Coordinators: T. Ummenhofer
Part of the modules: Construction of Steel and Composite Bridges (p. 50)[bauiM1S07- STAHLBRÜ]

ECTS Credits	Course type	Hours per week	Term	Instruction language
6	lecture + exercise	2/2	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Material Science, Welding and Fatigue [6212803]

Coordinators: P. Knödel
Part of the modules: Material Science, Welding and Fatigue (p. 48)[bauiM1S06-SCHWEISSEN]

ECTS Credits	Course type	Hours per week	Term	Instruction language
6	lecture + exercise	3/1	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Standard Valuation in Public Transport - Using an Example [6234904]

Coordinators: E. Hohnecker
Part of the modules: Traffic Infrastructure (p. 163)[bauiM3S16-EBVERKEHR]

ECTS Credits	Course type	Hours per week	Term	Instruction language
1,5	exercise	1	Winter term	de

Learning Control / Examinations
The conjoined assessment of the lectures *Determination of demand, Timetable construction and Alignment* [6234810; 6234811] and *"Standardisierte Bewertung" in public transport using an example* [6234904] consists of an oral presentation and a written paper according §4(2), 3 of the examination regulation.
The mark consist of both parts of the assessment (66% of the mark of the presentation and 34% of the written paper).
The exam is offered each semester. The re-examination is offered upon prior agreement with the interested participants and not later than the next regular examination date.

Conditions
See module description.
The lecture is obligatory in the module *Project in Public Transportation*.

Recommendations
See module description.

Learning Outcomes
See German version.

Content
practise: urban traffic project: economic evaluation

Remarks
See German version.

Course: Steady and Unsteady-state Operation of Hydraulic Systems [6221804]

Coordinators: C. Lang
Part of the modules: Technical Hydraulics (p. 124)[bauiM2S17-SM3]

ECTS Credits	Course type	Hours per week	Term	Instruction language
6	lecture + exercise	2/2	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Mass Fluxes in River Basins [6223812]

Coordinators: S. Fuchs
Part of the modules: River Basin Modeling (p. 141)[bauiM2S30-SW7]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture	2	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Traffic Engineering [6232703]

Coordinators: P. Vortisch
Part of the modules: Models and Methods in Traffic Engineering and Transportation Planning (p. 145)[bauiM3P2-VERMODELL]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	1/1	Winter term	de

Learning Control / Examinations
The assessment consists of an oral exam according to §4(2), 2 of the examination regulation.

Conditions
See module description.

Learning Outcomes

Content

Course: Strategic Transport Planning [6232808]

Coordinators: V. Waßmuth
Part of the modules: Planning of Transportation Systems (p. 153)[bauiM3S04-VERPLAN]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture	2	Summer term	de

Learning Control / Examinations
see module description

Conditions
See module description.

Learning Outcomes

Content

Course: Flow Measuring Technique [6221703]

Coordinators: B. Ruck
Part of the modules: Experimental Techniques II: Measurement Techniques (p. 126)[bauiM2S18-SM4]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	1/1	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Flow Behavior [6222807]

Coordinators: F. Seidel
Part of the modules: River Dynamics (p. 119)[bauiM2S13-WB5]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	2	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Technical and Economic Management Tools in Highway Engineering [6233805]

Coordinators: H. Rethage
Part of the modules: Special Topics in Highway Engineering (p. 160)[bauiM3S13-STRSPEZ]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture	2	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Theoretical Soil Mechanics [6251801]

Coordinators: A. Niemunis
Part of the modules: Theoretical Soil Mechanics (p. 194)[bauiM5P1-THEOBM]

ECTS Credits	Course type	Hours per week	Term	Instruction language
6	lecture + exercise	4	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Thermodynamics in Environmental Systems [6224901]

Coordinators: E. Zehe, U. Ehret
Part of the modules: Thermodynamics in Environmental Systems (p. 102)[bauiM2S02-HY2]

ECTS Credits	Course type	Hours per week	Term	Instruction language
6	lecture + exercise	4	Winter term	

Learning Control / Examinations

Conditions

None.

Learning Outcomes

Content

Course: Operation Methods for Foundation and Marine Construction [6241911]

Coordinators: H. Schneider
Part of the modules: Advanced Studies in Construction Engineering (p. 186)[bauiM4S10-]

ECTS Credits	Course type	Hours per week	Term	Instruction language
1,5	lecture	1	Winter term	de

Learning Control / Examinations
The assessment consists of an oral exam (20 min.) taking place in the recess period (according to §4 (2), 2 of the examination regulation).

Conditions
None.

Learning Outcomes
Students

- Have specialized knowledge regarding the presented construction methods and construction machinery
- Can evaluate different construction methods and construction machinery regarding the context of use.
- Can determine and combine appropriate construction methods.

Content
Students acquire knowledge regarding design choices and construction methods of temporary pit systems, foundations and harbor facilities:

- Injection,
- Underpinning,
- Pipe-jacking,
- Caisson techniqu
- Fast ice building technique
- Bank protection.

Media
Lecture slides.

Course: Supporting Timber Structures [6213901]

Coordinators: M. Frese
Part of the modules: Structures in Steel and Timber (p. 55)[bauiM1S10-BAUING-TSH]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	2	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Supporting Steel Structures [6212907]

Coordinators: T. Ummenhofer
Part of the modules: Structures in Steel and Timber (p. 55)[bauiM1S10-BAUING-TSH]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	1/1	Winter term	

Learning Control / Examinations

Conditions

None.

Learning Outcomes

Content

Course: Tunnel Construction in Soils and in Existence [6251907]

Coordinators: B. Fröhlich, P. Kudella
Part of the modules: Rock Engineering and Underground Construction (p. 210)[bauiM5S05-FELSHOHL]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	2	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Tunnel Construction and Blasting Engineering [6241910]

Coordinators: S. Haghsheno, L. Scheuble, U. Matz
Part of the modules: Advanced Studies in Construction Engineering (p. 186)[bauiM4S10-]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture	2	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Modelling of Turbulent Flows - RANS and LES [6221913]

Coordinators: M. Uhlmann
Part of the modules: Analysis of Turbulent Flows (p. 142)[bauiM2S32-NS3], Turbulent Flows (p. 129)[bauiM2S20-NS1]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture	2	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Landfills [6251913]

Coordinators: A. Bieberstein
Part of the modules: Environmental Geotechnics (p. 218)[bauiM5S09-UMGEOTEC]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	2	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Exercises in Numerical Modelling [6251818]

Coordinators: A. Niemunis
Part of the modules: Numerical Modelling in Geotechnics (p. 212)[bauiM5S06-NUMMOD]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	exercise	2	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Environmental Aspects of Guided Transport Systems [6234901]

Coordinators: E. Hohnecker
Part of the modules: Economics, Law and Environmental Aspects in Railway Transportation (p. 162)[bauiM3S15-EBUMWELT]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture	2	Winter term	de

Learning Control / Examinations
The assessment will consist of a oral exam (20 min) according to §4 (2), 1 of the examination regulation.
The exam is offered each semester. The re-examination is offered upon prior agreement with the interested participants and not later than the next regular examination date.

Conditions
See module description.

Learning Outcomes
See German version.

Content
Active and passive noise protection, determination of sound emission, environmental aspects, quality in public transport, customer satisfaction and loyalty in long distance and local rail traffic

Remarks
See German version.

Course: Environmental Communication [6224905]

Coordinators: C. Kämpf
Part of the modules: Environmental Communication (p. 111)[bauiM2S07-HY7]

ECTS Credits	Course type	Hours per week	Term	Instruction language
6	seminar	2	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Environmental Impact Assessment [6233804]

Coordinators: R. Roos
Part of the modules: Laws and Proceedings concerning Traffic and Roads (p. 148)[bauiM3P5-VERFRECHT]

ECTS Credits	Course type	Hours per week	Term	Instruction language
1,5	lecture	1	Summer term	

Learning Control / Examinations
See module description

Conditions
See corresponding module information

Learning Outcomes

Content

Course: Business and Human Resources [6241830]

Coordinators: S. Haghsheno, E. Eschen
Part of the modules: Business and Human Resource Management (p. 179)[bauiM4S01-]

ECTS Credits	Course type	Hours per week	Term	Instruction language
4,5	lecture + exercise	2/1	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Urban Material Flows [6223702]

Coordinators: S. Fuchs
Part of the modules: Urban Material Flows (p. 97)[bauiM2P7-URBMATFL]

ECTS Credits	Course type	Hours per week	Term	Instruction language
6	lecture + exercise	2/2	Summer term	en

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Urban Water Management [6220902]

Coordinators: S. Fuchs, P. Klingel, U. Mohrlok
Part of the modules: Urban Water Management (p. 135)[bauiM2S25-SW2]

ECTS Credits	Course type	Hours per week	Term	Instruction language
6	lecture + exercise	4	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Process Engineering [6241704]

Coordinators: H. Schneider, H. Schlick
Part of the modules: Machinery and Process Engineering (p. 177)[bauiM4P6-]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture	2	Winter term	de

Learning Control / Examinations
The assessement consists of a written exam (90 minutes) (following §4(2), 1 of the examination regulation).

Conditions
The course Baumaschinen und maschinelle Verfahrenstechnik [6241704] is compulsory and must be examined.

Recommendations
It is recommended to attend the module Fundamentals of Construction [WI3INGBGU3] of the B.Sc. studies.

Learning Outcomes
Students understand the important fields of mechanical process engineering in construction. They can evaluate construction methods and aggregate production methods based on the context of use and they can analyze the use of important construction equipment, construction methods and aggregate production methods.

Content
The lecture comprises:

- Overview of construction equipment (Bauger√§teliste BGL)
- Equipment characteristics and variants
- Operational characteristics of equipment
- Mode of operation of equipment and of systems of equipment
- Overview of mode of production in earth moving, foundation construction and marine construction.
- Design and mode of operation of aggregate production.

Media
Lecture slides.

Course: Disassembly Process Engineering [6241828]

Coordinators: S. Gentes
Part of the modules: Environmentally-friendly Recycling and Disassembly of Buildings (p. 180)[bauiM4S06-]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	1/1	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Process Technologies in Storm Water Treatment [6223801]

Coordinators: S. Fuchs, E. Hoffmann
Part of the modules: Water Treatment Technologies (p. 133)[bauiM2S24-SW1]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	2	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Process Technologies in Water Supply and Wastewater Disposal [6223803]

Coordinators: E. Hoffmann
Part of the modules: Water Treatment Technologies (p. 133)[bauiM2S24-SW1]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	2	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Deformation and Fracture Processes [6211810]

Coordinators: H. Müller, E. Kotan
Part of the modules: Concrete Construction Technology (p. 74)[bauiM1S24-BETONTECH]

ECTS Credits	Course type	Hours per week	Term	Instruction language
1,5	lecture	1	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Laws concerning Traffic and Roads [6233803]

Coordinators: D. Hönig
Part of the modules: Laws and Proceedings concerning Traffic and Roads (p. 148)[bauiM3P5-VERFRECHT]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture	2	Summer term	de

Learning Control / Examinations
See module description.

Conditions
See corresponding module information.

Learning Outcomes

Content

Course: Traffic Management and Transport Telematics [6232802]

Coordinators: P. Vortisch
Part of the modules: Traffic Management and Simulation Methods (p. 152)[bauiM3S03-VERMANAGE]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	1/1	Summer term	de

Learning Control / Examinations
The assessment consists of an oral exam according to §4(2), 2 of the examination regulation.

Conditions
See module description.

Learning Outcomes

Content

Course: Waterway Engineering [6222803]

Coordinators: A. Kron
Part of the modules: Waterway Engineering (p. 118)[bauiM2S12-WB4]

ECTS Credits	Course type	Hours per week	Term	Instruction language
6	lecture + exercise	4	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Rock Testing [6251909]

Coordinators: E. Gerolymatou
Part of the modules: Geotechnical Testing and Measuring Technology (p. 214)[bauiM5S07-VERSMESS]

ECTS Credits	Course type	Hours per week	Term	Instruction language
1,5	lecture	1	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Unsaturated, Viscous and Cyclic Soil Behaviour - Theory and Element Tests [6251901]

Coordinators: A. Niemunis, T. Wichtmann
Part of the modules: Special Issues of Soil Mechanics (p. 202)[bauiM5S01-SPEZBM]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	2	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Dynamics of Water and Mass Transport in Watersheds [6224803]

Coordinators: E. Zehe, J. Wienhöfer
Part of the modules: Dynamics of Water and Mass Transport in Watersheds (p. 104)[bauiM2S03-HY3]

ECTS Credits	Course type	Hours per week	Term	Instruction language
6	lecture + exercise	4	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Water Treatment [6223808]

Coordinators: E. Hoffmann
Part of the modules: Water Supply and Sanitation Systems and Plants (p. 138)[bauiM2S28-SW5]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	2	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Hydraulic Engineering Project [6220901]

Coordinators: C. Lang
Part of the modules: Experimental Techniques I: Small Scale Experiments (p. 120)[bauiM2S15-SM1]

ECTS Credits	Course type	Hours per week	Term	Instruction language
1,5	project	1	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Water Resources and River Basin Management [6224801]

Coordinators: U. Ehret
Part of the modules: Water Resources and River Basin Management (p. 100)[bauiM2S01-HY1]

ECTS Credits	Course type	Hours per week	Term	Instruction language
6	lecture + exercise	4	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Water Distribution [6222905]

Coordinators: P. Klingel
Part of the modules: Water Supply and Sanitation Systems and Plants (p. 138)[bauiM2S28-SW5]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	2	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Studies of Development Projects in Water Resources Management [6222901]

Coordinators: F. Nestmann
Part of the modules: Studies of Development Projects in Water Resources Management (p. 115)[bauiM2S09-WB1]

ECTS Credits	Course type	Hours per week	Term	Instruction language
6	lecture	4	Winter term	

Learning Control / Examinations

Conditions

None.

Learning Outcomes

Content

Course: Water and Energy Cycles in Hydrological Systems: Processes, Predictions and Management [6224702]

Coordinators: E. Zehe
Part of the modules: Water and Energy Cycles (p. 98)[bauiM2P8-WATENCYC]

ECTS Credits	Course type	Hours per week	Term	Instruction language
6	lecture + exercise	2/2	Winter term	en

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Interaction Flow - Building Structure [6221903]

Coordinators: C. Lang
Part of the modules: Interaction Flow - Building Structure (p. 122)[bauiM2S16-SM2]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture + exercise	1/1	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Tendering, Planning and Financing in Public Transport [6232807]

Coordinators: A. Pischon
Part of the modules: Special Topics in Transportation (p. 170)[bauiM3S21-VERSPEZ]

ECTS Credits	Course type	Hours per week	Term	Instruction language
3	lecture	2	Summer term	de

Learning Control / Examinations
The assessment consists of an oral exam according to §4(2), 2 of the examination regulation.

Conditions
See module description.

Learning Outcomes

Content

Course: Economic Efficiency of Track Guided Transport Systems [6234902]

Coordinators: E. Hohnecker, staff
Part of the modules: Economics, Law and Environmental Aspects in Railway Transportation (p. 162)[bauiM3S15-EBUMWELT]

ECTS Credits	Course type	Hours per week	Term	Instruction language
1,5	lecture	1	Winter term	de

Learning Control / Examinations
The assessment will consist of a oral exam (20 min) according to §4 (2), 1 of the examination regulation.
The exam is offered each semester. The re-examination is offered upon prior agreement with the interested participants and not later than the next regular examination date.

Conditions
See module description.

Recommendations
See module description.

Learning Outcomes
See German version.

Content
basics of economy, accounting and finance, financing of investments, demand and offer for transportation, transportation market, transport policy

Remarks
See German version.

Index

T

U

W