Karlsruhe Institute of Technology

Module Handbook
Civil Engineering (M.Sc.)

Summer Term 2014
Long version
Date: 17.04.2014

Department of Civil Engineering, Geo- and Environmental Sciences

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

Publisher:

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Environmental Sciences
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1 Degree programme

1.1 Objectives of the master degree programme

Within the master degree programme Civil Engineering at the Karlsruhe Institute of Technology (KIT) the scientific qualifications obtained by the bachelor degree programme can be completed and deepened. By that, the student will be enabled to apply self-reliant scientific findings and methods and evaluate their importance and consequences for solving complex scientific and societal problems.
Thus, the master graduate of the Karlsruhe Institute of Technology (KIT) will be enabled additionally to develop innovative problem solutions beyond the application of established structurally engineered and scientific rules, and to enter new fields of engineering.

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). All modules in the master degree programme comprise 6 CP and are integrated into the subject-related focuses

I Construction Engineering

II Water and Environment

III Mobility and Infrastructure

IV Technology and Management in Construction

V Geotechnical Engineering

Essential information of all modules is listed in tables 1 – 5 ordered by the focuses. This module handbook includes a complete descriptions of the modules.
Within the **Focus Study** the students have to select **two focuses** with an extent of 30 CP each. The single focuses are characterized by a different number of compulsory modules which have to be complemented by a respective number of compulsory elective modules for the selected focus.
Within the **Complementary Study** the students can choose freely **four subject-related modules** from the master study programme Civil Engineering. They have to comprise one module **key qualifications** out of the offer of the KIT House of Competence (HoC) with extent of 6 CP. The selection of the focuses has to be accompanied and confirmed by a **mentor** (professor of the elected focuses) chosen by the student.
Normally, the **Master Thesis** has to be prepared in the 4. Semester within one of the selected focuses. The period for preparation is six months. The thesis has to be completed by a presentation, which is included in the grading, within a month after submission. It is strongly recommended to start the **Master Thesis** after completion of the modules in the Focus Study and the module key qualification in order to have gained the necessary subject-related and professional skills.

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 PM + 2 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 PM + 2 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) 2.-3. SS 4 SWS 6 CP
- **complementary module 2** (freely selectable) 2.-3. SS 4 SWS 6 CP
- **complementary module 3** (freely selectable) 2.-3. SS 4 SWS 6 CP
- **complementary module 4** (freely selectable) 2.-3. SS 4 SWS 6 CP
- **key qualifications** (to be chosen out of offer of HoC) 2.-3. SS 4 SWS 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 **Design and Construction of Components in Reinforced Concrete** 1. SS 6 CP
- PM 2 **Steel and Composite Structures** 2. SS 6 CP
- PM 3 **Surface Structures and Dynamics of Structures** 1. SS 6 CP

2 SM have to be chosen from the offer of Focus I.

- **compulsory elective module 1** 2./3. SS 6 CP
- **compulsory elective module 2** 2./3. SS 6 CP

II Water and Environment

In addition to the 3 PM, 2 SM of Focus II have to be chosen.

- PM 1 **Advanced Fluid Mechanics** 1. SS 6 CP
- PM 2 **Dynamics of Water and Mass Transport in River Basins** 1. SS 6 CP
- PM 3 **Mass Fluxes and Cycles** 1. SS 6 CP

2 SM have to be chosen from the offer of Focus II.

- **compulsory elective module 1** 2./3. SS 6 CP
- **compulsory elective module 2** 2./3. SS 6 CP

III Mobility and Infrastructure

3 PM have to be chosen out of the 5 PM of Focus III.

- PM 1 **Urban and Regional Planning** 1. SS 6 CP
- PM 2 **Models and Methods in Traffic Engineering and Transportation Planning** 1. SS 6 CP
- PM 3 **Infrastructure Management** 2. SS 6 CP
- PM 4 **Track Guided Transport Systems - Technical Design and Components** 1. SS 6 CP
- PM 5 **Laws and Proceedings concerning Traffic and Roads** 2. 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** 2./3. SS 6 CP
- **compulsory elective module 2** 2./3. SS 6 CP

IV Technology und Management in Construction

In addition to the 4 PM, 1 SM Focus IV has to be chosen.

- PM 1 **Construction Management and Work Planning** 1. FS 6 LP
- PM 2 **Construction Equipment and Machinery** 1. FS 6 LP
- PM 3 **Economics and Management in Construction** 2. FS 6 LP
- PM 4 **Sustainability in Real Estate Management** 2. FS 6 LP

1 SM of Focus IV has to be chosen.

- **compulsory elective module 1** 2./3. FS 6 LP

V Geotechnical Engineering

5 PM of Focus V have to be chosen.

- PM 1 **Theoretical Soil Mechanics** 2. FS 6 LP
- PM 2 **Earthworks and Foundation Engineering** 1. FS 6 LP
- PM 3 **Rock Mechanics and Tunnelling** 2. FS 6 LP
- PM 4 **Basics in Numerical Modelling** 1. FS 6 LP
- PM 5 **Design and Construction of Components in Reinforced Concrete *** 1. FS 6 LP

*) If PM 5 is allocated by selection of Focus „Construction Engineering“, SM 2 **or** SM 3 has to be chosen instead.

- SM 2 **Ground Investigation** 2. FS 6 LP
- SM 3 **Applied Geotechnics** 2. FS 6 LP

Legend

- SS: subject-related semester
- SWS: (contacvt) hours per week
- 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: Feb. 2014

Karlsruhe Institute of Technology

Focus I ”Construction Engineering”

All modules offered in the focus ”Construction Engineering” are included in Table 1.

Three compulsory modules are predetermined for this focus:

- Design and Construction of Components in Reinforced Concrete
- Steel and Composite Structures
- Surface Structures and Dynamics of Structures

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.

Those can be accepted to the masters thesis who completed compulsory modules 1 to 3. The earliest date for starting is therefore the third subject-related semester in the master programme.

The preparation of a master thesis in the field of timber structures requires necessarily the registration to module 1S12 (Timber Structures).

Those students planning the master thesis at the chair of Building Materials and Concrete Constructions have to choose at least one compulsory elective module out of 1S24 – 1S26.

If the master thesis shall be prepared in the field of building physics the examination Building Physics I has to be passed.

Table 1: Study Focus Construction Engineering

Tab. 1: Modules in Focus I, Construction Engineering

module	module name	course	semester *) SWS 1 L/E	2 L/E	3 L/E	CP course	CP module	LC
1P1	Design and Construction of Components in Reinforced Concrete	Design and Construction of Components in Reinforced Concrete	2/2			6	6	wE
1P2	Steel and Composite Structures	Steel and Composite Structures		2/2		6	6	wE
1P3	Surface Structures and Dynamics of Structures	Surface Structures	2/0			3	6	wE
		Dynamics of Structures	2/0			3		wE
sum compulsory modules			**8**	**4**			**12**	
1S01	Bracing and Stability in Reinforced Concrete	Bracing and Stability in Reinforced Concrete		2/2		6	6	wE
1S02	Basics of Prestressed Concrete	Basics of Prestressed Concrete		2/2		6	6	wE
1S03	Solid Construction Bridges	Solid Construction Bridges			2/2	6	6	wE
1S04	Applied Dynamics of Structures	Applied Dynamics of Structures		1/1		3	6	oE
		Earthquake Engineering			1/1	3		
1S05	Anchorage in Concrete	Anchorage in Concrete I		1/1		3	6	oE
		Anchorage in Concrete II			1/1	3		
1S06	Material Science, Welding and Fatigue	Material Science, Welding and Fatigue		3/1		6	6	wE
1S07	Construction of Steel and Composite Bridges	Construction of Steel and Composite Bridges		2/2		6	6	wE
1S08	Hollow Section Structures	Hollow Section Structures			2/2	6	6	oE
1S09	Glass, Plastic and Cable Structures	Glass, Plastic and Cable Structures			3/1	6	6	oE
1S10	Structures in Steel and Timber	Supporting Steel Structures			1/1	3	6	oE
		Supporting Timber Structures			1/1	3		
1S11	Preservation of Steel and Timber Structures	Preservation of Steel Structures			2/0	3	6	wE
		Preservation of Timber Structures			1/1	3		
1S12	Timber Structures	Timber Structures		2/2		6	6	wE
1S13	Timber and Wood-based Materials	Timber and Wood-based Materials		2/2		6	6	oE
1S14	Non-linear Analysis of Beam Structures	Non-linear Analysis of Beam Structures	2/2			6	6	wE

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

module	module name	course	semester *) SWS			CP course	CP module	LC
			1 L/E	2 L/E	3 L/E			
1S15	Computational Analysis of Structures	Computational Analysis of Structures		2/2		6	6	oE
1S16	FE-Applications in Practical Engineering	FE-Applications in Practical Engineering		2/2		6	6	oE
1S17	Shell Structures and Stability of Structures	Shell Structures		1/1		3	6	oE
		Stability of Structures		1/1		3		
1S18	Numerical Methods in Structural Analysis	Numerical Methods in Structural Analysis			2/2	6	6	oE
1S19	Non-linear Analysis of Surface Structures	Non-linear Analysis of Surface Structures			2/2	6	6	oE
1S20	Basics of Finite Elements	Basics of Finite Elements	2/2			6	6	oE
1S21	Fracture and Damage Mechanics	Fracture and Damage Mechanics			2/2	6	6	oE
1S22	Material Models in Solid Mechanics	Material Models in Solid Mechanics		2/2		6	6	oE
1S23	Contact Mechanics I - Statics	Contact Mechanics I - Statics		2/2		6	6	oE
1S24	Concrete Construction Technology	Concrete Technology			2/1	4,5	6	oE
		Deformation and Fracture Processes			1/0	1,5		
1S25	Durability and Service Life Design	Corrosion Processes and Life Time			2/1	4,5	6	oE
		Analytic Methods			1/0	1,5		
1S26	Building Preservation of Concrete and Masonry Constructions	Protection, Rehabilitation and Reinforcement of Concrete and Masonry Constructions		2/1		4,5	6	oE
		Building Analyses		1/0		1,5		
1S27	Building Physics I	Applied Building Physics			2/0	3	6	oE
		Building Technology			2/0	3		oE
1S28	Building Physics II	Practical Noise Control		2/0		3	6	oE
		Practical Fire Protection		2/0		3		oE
1S29	Materials Testing and Measuring Techniques	Measuring Techniques in Civil Engineering			1/1	3	6	oE
		Materials Testing in the Field of Concrete			2/0	3		
1S30	Finite Elements for Field and Time Dependent Problems	Finite Elements for Field and Time Dependent Problems		2/2		6	6	oE

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

module	module name	course	semester *) SWS			CP course	CP module	LC
			1 L/E	2 L/E	3 L/E			
1S31	Contact Mechanics II - Dynamics	Contact Mechanics II - Dynamics			2/2	6	6	oE
1S32	Continuum Mechanics of Heterogeneous Solids	Continuum Mechanics	2/0			3	6	oE
		Micromechanics of Heterogeneous Solids		2/0		3		
1S33	Laboratory Course on Structural Vibrations	Laboratory Course on Structural Vibrations I	0/2			3	6	oE
		Laboratory Course on Structural Vibrations II		0/2		3		
1S34	Model Formulation in Strength of Materials and Theory of Kinetic Stability for Structures	Model Formulation in Strength of Materials		2/0		3	6	oE
		Theory of Kinetic Stability for Structures			2/0	3		
sum compulsory elective modules			**12**	**66**	**58**		**204**	

explanations:

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

*) The master's degree study can be started in summer and winter semester as well.
Within the column „semester“ the numbers „1“ and „3“ label courses taking place in the winter term, the number „2“ labels courses of the summer term.

Focus II ”Water and Environment”

All modules offered in the focus ”Water and Environment” are included in Table 2.

In this focus the three compulsory modules are predetermined:

- Advanced Fluid Mechanics
- Dynamics of Water and Mass Transport in River Basins
- Mass Fluxes and Cycles

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

Normally, in case of selecting the focus ”Water and Environment” the examinations in the compulsory modules listed above shall be passed in advance to the examinations in the chosen compulsory elective modules.

For the registration of the master thesis the passing in the five modules (30 CP) of each focus and the module Key Qualification (6 CP) has to be approved.

Table 2: Study Focus Water and Environment

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

module	module name	course	semester *) SWS 1 L/E	2 L/E	3 L/E	CP course	CP module	LC
2P1	Advanced Fluid Mechanics	Advanced Fluid Mechanics	2/0			3	6	wE
		Numerical Fluid Mechanics I	1/1			3		wE
2P2	Dynamics of Water and Mass Transport in River Basins	Multi-Phase Flow	2/0			3	6	wE
		Terrestrial Water Flows and Mass Transport	2/0			3		wE
2P3	Mass Fluxes and Cycles	Mass Fluxes	2/0			3	6	wE
		Bioprocess Engineering	2/0			3		wE
sum compulsory modules			**12**				**12**	
2S01	Water Resources and River Basin Management	Water Resources and River Basin Management		2/2		6	6	EoT
2S02	Thermodynamics in Environmental Systems	Thermodynamics in Environmental Systems			2/2	6	6	EoT
2S03	Dynamics of Water and Mass Transport in Watersheds	Dynamics of Water and Mass Transport in Watersheds		2/2		6	6	EoT
2S04	Data Analysis and Environmental Monitoring	Data Analysis and Environmental Monitoring		2/2		6	6	EoT
2S05	Experimental Hydrology and Process Monitoring in Environmental Systems	Hydrology Field Exercise and Literature Seminar		0/4		6	6	EoT
2S05	Aquatic Ecosystems	Aquatic Ecosystems			2/2	6	6	EoT
2S07	Environmental Communication	Environmental Communication			2/2	6	6	EoT
2S08	Groundwater Management	Groundwater Management		2/0		3	6	oE
		Numerical Groundwater Modelling			1/1	3		EoT
2S09	Studies of Development Projects in Water Resources Management	Studies of Development Projects in Water Resources Management			2/2	6	6	oE
2S10	Practical Use of Numerical Methods in Fluid Mechanics	Practical Use of Numerical Methods in Fluid Mechanics			2/2	6	6	wE
2S11	Hydro Power Engineering	Hydro Power Engineering		3/1		6	6	oE
2S12	Waterway Engineering	Waterway Engineering		2/2		6	6	oE
2S13	River Dynamics	Morphodynamics		1/1		3	6	oE
		Flow Behaviour		1/1		3		

Tab. 2 (cont.): Modules in Focus II, Water and Environment								
module	**module name**	**course**	**semester *) SWS**			**CP course**	**CP module**	**LC**
			1 L/E	**2 L/E**	**3 L/E**			
2S15	Experimental Techniques I: Small Scale Experiments	Experimental Methods		1/2		4,5	6	oE
		Hydraulic Engineering Project			0/1	1,5		EoT
2S16	Interaction Flow - Building Structure	Interaction Flow - Building Structure			1/1	3	6	oE
		Building and Environ-mental Aerodynamics			1/1	3		oE
2S17	Technical Hydraulics	Steady and Unsteady-state Operation of Hydraulic Systems		2/2		6	6	oE
2S18	Experimental Techniques II: Measurement Techniques	Flow Measuring Technique	1/1			3	6	oE
		Signal Processing in Fluid Mechanics		1/1		3		oE
2S19	Environmental Fluid Mechanics	Environmental Fluid Mechanics			2/2	6	6	oE
2S20	Turbulent Flows	Fluid Mechanics of Turbulent Flows		2/0		3	6	oE
		Modelling of Turbulent Flows - RANS and LES			2/0	3		oE
2S21	Advanced Computational Fluid Dynamics	Parallel Programming Techniques for Engineering Problems		1/1		3	6	sP
		Numerical Fluid Mechanics II		1/1		3		oE
2S22	Wastewater Analyses in Practice	Wastewater Analyses and Application		0/4		6	6	EoT
2S23	Technologies for Solid Waste Management	Processing of Wastes with Excursions		2/2		6	6	oE
2S24	Water Treatment Technologies	Process Technologies in Storm Water Treatment		1/1		3	6	EoT
		Process Technologies in Water Supply and Wastewater Disposal		1/1		3		oE
2S25	Urban Water Management	Urban Water Management			2/2	6	6	oE
2S26	Water Quality of Surface Water Bodies and Groundwater	Surface Water Quality		1/2		4,5	6	EoT
		Groundwater Quality		1/0		1,5		

<table>
<tr><th colspan="9">Tab. 2 (cont.): Modules in Focus II, Water and Environment</th></tr>
<tr><th rowspan="2">module</th><th rowspan="2">module name</th><th rowspan="2">Course</th><th colspan="3">semester *)
SWS</th><th rowspan="2">CP course</th><th rowspan="2">CP module</th><th rowspan="2">LC</th></tr>
<tr><th>1
L/E</th><th>2
L/E</th><th>3
L/E</th></tr>
<tr><td rowspan="2">2S27</td><td rowspan="2">Applied Ecology</td><td>Principles of Applied Ecology</td><td></td><td>2/0</td><td></td><td>3</td><td rowspan="2">6</td><td>oE</td></tr>
<tr><td>Seminar: Ecological Mana-gement of Water Bodies</td><td></td><td></td><td>2/0</td><td>3</td><td>EoT</td></tr>
<tr><td rowspan="2">2S28</td><td rowspan="2">Water Supply and Sanitation Systems and Plants</td><td>Water Treatment</td><td></td><td>1/1</td><td></td><td>3</td><td rowspan="2">6</td><td>oE</td></tr>
<tr><td>Water Distribution</td><td></td><td></td><td>1/1</td><td>3</td><td>EoT</td></tr>
<tr><td rowspan="2">2S29</td><td rowspan="2">Industrial Water Management</td><td>Cleaner Production – Closing the Loop</td><td></td><td>1/1</td><td></td><td>3</td><td rowspan="2">6</td><td rowspan="2">oE</td></tr>
<tr><td>Appropriated Technologies</td><td></td><td></td><td>1/1</td><td>3</td></tr>
<tr><td rowspan="2">2S30</td><td rowspan="2">River Basin Modelling</td><td>Mass Fluxes in River Basins</td><td></td><td>2/0</td><td></td><td>3</td><td rowspan="2">6</td><td>oE</td></tr>
<tr><td>Modelling Mass Fluxes in River Basins</td><td></td><td></td><td>0/2</td><td>3</td><td>EoT</td></tr>
<tr><td colspan="3">Sum compulsory elective modules</td><td>2</td><td>69</td><td>45</td><td></td><td>174</td><td></td></tr>
</table>

explanations:

2PX =	Focus II, compulsory module	wE =	written examination
2SXX =	Focus II, compulsory elective module	oE =	oral examination
CP =	credit point (1 SWS = 1,5 CP)	EoT =	examination of other type
LC =	learning control		

*) The master's degree study can be started in summer and winter semester as well.
Within the column „semester" the numbers „1" and „3" label courses taking place in the winter term, the number „2" labels courses of the summer term.

Focus III ”Mobility and Infrastructure”

All modules offered in the focus ”Mobility and Infrastructure” are included in Table 3.

In this focus five compulsory modules are predetermined:

- Urban and Regional Planning
- Models and Methods in Traffic Engineering and Transportation Planning
- Infrastructure Management
- Track Guided Transport Systems – Technical Design and Components
- Laws and Proceedings concerning Traffic and Roads

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.

For the registration of the master thesis 4 out of the 5 modules in this focus have to be passed.

Table 3: Study Focus Mobility and Infrastructure

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

module	module name	course	semester *) SWS			CP course	CP module	LC
			1 L/E	2 L/E	3 L/E			
3P1	Urban and Regional Planning	Urban Planning	1/1			3	6	oE
		Regional Planning	2/0			3		
3P2	Models and Methods in Traffic Engineering and Transportation Planning	Methods and Models in Transportation Planning	1/1			3	6	oE
		Traffic Engineering	1/1			3		
3P3	Infrastructure Management	Design and Construction of Highways		2/0		3	6	oE
		Operation and Maintenance of Highways		2/0		3		
3P4	Track Guided Transport Systems - Technical Design and Components	Track Guided Transport Systems - Technical Design and Components	3/1			6	6	wE
3P5	Laws and Proceedings concerning Traffic and Roads	Laws concerning Traffic and Roads		2/0		3	6	oE
		Environmental Impact Assessment		1/0		1,5		oE
		Assessment and Evaluation Techniques		1/0		1,5		oE
sum compulsory modules **) **) 3 compulsory modules have to be chosen, total 18 CP			**12**	**8**			**30**	
3S01	Urban Renewal	Urban Management		1/1		3	6	oE
		History of Urban Planning and the Built Environment		1/0		1,5		
		Building Theory		1/0		1,5		
3S02	Space and Infrastructure	Logistics, Supply and Disposal		1/1		3	6	oE
		Planning Techniques and Planning Methods		1/1		3		
3S03	Traffic Management und Simulation Methods	Traffic Management and Transport Telematics		1/1		3	6	oE
		Traffic Flow Simulation		1/1		3		
3S04	Planning of Transportation Systems	Characteristics of Transportation Systems		2/0		3	6	oE
		Tendering, Planning and Financing in Public Transport		1/1		3		

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

module	module name	course	semester *) SWS			CP course	CP module	LC
			1 L/E	2 L/E	3 L/E			
3S05	Highway Design	IT-based Road Design			1/1	3	6	oE
		Highway Design Project Study			0/2	3		
3S06	Road Construction	Practical Laboratory Trai-ning in Road Construction			0/2	3	6	oE
		Pavement Structural De-sign and Failure Analysis			2/0	3		
3S07	Track Guided Transport Systems - Basics of Operating Systems	Operation		2/0		3	6	wE
		Facilities and Rolling Stock		1/1		3		
3S08	Track Guided Transport Systems - Operational Logistics and Management	Operation Systems and Track Guided Infrastructure Capacity		2/0		3	6	oE
		Management in Public Transport		2/0		3		
3S09	Project Integrated Planning	Project Integrated Planning			0/4	6	6	oE
3S10	Data Analysis and Transportation Modelling	Transportation Data Analysis			1/1	3	6	oE
		Seminar in Transportation			0/2	3		EoT
3S11	Intermodality in Long-distance, Freight and Air Transport	Freight Transport		1/1		3	6	wE
		Long-distance and Air Traffic			2/0	3		
3S12	Road Safety	Safety Management in Highway Engineering			1/1	3	6	oE
		Seminar in Highway Engineering			0/2	3		
3S13	Special Topics in Highway Engineering	Technical and Economic Management Tools in Highway Engineering		2/0		3	6	oE
		Simulations and Analysis Methods in Highway Engineering		1/0		1,5		oE
		Special Topics in Highway Engineering		1/0		1,5		
3S14	Dimensioning and Construction of Railway Lines	Infrastructure Dimensio-ning and Railway Traffic		1/1		3	6	oE
		Infrastructure Equipment of Railway Tracks		1/0		1,5		
		Construction and Maintenance of Track Infrastructure		1/0		1,5		

Tab. 3 (cont.): Modules in Focus III, Mobility and Infrastructure								
module	**module name**	**course**	**semester *) SWS**			**CP course**	**CP module**	**LC**
			1 L/E	**2 L/E**	**3 L/E**			
3S15	Economics, Law and Environmental Aspects in Railway Transportation	Environmental Aspects of Guided Transport Systems			2/0	3	6	oE
		Economic Efficiency of Guided Transport Systems			1/0	1,5		
		Law Aspects of Guided Transport Systems			1/0	1,5		
3S16	Traffic Infrastructure	Determination of Demand, Timetable Construction and Alignment		1/2		4,5	6	oE
		Standard Valuation in Public Transport. Using an Example			0/1	1,5		
sum compulsory elective modules **) **) At least 2 modules of compulsory elective modules and not already chosen compulsory modules have to be chosen, total at least 12 CP				**37**	**27**		**96**	

explanations:

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

*) The master's degree study can be started in summer and winter semester as well.
Within the column „semester" the numbers „1" and „3" label courses taking place in the winter term, the number „2" labels courses of the summer term.

Focus IV ”Technology and Management in Construction”

All modules offered in the focus ”Technology and Management in Construction” are included in Table 4. There, information is provided in which semester the corresponding lectures take place and how the respective learning control is carried out.

In this focus four compulsory modules are predetermined:

- Construction Management and Work Planning
- Construction Equipment and Machinery
- Economics and Management in Construction
- Sustainability in Real Estate Management

In addition, two compulsory elective modules have 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.

For the registration of the master thesis the compulsory modules 1 to 4 have to be passed and both student research projects have to be attested. The earliest date for starting 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	module name	course	semester *) SWS 1 L/E	2 L/E	3 L/E	CP course	CP module	LC
4P1	Construction Management and Work Planning	„Arbeitsvorbereitung und Bauleitung“	2/0			3	6	wE
		„Baubetriebliche Verfahrenstechnik“	2/0			3		
4P2	Construction Equipment and Machinery	Fundamental Mechanics of Construction Equipment	1/0			1,5	6	wE
		Construction Equipment and Mechanical Process Engineering	2/1			4,5		
4P3	Economics and Management in Construction	Cost Estimation		1/1		3	6	wE
		Financing / Investment / Controlling		1/0		1,5		
		Building Laws		1/0		1,5		
4P4	Sustainability in Real Estate Management	Sustainability in Real Estate Management		1/1		3	6	wE
		Real Estate Life Cycle Management		1/0		1,5		
		Facility and Real Estate Management II		1/0		1,5		
sum compulsory modules			**8**	**8**			**24**	
4S01	Business and Human Resource Management	Business and Human Resource Management		2/0		3	6	oE
		Human Resources in the Real Estate Sector		1/0		1,5		
		Contract and Employment Law		1/0		1,5		
4S04	Construction Process Engineering and Quality Management	„Spannbeton in der baubetrieblichen Praxis“		1/0		1,5	6	oE
		„Beton- und Stahlbeton-instandsetzung“		1/0		1,5		
		Quality and Environmental Management		1/0		1,5		
		Test Procedures in Construction		1/0		1,5		

Tab. 4 (cont.): Modules in Focus IV, Technology and Management in Construction								
module	**module name**	**course**	**semester *) SWS**			**CP course**	**CP module**	**LC**
			1 L/E	**2 L/E**	**3 L/E**			
4S05	Advanced Project Management	Supplementary Claim Management		1/0		1,5	6	oE
		Project Control		1/0		1,5		
		Project Management II		1/1		3		
4S06	Environmentally-friendly Recycling and Disassembly of Buildings	Project Studies		1/1		3	6	oE
		Disassembly Process Engineering		1/1		3		
4S07	Upgrading of Existing Buildings and Energetic Refurbishment	Upgrading of Existing Buildings			2/1	4,5	6	oE
		Energetic Refurbishment			1/0	1,5		
4S08	Real Estate Management	Public Real Estate Management			1/0	1,5	6	oE
		Public Private Partnership			1/0	1,5		
		Project Development			1/0	1,5		
		Corporate Real Estate Management			1/0	1,5		
4S09	Lean Construction	Lean Construction			2/2	6	6	oE
4S10	Advanced Studies in Construction Engineering	Tunnel Construction and Blasting Engineering			2/0	3	6	oE
		Operation Methods for Foundation and Marine Construction			1/0	1,5		
		Operation Methods for Earthmoving			1/0	1,5		
4S12	Decommissioning of Nuclear Facilities	Removal and Decontami-nation of Nuclear Facilities			1/1	3	6	oE
		New Development and Op-timization of Decommissio-ning Machine Technology			1/1	3		
4S13	Facility Management in Hospitals and Hospital Management	Facility Management in Hospitals			2/1	4,5	6	EoT
		Hospital Management		1/0		1,5		oE
4S14	Building Preservation in Concrete and Masonry Constructions *(identical with 1S26 of Focus I)*	Protection, Rehabilitation and Reinforcement of Concrete and Masonry Constructions		2/1		4,5	6	oE
		Building Analyses		1/0		1,5		
sum compulsory elective modules				**21**	**23**		**66**	

explanations:

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

*) The master's degree study can be started in summer and winter semester as well.
Within the column „semester“ the numbers „1“ and „3“ label courses taking place in the winter term, the number „2“ labels courses of the summer term.

Focus V ”Geotechnical Engineering”

All modules offered in the focus ”Geotechnical Engineering” are included in Table 5.

In this focus five compulsory modules are predetermined:

- Theoretical Soil Mechanics
- Earthworks and Foundation Engineering
- Rock Mechanics and Tunneling
- Basics in Numerical Modelling
- Design and Construction of Components in Reinforced Concrete

In case that the compulsory module Design and Construction of Components in Reinforced Concrete 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.

Two student research projects in the fields Earth Dams or Foundation Engineering and Rock Engineering are involved in the compulsory part of the focus. These have to be prepared accompanying the study of 5P2 and 5P3 and support the preparation of the examinations. The projects have to be submitted for the registration to the respective examination and will be attested by a colloquium respectively. The completion of the examination prerequisite will be checked by the institute.

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 5P5 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 Geomechanic Processes (5S10) following Rock Mechanics and Tunnelling (5P3)

For the registration of the master thesis four out of the five compulsory modules have to be passed, mandatory 5P4 (”Basics in Numerical Modelling”). The earliest date for starting is therefore the third subject-related semester in the master programme.

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	module name	course	semester *) SWS 1 L/E	2 L/E	3 L/E	CP course	CP module	LC
5P1	Theoretical Soil Mechanics	Stress, Strain and Limit States in Soils		2/1		4,5	6	wE
		Triaxial Testing in Soil Mechanics		1/0		1,5		
5P2	Earthworks and Foundation Engineering	Foundation Types	1/1			3	6	wE
		Basics in Earthworks and Embankment Dams	1/1			3		
5P3	Rock Mechanics and Tunnelling	Stress, Strain and Limit States in Rock		1/1		3	6	wE
		Basics in Tunnel Construction		1/1		3		
5P4	Basics in Numerical Modelling	Continuum Mechanics for Geotechnics	1/1			3	6	oE
		Numerics in Geotechnics	2/0			3		
5P5	Design and Construction of Components in Reinforced Concrete **) *(identical with 1P1 of Focus I)*	Design and Construction of Components in Reinforced Concrete	2/2			6	6	wE
sum compulsory modules **) Since module 5P5 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	Soil as Viscous Multi-phase System			1/1	3	6	wE
		Soil Dynamics			1/1	3		
5S02	Ground Investigation **)	Soil Mechanical Laboratory Exercises		0/2		3	6	oE
		Geomechanical Field Exercise		0/2		3		
5S03	Applied Geotechnics **)	Foundations and Retaining Structures		1/1		3	6	wE
		Special Foundation Engineering and Design		1/1		3		
5S04	Ground Water and Earth Dams	Geotechnical Ground Water Problems		1/1		3	6	wE
		Embankment Dams (Advanced)		1/1		3		

Tab. 5 (cont.): Modules in Focus V, Geotechnical Engineering								
module	**module name**	**course**	**semester *) SWS**			**CP course**	**CP module**	**LC**
			1 L/E	**2 L/E**	**3 L/E**			
5S05	Rock Engineering and Underground Construction	Aboveground Rock Engineering			1/1	3	6	wE
		Tunnel Construction in Soils and in Existence			1/1	3		
5S06	Numerical Modelling in Geotechnics	Exercises in Numerical Modelling		0/2		3	6	oE
		FEM Applications in Geotechnical Modelling		2/0		3		
5S07	Geotechnical Testing and Measuring Technology	Rock Testing			1/0	1,5	6	oE
		Testing in Dam and Wastefill Engineering			1/0	1,5		
		Geotechnical Measuring Technology			1/1	3		
5S08	Special Underground Engineering	Ground Improvement, Grouting and Soil Freezing		1/1		3	6	oE
		Anchoring, Piling and Slurry Wall Technology		1/1		3		oE
5S09	Environmental Geotechnics	Landfills			1/1	3	6	oE
		Brownfield Sites – Investigation, Evaluation, Rehabilitation			2/0	3		oE
5S10	Coupled Geomechanic Processes	Time-dependent Phenomena in Hard Rock			1/1	3	6	wE
		Coupled Phenomene in Geomechanics			1/1	3		
sum compulsory elective modules				**20**	**20**		**60**	

explanations:

5PX = Focus V, compulsory module
5SXX = Focus V, compulsory elective module
CP = credit point (1 SWS = 1,5 CP)
LC = learning control

wE = written examination
oE = oral examination

*) The master's degree study can be started in summer and winter semester as well.
Within the column „semester“ the numbers „1“ and „3“ label courses taking place in the winter term, the number „2“ labels courses of the summer term.

2 Useful tips and informative items

Module Handbook

Generally, the programme is composed of **modules** and **courses**. 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 modules are assigned to the subject-related **focuses**. A certain number of **compulsory modules** is predetermined in each focus. The further **compulsory elective modules** can be chosen in the focus or as complementary module. This enables the student to customize content and time schedule of the interdisciplinary study according to personal needs, interest and job perspective.
The **module handbook** describes the modules belonging to the programme. It describes:

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

The module handbook serves as a necessary orientation and as a helpful guide throughout the studies.
However, the module handbook does not replace the **course catalogue** or the individual announcements of the institutes, which provide important information concerning each semester and variable course details (e.g. time and location of the course) as well as short-term modifications.

Selection of focuses and modules

Every student selects the focuses with the respective modules and the complementary modules in agreement with her/his chosen mentor (professor of the selected focuses) in advance to the registration for the examination. Therefore, the forms 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 sent to the programme coordinator.
The choice 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 taken over to the master degree certificate. On the other hand, changes of the module choice are generally possible, as far as the respective module is not completed. However, they are only advised in exceptional cases, e.g. if a compulsory elective module is not offered at short notice.

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. After attendance of the examination, a module cannot be replaced by another one any more.
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.

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
`https://campus.studium.kit.edu/exams/registration.php`

Repeating examinations

Principally, a failed examination can be repeated once. If the **repeat examination** (including an oral repeat examination) will be failed as well, the **examination claim** is lost. If the repeat examination is not passed successfully by the **next but one examination date** at the latest, the examination claim is lost, as well.
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 committee. 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.

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'.

Acceptance, preparation and completion of the master thesis

The master thesis is going to be prepared in one of the selected focuses. It has to be assigned by a **professor** of the **Civil Engineering** programmes. The wishes of the students shall be respected when formulating of the topic. Those are accepted for the master thesis who has passed successfully the required module examinations in the selected focuses or in the focus in which the master thesis shall be prepared respectively:

Focus I, Construction Engineering:
: The compulsory modules 1 – 3 has to be passed successfully.
: The preparation of a master thesis in the field of timber structures requires necessarily the registration to module 1S12 (Timber Structures).
: The preparation of a master thesis at the chair of Building Materials and Concrete Constructions requires the choice of at least one compulsory elective module out of 1S24 – 1S26.
: The preparation of a master thesis in the field of building physics requires passing of the examination Building Physics I.

Focus II, Water and Environment
: Passing of the five modules (30 CP) of each focus and the module Key Qualification (6 CP) has to be approved.

Focus III, Mobility and Infrastructure:
: 4 out of the 5 compulsory modules in this focus have to be passed.

Focus IV, Technology and Management in Construction:
: The compulsory modules 1 – 4 have to be passed and both student research projects have to be attested.

Focus V, Geotechnical Engineering:
: 4 out of the 5 compulsory modules have to be passed, mandatory 5P4 ("Basics in Numerical Modelling").

The **application for acceptance** (registration) of the master thesis is done via the self-service function for students. This 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 **acceptance** of the master thesis is carried out by the programme coordinator after approval of the prerequisites to be provided (s. above).
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**.

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.

Further information

More detailed information about the legal and general conditions of the programme can be found in the examination regulation of the programme (in the appendix).

Contact persons

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Used abbreviations

LP/CP	Credit Points/ECTS	Leistungspunkte/ECTS
LV	course	Lehrveranstaltung
RÜ	computing lab	Rechnerübung
S	summer term	Sommersemester
Sem.	semester/term	Semester
ER/SPO	examination regulations	Studien- und Prüfungsordnung
KS/SQ	key qualifications	Schlüsselqualifikationen
SWS	contact hour	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.

the following modules are not any more offered since winter term 2013/14:

Nature-orientated River Engineering [bauiM2S14-WB6]

Innovation in Construction Process Engineering - Case Studies [bauiM4S02-]

Environmental Engineering and Strategies for Energy Supply [bauiM4S03-]

Advanced Construction Equipment Technology [bauiM4S11-]

Change of examination in the module ”Water Quality of Surface Water Bodies and Groundwater” [bauiM2S26-SW3]:

As of summer term 2014 the module examination consists of the grading of a report on field exercises. The preparation of a term paper about a chosen topic from the module content list is prerequisite for the examination.

Change of examination in the module ”Numerical Modelling in Geotechnics” [bauiM5S06-NUMMOD]:

As of summer term 2014 the module examination consists of an oral examination. Basis for the oral examination is the preparation of a programming exercise.

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

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

Courses in module

ID	Course	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6211701	Design and Construction of Components in Reinforced Concrete (p. 196)	2/2	W	6	L. Stempniewski

Learning Control / Examinations
graded:
examination Design and Construction of Components in Reinforced Concrete, written, 90 min.
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
courses Basics of Reinforced Concrete I+II (0170601, 0170615)

Learning Outcomes
Achieving a higher level of insight into complex subjects of reinforced concrete

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6212801	Steel and Composite Structures (p. 338)	2/2	S	6	T. Ummenhofer

Learning Control / Examinations
graded:
examination Steel and Composite Structures, written, 90 min.
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
course Basics in steel structures (0170504)

Learning Outcomes
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.

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6214701	Surface Structures (p. 239)	2	W	3	W. Wagner
6215701	Dynamics of Structures (p. 185)	2	W	3	P. Betsch, T. Seelig

Learning Control / Examinations
graded:
partial examination Surface Structures, written
partial examination Dynamics of Structures, written
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 (0170401, 0170501)

Learning Outcomes
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.

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:
Script Flächentragwerke

Hake, E. , Meskouris, K. (2001): Statik der Flächentragwerke, Springer.
Altenbach, H., Altenbach, J., Naumenko, K. (1998): Ebene Flächentragwerke, Grundlagen der Modellierung und Berechnung von Scheiben und Platten, Springer.
Sub-module Dynamics of Structures:
Script: 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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6211801	Bracing and Stability in Reinforced Concrete (p. 182)	2/2	S	6	L. Stempniewski

Learning Control / Examinations
graded:
examination Bracing and Stability in Reinforced Concrete, written, 90 min.
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
course Basics of Reinforced Concrete I (0170601),
module Design and Construction of Components in Reinforced Concrete [bauiM1P1-BEMISTB]

Learning Outcomes
Design of Buildings regarding Bracing and Stability

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6211803	Basics of Prestressed Concrete (p. 255)	2/2	S	6	L. Stempniewski

Learning Control / Examinations
graded:
examination Basics of Prestressed Concrete, written, 90 min.
grading:
grade of module is defined by grade of examination

Conditions
none

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

Learning Outcomes
Understanding the basics and Functionality of Prestressed Concrete.

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6211901	Solid Construction Bridges (p. 281)	2/2	W	6	L. Stempniewski

Learning Control / Examinations
graded:
examination Solid Construction Bridges, written, 90 min.
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
module Basics of Prestressed Concrete [bauiM1S02-GDLSPANNB]

Learning Outcomes
Understanding how to design and build bridges regarding span, architecture and environment

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6211805	Applied Dynamics of Structures (p. 305)	1/1	S	3	L. Stempniewski
6211903	Earthquake Engineering (p. 226)	1/1	W	3	L. Stempniewski

Learning Control / Examinations
graded:
examination Applied Dynamics of Structures, oral, 30 min.
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
none

Learning Outcomes
Problems dynamics of structures arise more often in support structure planning.
Aim of the course is gainig basic knowledge with respect to practical topics in this field, whilst the three important interactions mankind - machinery - wind are in the front. Within the second part of the course basic knowledge of the calculation of reinforced concrete buildings under impact of earthquake loads shall be imparted.

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6211807	Anchorage in Concrete I (p. 194)	1/1	S	3	L. Stempniewski
6211905	Anchorage in Concrete II (p. 195)	1/1	W	3	L. Stempniewski

Learning Control / Examinations
graded:
examination Anchorage in Concrete, oral
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
none

Learning Outcomes
Comprehension of the Importance of using the right Anchorage System in a specific case and in the right Way

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6212803	Material Science, Welding and Fatigue (p. 340)	3/1	S	6	P. Knödel

Learning Control / Examinations
graded:
examination Material science, welding and fatigue, written, 90 min.
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
course Basics in Steel Structures (0170504)

Learning Outcomes
see German version

Content
see German version

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6212901	Construction of Steel and Composite Bridges (p. 339)	2/2	S	6	T. Ummenhofer

Learning Control / Examinations
graded:
examination Construction of Steel and Composite Bridges, written, 60 min.
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
course Basics in Steel Structures (0170504),
module Steel and Composite Structures [bauiM1P2-STAHLBAU]

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

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6212903	Hollow Section Structures (p. 261)	2/2	W	6	S. Herion

Learning Control / Examinations
graded:
examination Hollow Section Structures, oral, 30 min.
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
course Basics in Steel Structures (0170504)

Learning Outcomes
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.

Content

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

Remarks
Literature:
Manuscript: “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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6212905	Glass, Plastic and Cable Structures (p. 250)	3/1	W	6	D. Ruff

Learning Control / Examinations
graded:
examination Glass, Plastic and Cable Structures, oral, 30 min.
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
course Basics in Steel Structures (0170504)

Learning Outcomes
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.

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6212907	Supporting Steel Structures (p. 352)	1/1	W	3	T. Ummenhofer
6213901	Supporting Timber Structures (p. 351)	1/1	W	3	M. Frese

Learning Control / Examinations
graded:
examination Structures in Steel and Timber, oral, 60 min.
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
course Basics in Steel Structures (0170504),
modules Steel and Composite Structures [bauiM1P2-STAHLBAU], Timber Structures [bauiM1S12-BAUING-HB]

Learning Outcomes
Structures in Steel:
The students have knowledge in the design of structures, regarding the necessary boundary conditions.
Structures in Timber:
Timber bridges Nail plate connections Timber structures for halls Learning from failures Dome structures. The lecture gives an overview about damages to timber structures and their reasons and highlights the topic „timber structures" from pathological perspective. In doing so the aims are achieving awareness of damages and learning strategies to avoid damages and failures.

Content
Structures in Steel:

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

Structures in Timber:

- Timber bridges Nail plate connections Timber structures for halls Learning from failures Dome structures
- 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
Structures in Timber:
Blaß, H.J.; Frese, M.: Schadensanalyse von Hallentragwerken aus Holz, KIT Scientific Publishing, Karlsruhe 2010.
Blaß, H.J.; Görlacher, R.; Steck, G. (Ed.) Holzbauwerke STEP 1 - Bemessung und Baustoffe. Fachverlag Holz, Düsseldorf, 1995 (ISSN-Nr. 04462114)

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6212909	Preservation of Steel Structures (p. 192)	2	W	3	T. Ummenhofer
6213903	Preservation of Timber Structures (p. 191)	1/1	W	3	R. Görlacher

Learning Control / Examinations
graded:
examination Steel and Timber Structures, written, 90 minutes (45 min. each)
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
module Timber Structures (bauiM1S12-BAUING-HB)

Learning Outcomes
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.

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
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 Manuscript „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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6213801	Timber Structures (p. 263)	2/2	S	6	H. Blaß

Learning Control / Examinations
graded:
examination Timber Structures, written, 90 min.
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
none

Learning Outcomes
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.

Content

- Elements: Mechanically jointed beams, stressed skin panels, purlins
- Joints: Moment resisting connections, multiple-shear joints 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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6213803	Timber and Wood-based Materials (p. 262)	2/2	S	6	C. Sandhaas

Learning Control / Examinations
graded:
examination Timber and Wood-based Materials, oral, 30 min.
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
module Timber Structures [bauiM1S12-BAUING-HB]

Learning Outcomes
The students gain fundamental understanding of wood as a natural building material, its anatomic structure and physical properties. They understand how these properties are influenced by the growth and the growing conditions of trees as a supplier of wood. The students have a good knowledge of wood processing from logging to ready-made building materials. Apart from solid timber products, they are familiar with production, properties and use of wood-based products like glulam, plywood, particle boards and fibre boards. During excursions, the students gain insight into sustainable forest management and the production of wood-based building materials. A short paper assignment in English introduces the students to scientific working and writing, allows them to autonomously and coherently summarise findings from literature and is a good preparation for the master thesis. The paper assignment consists of a literature research, comprises 4-6 pages and is carried out as a group work.

Content

- Wood anatomy
- wood characteristics
- wood physics
- 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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6214702	Non-linear Analysis of Beam Structures (p. 296)	2/2	W	6	I. Münch

Learning Control / Examinations
graded:
examination Non-linear Analysis of Beam Structures, written, 90 min.
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
courses Structural Analysis I+II (0170401, 0170501)

Learning Outcomes
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.

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:
Script 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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6214801	Computational Analysis of Structures (p. 213)	2/2	S	6	W. Wagner

Learning Control / Examinations
graded:
examination Computational Analysis of Structures, oral, 30 min.
attested:
student research paper as examination prerequisite, 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]

Learning Outcomes
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.

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:
Script Computergestützte Tragwerksmodellierung
Krätzig, W.B., Basar, Y. (1997): Tragwerke 3 - Theorie und Anwendung der Methode der Finiten Elemente, Springer.
Werkle, H. (2001): 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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6214803	FE-Applications in Practical Engineering (p. 233)	2/2	S	6	W. Wagner

Learning Control / Examinations
graded:
examination FE-Applications in Practical Engineering, oral, 30 min.
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
module Computational Analysis of Structures [bauiM1S15-CTWM]

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

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: Script 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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6214805	Shell Structures (p. 320)	1/1	S	3	I. Münch
6214807	Stability of Structures (p. 334)	1/1	S	3	I. Münch

Learning Control / Examinations
graded:
examination Shell Structures and Stability of Structures, oral, 40 min.
attested:
student research paper as examination prerequisite, definition of a project available from lecturer
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
course Surface Structures (6214701)

Learning Outcomes
Students will learn the theory and analytical and computational modeling of shell structures and of stability problems.

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:
Script Schalentragwerke
Script Stabilität der Tragwerke

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6214901	Numerical Methods in Structural Analysis (p. 299)	2/2	W	6	I. Münch

Learning Control / Examinations
graded:
examination Numerical Methods in Structural Analysis, oral, 30 min.
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
module Computational Analysis of Structures [bauiM1S15-CTWM]

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

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:
Script 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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6214903	Non-linear Analysis of Surface Structures (p. 295)	2/2	W	6	W. Wagner

Learning Control / Examinations
graded:
examination Non-linear Analysis of Surface Structures, oral, 30 min.
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
none

Learning Outcomes
Students will learn the essential principles of nonlinear analysis of surface structures.

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:
Script

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6215901	Basics of Finite Elements (p. 257)	2/2	W	6	P. Betsch

Learning Control / Examinations
graded:
examination Basics of Finite Elements, oral, 30 min.
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
none

Learning Outcomes
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.

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6215903	Fracture and Damage Mechanics (p. 212)	2/2	W	6	T. Seelig

Learning Control / Examinations
graded:
examination Fracture and Damage Mechanics, oral, 45 min.
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
course Introduction to Continuum Mechanics (0170607)

Learning Outcomes
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

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6215801	Material Models in Solid Mechanics (p. 180)	2/2	S	6	T. Seelig, P. Betsch

Learning Control / Examinations
graded:
examination Material Models in Solid Mechanics, oral, 45 min.
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
course Introduction to Continuum Mechanics (0170607)

Learning Outcomes
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.

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: Contact Mechanics I - Statics [bauiM1S23-KONTMECH-I]

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6215803	Contact Mechanics I - Statics (p. 270)	2/2	S	6	C. Hesch, A. Konyukhov

Learning Control / Examinations
graded:
examination Contact Mechanics I, oral , 30 min.
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
course Introduction to Continuum Mechanics (0170607),
module Basics of Finite Elements [bauiM1S20-GRUNDFE]

Learning Outcomes
Contact problems appear within a large number of engineering problems. The main difficulty in the solution of contact problems is the nonlinearity of the governing equilibrium equations even for small displacement problems. This nonlinearity is arising from a lack of a-priori knowledge about a contact area and contact stresses. Thus, an advanced mathematical modeling should be applied. Several contact approaches for modeling contact conditions within the Finite Element method are described during the course. Particular problems arising during the modeling are discussed and illustrated by numerical examples using also commercial F.E. programs. Numerical implementations for the FEAP code (Finite Element Analysis Program, version FEAP-MeKa) are done for 2d examples.

Content

- Introduction into contact mechanics: equilibrium equations, boundary conditions, nonlinearities appearing in contact modeling.
- Non-frictional contact. Contact with a rigid obstacle. SIGNORINI's problem. Variational formulation.
- Contact kinematics for an arbitrary two body contact problem. Variational formulation. KUHN-TUCKER conditions.
- Analytical solutions for simple contact problems: HERTZ contact problems.
- General description of NEWTON's iterative solution method for nonlinear equations. Convergence. Consistent linearization.
- Various solution methods: merits and drawbacks within the Finite Element formulation. Method of LAGRANGE multipliers. Penalty method. Augmented LAGRANGE method.
- Small displacement problems. Simple Finite Element formulation based on the penalty approach: node-to-ground contact element for SIGNORINI's problem, node-to-node contact element for the arbitrary two body contact problem.
- Large displacement contact problems. Concept of global and local searching algorithms. Closest point projection procedure.
- Master-slave algorithm. Node-to-segment contact element. Formulation for various approaches (Penalty, Augmented LAGRANGE method).
- Continuous transfer of contact stresses through the contact surface. Patch test.
- Various approaches to satisfy a patch test: Mortar method and segment-to-segment contact element.
- Basis of frictional contact problems. Coulomb friction law. Variational formulation. KUHN-TUCKER conditions. Return-mapping algorithm.
- Small displacement friction problem: node-to-node contact element. Patch sliding test for the sticking-sliding zone.

Remarks
Literature:
[1] Johnson: Contact Mechanics
[2] Laurson: Computational Contact and Impact Mechanics
[3] Wriggers: Computational Contact Mechanics

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6211809	Concrete Technology (p. 201)	2/1	W	4,5	M. Haist, V. Kvitsel
6211810	Deformation and Fracture Processes (p. 366)	1	W	1,5	H. Müller, E. Kotan

Learning Control / Examinations
graded:
examination Concrete Construction Technology, oral, 30 min.
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
none

Learning Outcomes
see German version

Content
see German version

Remarks
Literature:

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6211907	Corrosion Processes and Life Time (p. 274)	2/1	W	4,5	J. Eckhardt, M. Haist, M. Vogel
6211908	Analytic Methods (p. 175)	1	W	1,5	J. Eckhardt, M. Vogel

Learning Control / Examinations
graded:
examination Durability and Service Life Design, oral, 30 min.
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
course Building Chemistry (0170108)

Learning Outcomes
see German version

Content
see German version

Remarks
Literature:

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6211811	Protection, Rehabilitation and Reinforcement of Concrete and Masonry Constructions (p. 321)	2/1	S	4,5	E. Kotan, H. Müller, M. Günter
6211813	Building Analyses (p. 190)	1	S	1,5	E. Kotan, H. Müller, M. Vogel

Learning Control / Examinations
graded:
examination Building Preservation of Concrete and Masonry Constructions, oral, 30 min.
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
none

Learning Outcomes
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.

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-out as well as (selection):
[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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6211909	Applied Building Physics (p. 177)	2	W	3	E. Kotan, J. Heiß, M. Vogel
6211910	Building Technology (p. 245)	2	W	3	S. Wirth

Learning Control / Examinations
graded:
partial examination Applied Building Physics, oral, 20 min.
partial examination Building Technology, oral, 20 min.
grading:
grade of module is defined by weighted average according credit points of grades of the partial examinations

Conditions
none

Recommendations
none

Learning Outcomes
see German version

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6211814	Practical Noise Control (p. 307)	2	S	3	R. Grigo
6211815	Practical Fire Protection (p. 306)	2	S	3	H. Schröder

Learning Control / Examinations
graded:
partial examination Practical Fire Protection, oral, 20 min.
partial examination Practical Noise Control, oral, 20 min.
grading:
grade of module is defined by weighted average according credit points of grades of the partial examinations

Conditions
none

Recommendations
none

Learning Outcomes
see German version

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6211911	Measuring Techniques in Civil Engineering (p. 287)	1/1	W	3	N. Herrmann
6211913	Materials Testing in the Field of Concrete (p. 282)	2	W	3	N. Herrmann

Learning Control / Examinations
graded:
examination Materials Testing and Measuring Techniques, oral, 30 min.
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
none

Learning Outcomes
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.

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: Finite Elements for Field and Time Dependent Problems [bauiM1S30-FE2]

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6215905	Finite Elements for Field and Time Dependent Problems (p. 238)	2/2	S	6	P. Betsch

Learning Control / Examinations
graded:
examination Finite Elements, oral, 30 min.
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
module Basics of Finite Elements [bauiM1S20-GRUNDFE]

Learning Outcomes
Students will get insight into analysis of general field problems. Also, time integrationfor the solution of structural problems will be discussed in detail to enable the participants to choose the proper algorithms and parameters in applications. The students will also work on program for 2 dim heat transport problems, as well as time integration schemes. In addition, the formulation of mixed elements is introduced.

Content
Field problems -Finite elements for general field problems and heat transport problems, simple fluids quasi-harmonic equation -Heat conduction, elastic torsion of prismatic bars - FE discretisation Time dependent problems -Time integration of semi-discrete equations - first order equations -Simple time integration algorithms: finite elements, collocation, stability of algorithms, accuracy and error -Newmark family of algorithms, generalized algorithms, modifications -Stability, numerical dissipation and dispersion -Judgement of algorithms, numerical examples; modification of parameters Mixed elements elastostatics -Problems in the application of elements with pure displacement approximation, locking problems -Basic concepts of functional analysis, mixed functionals, Hu-Washizu, Hellinger -Reissner functionals, solvability, stability -Discretisation with finite elements, detection of locking effects -Plane stress elements based on Hellinger-Reissner's functional stress approximation, enhanced assumed strain approach (EAS), assumed natural strain approach (ANS) -Outlook on three-dimensional plate- and shell problems

Remarks
Literature:
[1] Zienkiewicz, Taylor: The Finite Element Method, Volume 1,2 & 3, 2000.
[2] Hughes: The Finite Element Method, 1987.
[3] Belytschko, Liu, Moran: Nonlinear Finite Element for Continua and Structures, 2000.
[4] Wriggers: Nichtlineare Finite-Element-Methoden, 2001.

Module: Contact Mechanics II - Dynamics [bauiM1S31-KONTMECH-II]

Coordination: A. Konyukhov
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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6215907	Contact Mechanics II - Dynamics (p. 271)	2/2	W	6	A. Konyukhov

Learning Control / Examinations
graded:
examination Contact Mechanics II, oral, 30 min.
grading:
grade of module is defined by grade of examination

Conditions
module Contact Mechanics I [bauiM1S23-KONTMECH-I]

Recommendations
course Introduction to Continuum Mechanics (0170607),
module Basics of Finite Elements [bauiM1S20-GRUNDFE]

Learning Outcomes

- Understand modern contact algorithms for structures subjected to large deformations and dynamic loading.
- Understand specific FE-issues related to different contact approaches.
- Perform partially own implementation.

Content

- Advanced studies in mathematics necessary to define 3D contact of surfaces
- Differential geometry of surfaces
- Contact kinematics for arbitrary two bodies contact problem.
- Linearization of various parameters in covariant form.
- Variational formulation of contact.
- Regularization of contact conditions in covariant form. Coulomb friction law in covariant form. Kuhn-Tucker conditions for non-frictional and frictional contact.
- Return-mapping algorithm.
- Linearization of a virtual work in covariant form. Sticking and sliding cases. Geometrical interpretation.
- Finite element implementation within the node-to-segment approach.
- Continuous transfer of contact stresses through the contact surface. Non-frictional and frictional patch tests.
- Various approaches to satisfy the patch test: Mortar method and segment-to-segment contact element.
- Dynamic contact problems. Explicit and implicit numerical integration scheme. Stability and tolerance of time integration schemes: selection of a time step.
- Deformable and rigid bodies. Various approaches to satisfy contact conditions: integration of non-holonomic constraints, force method (penalty).
- Fully elastic and plastic impact: different regularizations. Aspects of finite element modeling.
- Momentum and energy conservation properties of the time integration scheme.

Remarks
Literature:
[1] Synge: Tensor calculus
[2] Gerretsen: Lectures on tensor calculus and differential geometry
[3] Johnson: Contact Mechanics
[4] Laurson: Computational Contact and Impact Mechanics
[5] Wriggers: Computational Contact Mechanics

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6215702	Continuum Mechanics (p. 272)	2	W	3	T. Seelig, P. Betsch
6215805	Micromechanics of Heterogeneous Solids (p. 283)	2	S	3	T. Seelig, P. Betsch

Learning Control / Examinations
graded:
examination Continuum Mechanics of Heterogeneous Solids, oral
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
none

Learning Outcomes
see German version

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: Laboratory Course on Structural Vibrations [bauiM1S33-MESSPRAK]

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6215703	Laboratory Course on Structural Vibrations I (p. 285)	2	W	3	T. Seelig, P. Betsch
6215806	Laboratory Course on Structural Vibrations II (p. 286)	2	S	3	T. Seelig, P. Betsch

Learning Control / Examinations
graded:
examination Laboratory Course on Structural Vibrations, oral
grading:
grade of module is defined by grade of examination

Conditions
course Dynamics of Structures (6215701)

Recommendations
none

Learning Outcomes
PART I - BASICS: The knowledge acquired in the lectures "Structural Dynamics" and "Dynamics" will be applied to real practical structures. Theoretical computations and experimentally gained results will be compared and interpreted. More complicated phenomena of theory, e.g. natural modes, anti-resonance etc., will be visualised. Students will carry out experiments, if possible, by themselves.
PART II - TIME DOMAIN AND MODAL ANALYSIS, PARAMETER IDENTIFICATION: The goal is the consideration and experimental investigation of vibrational behavior of lab structures by modal analysis. In addition, the estimation of structural parameters as resonance frequencies and modal damping is discussed and shown by experiments. All lab tests will be performed on lab examples showing similar properties as real-world civil structures.

Content
PART I - BASICS: Measuring of the dynamics behaviour of small-scale structure models (linear, discrete single- and multiple degree-of-freedom systems) in the laboratory and of real structures on site. Information about sensors, i.e. internal design, function limits as well as about electronic conditioning and processing of the signals is given within the course. Strains, forces, moments, displacements, velocities and accelerations will be measured. Different kinds of excitation, e.g. by a ground-motion, unbalances or hammer are considered. Furthermore the required measuring devices, their properties and limits will be presented.
PART II - TIME DOMAIN AND MODAL ANALYSIS, PARAMETER IDENTIFICATION: -Time Domain Analysis (Sampling Theory, Transformations, etc.) - Modal Anlysis (Exitation, Mass Load Effects) - Parameter Estimation

Remarks
Literature:
[1] Haug, A.: Elektronisches Messen mechanischer Größen, Hauser, 1969
[2] Müller, R. et al.: Mechanische Größen elektrisch gemessen, Expert Verlag, 1984
[3] Heymann, J. (Hrsg.): Messverfahren der experimentellen Mechanik, Springer, 1986

Module: Model Formulation in Strength of Materials and Theory of Kinetic Stability for Structures [bauiM1S34-MOFEKIST]

Coordination: P. Betsch
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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6215807	Model Formulation in Strength of Materials (p. 289)	2	S	3	P. Betsch, T. Seelig
6215910	Theory of Kinetic Stability for Structures (p. 269)	2	W	3	P. Betsch, T. Seelig

Learning Control / Examinations
graded:
examination Model Formulation in Strength of Materials and Theory of Kinetic Stability for Structures, oral
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
none

Learning Outcomes
MODELING TECHNIQUES IN STRENGTH OF MATERIALS: Mechanical Models of Strength of Materials (beams, plates or a shells) are based on special kinematics of the cross-section during deformation. In such a way the general continuum-mechanical problem can be considerably reduced from partial boundary value problems to ordinary ones. On the other hand, as a result of this simplification, all the models have limitations, concerning their range of application. The limits of the customary models in the Strength of Materials will be revealed and the transitions between different models will be discussed.
THEORY OF KINETIC STABILITY OF STRUCTURES: A mathematical based theory of stability of equilibrium is presented based on the two methods of Liapunov.

Content
MODELING TECHNIQUES IN STRENGTH OF MATERIALS: Mathematic tools -Regular perturbation techniques -Singular perturbation techniques One-dimensional continuum -Plane elastica (linear and non-linear theories) -Stress concentration due to shear deformation -Elastic foundation theories -Areas and cables -Local bending effects in cables -Spatial elastica Two-dimensional continuum -Stress and deformation concentration in different plate theories -Corner singularity as boundary layer problem -Non-linear plate theory (Membrane influence) -Non-linear theory of slightly curved shells
THEORY OF KINETIC STABILITY OF STRUCTURES: Definition of stability by Lyapunov -Demonstrative definition of stability -Lyapunov's definition of stability -Asymptotic stability First Method -Imperfection and disturbed bifurcation -Method of small vibrations -Imperfection sensitivity of symmetric, non-symmetric and oblique bifurcation -Stability degree and practical instability -Unilateral constraints -Alternating constraints -Direction dependent force laws -Bifurcation from the non-trivial state -Interaction Second Method -Energy integral -Principle of minimum of potential energy -Inner and outer potential (examples) -Analogy to the motion of a sphere -Zero natural values -Non-linear constraints -Sensitivity of equilibrium states -Local and global instability -Transition from stress problems to stability problems

Remarks
Literature:
[1] Timoshenko, S., Goodier, J.: Theory of Elasticity, McGraw-Hill, 1951
[2] Reismann, H., Pawlik, P.: Elasticity: theory and applications, Wiley, 1980
[3] Hahn, W.: Stability of Motion, Springer, 1967

4.2 Modules Study Focus 2: Water and Environment

Module: Advanced Fluid Mechanics [bauiM2P1-AFM]

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6221701	Advanced Fluid Mechanics (p. 242)	2	W	3	N. N.
6221702	Numerical Fluid Mechanics I (p. 300)	1/1	W	3	M. Uhlmann

Learning Control / Examinations
graded:
partial examination Advanced Fluid Mechanics, written
partial examination Numerical Fluid Mechanics I, written
grading:
grade of module is defined by weighted average according credit points of grades of the partial examinations

Conditions
none

Recommendations
Hydromechanics, Numerical treatment of partial differential equations

Learning Outcomes
Theoretical background for a quantitative description of fluid flow phenomena in technical systems and the environment. Introduction to the numerical computation of fluid flow problems; techniques for the analysis of numerical methods applicable to the fundamental flow equations; design of solution strategies; practical realization of the algorithms through independent programming exercises.

Content
Advanced Fluid Mechanics:

- Budgets and flow equations
- vortex dynamics
- gravity waves
- mixing
- heat transfer
- buoyancy
- flow stability

Numerical Fluid Mechanics I:

- General introduction to CFD, Conservation laws, Mathematical properties of the equations,
- Fundamentals of numerical discretization: finite-differences, Finite-volume method
- Numerical stability & error analysis
- Temporal integration
- Solution of algebraic systems of equations

Remarks
Literature:
P.Kundu & I.Cohen, "Fluid Mechanics", Academic Press, 2010
C. Hirsch, "Numerical computation of internal and external flows", Butterworth-Heinemann, 2nd edition; 2007
C.A.J. Fletcher, "Computational techniques for fluid dynamics"; 2nd edition, 1991

R.J. LeVeque, “Finite difference methods for ordinary and partial differential equations” Society for Industrial and Applied Mathematics, 2007
R.J. LeVeque “Finite volume methods for hyperbolic problems” Cambridge Univ. Press, 2002
W.H. Press et al. “Numerical recipes in Fortran/C/C++” Cambridge U. Press, second edition, 1986
P.J. Tritton, “Physical fluid dynamics”, 2 ed., Claredon Press, Oxford, 1992

Module: Dynamics of Water and Mass Transport in River Basins [bauiM2P2-WSF]

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6222701	Multi-Phase Flow (p. 284)	2	W	3	F. Nestmann
6224701	Terrestrial Water Flows and Mass Transport (p. 374)	2	W	3	E. Zehe

Learning Control / Examinations
graded:
partial examination Multi-Phase Flow, written
partial examination Terrestrial Water Flows and Mass Transport, written
grading:
grade of module is defined by weighted average according credit points of grades of the partial examinations

Conditions
none

Recommendations
none

Learning Outcomes
Students gain in-depth knowledge of the processes of water and solute transport in rivers and river basins, and they gain the basis for water quality modelling. The focus is on current and future challenges in terrestrial ecosystems, such as water and groundwater protection, water quality predictions, and the risk management of extremes in times of global change. Students know the physical principles of soil water movement and evaporation in catchments. They can assess the impact of important control variables and are familiar with the advection-dispersion solute transport theory. They understand the relationships and interactions between hydraulic and morphological phenomena in rivers and water bodies, and they can apply the related concepts and modelling approaches. In addition, they learn about phenomena associated with water-air mixtures and they can take this into account in the technical design of hydraulic structures.

Content
Multi-Phase Flow:

- Basics of River-Morphodynamics: classification, bedload and suspendedload
- Interaction between solids and flow: Methods of modelling and calculation of bedload rates
- Suspendedload: diffusion theory of Schmidt
- Bed forms: structure, flow resistance, methods of modelling
- Water-Air-mixtures: Basics, characteristics, technical applications

Terrestrial Water Flows and Mass Transport:

- Water dynamics in the unsaturated and saturated zone: Richards equation, soil hydraulic functions
- Infiltration in natural soils
- Energy balance
- Evaporation and evapotranspiration regime, approaches to quantify evaporation
- Biotic and abiotic interactions
- Advection, dispersion, advective-dispersive transport and analytical solutions
- Process-based and conceptual models

Remarks
Literature:
Plate, E. J.,Zehe, E. (2008): Hydrologie und Stoffdynamik kleiner Einzugsgebiete. Prozesse und Modelle, Schweizerbart, Stuttgart, 2008.

Module: Mass Fluxes and Cycles [bauiM2P3-STK]

Coordination: J. Winter
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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6223701	Mass Fluxes (p. 343)	2	W	3	S. Fuchs
6225701	Bioprocess Engineering (p. 207)	2	W	3	J. Winter

Learning Control / Examinations
graded:
partial examination Mass Fluxes, written
partial examination Bioprocess Engineering, written
grading:
grade of module is defined by weighted average according credit points of grades of the partial examinations

Conditions
none

Recommendations
none

Learning Outcomes
Students gain in depth understanding of mass fluxes in natural and technical systems. They will be able to recognize needs for the management and to derive efficient measures / technologies. Beyond the given physical and physic-chemical options the performance of microbial metabolic processes for waste, waste water and contaminated air will be discussed.

Content
Mass Fluxes:

- introduction to basics of balancing and system analysis: definitions, separation of systems
- balance equations as basic tool for system description
- introduction to ideal reactors
- mathematical models for description of complex processes
- examples

Bioprocess Engineering:

- fundamentals of bacterial metabolism: energy yield and growth
- biological reactions of nitrogen and phosphorous removal
- utilization in technical processes.

Remarks
Literature:
Wastewater Treatment. M. Henze, P. Harremoes, J. la Cour Jansen, E. Arvin, Springer Verlag, Heidelberg, 1997
Wastewater Engineering, Treatment and Reuse.Metcalf & Eddy, McGraw-Hill, 2003
Imboden, D. & Koch, S. (2003): Systemanalyse – Einführung in die mathematische Modellierung natürlicher Systeme. 2. Auflage, Springer-Verlag.
Bossel, H. (1994): Modellbildung und Simulation – Konzepte, Verfahren und Modelle zum Verhalten dynamische Systeme. 2. Auflage, Vieweg Verlag.
Richtlinie 2008/105/EG des Europäischen Parlaments und des Rates vom 16. Dezember 2008 über Umweltqualitätsnormen im Bereich der Wasserpolitik

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6224801	Water Resources and River Basin Management (p. 377)	2/2	S	6	U. Ehret, J. Ihringer

Learning Control / Examinations
graded:
examination Water Resources and River Basin Management, take home exam and colloquium
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
Module “Water resources management and engineering hydrology” (6th semester BSc Civil Engineering)

Learning Outcomes
Students can independently apply the state of the art application-specific methods and tools for river basin management. They have extensive knowledge of hydrological processes and possess expertise on the use of water balance models. By setting up their own hydrological model the students got to know the basic data needs of hydrological models, its potential applications and they can assess the reliability of the model results.

Content

- Water balance modelling: Operation, process description and applications of conceptual hydrological models used in a water management practice model (LARSIM).
- Building an own hydrological model (necessary basic data, model parameters and adjustment, calibration strategies)
- High water, and low water predictions
- Sensitivity analysis of model parameters
- Visualization and analysis of results
- Performance measures for validation of model results and uncertainty ranges
- Selected problems of water management: Water resources management principles and design of water management systems (design and management of dams)
- Regionalization of hydrological parameters and runoff characteristics

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: 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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6224901	Thermodynamics in Environmental Systems (p. 349)	2/2	W	6	E. Zehe, U. Ehret

Learning Control / Examinations
graded:
examinatoin Thermodynamics in Environmental Systems, take home exam and colloquium
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
none

Learning Outcomes
Students will become familiar with the basics of environmental systems theory and thermodynamics. They will get to know the global components of global energy and entropy flows as well as the main global mass cycles (using the example of the water cycle) and will learn how to quantify them. Based on the principles of thermodynamics students will gain insight in the mechanics of formation and conservation of complex structures, as for example of ecosystems.

Content

- Fundamentals of environmental systems theory: System states and characteristics; fundamental processes in environmental systems (diffusion, advection, advection-dispersion) and types of differential partial equations to represent these processes
- Fundamentals of thermodynamics: 1.+2. principle of thermodynamics; thermodynamic gradients; ideal gas equation
- Thermodynamics in Environmental systems: thermodynamics both, near and far from the thermodynamic equilibrium; the earth as open, hierarchical, thermodynamic system far from the des thermodynamic equilibrium; formation and conservation of structures, evolution and irreversibility in environmental systems in the light of thermodynamics; the water cycle as a closed mass cycle in the light of thermodynamics - Mass and energy flows in the atmosphere - Mass and energy flows in the soil-vegetation-water-system; optimality and self-organization principles in environmental systems - Maximizing power - Maximizing entropy production - Minimizing the time to achieve equilibrium states

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6224803	Dynamics of Water and Mass Transport in Watersheds (p. 373)	2/2	S	6	E. Zehe, J. Wienhöfer

Learning Control / Examinations
graded:
examination Dynamics of Water and Mass Transport in Watersheds, take home exam and colloquium
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

Learning Outcomes
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.

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
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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6224805	Data Analysis and Environmental Monitoring (p. 215)	2/2	S	6	E. Zehe

Learning Control / Examinations
graded:
examination Data Analysis and Environmental Monitoring, take home exam and colloquium
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
Basic knowledge of statistics, take course “experimental hydrology and process monitoring in natural systems” in parallel

Learning Outcomes
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.

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
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: 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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6224807	Hydrology Field Exercise and Literature Seminar (p. 265)	0/4	S	6	J. Wienhöfer, U. Ehret

Learning Control / Examinations
graded:
examination Experimental Hydrology and Process Monitoring in Environmental Systems, take home exam and colloquium
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
none

Learning Outcomes
Students will gain in-depth knowledge of the water cycle and understand watersheds as integral phenomenon of morphological processes shaping the landscape. They are familiar with measuring principles and can independently handle measuring instruments for the monitoring of state variables and water fluxes at various scales (soil column, plot scale, hillslope scale, watershed scale). They will gain fundamental understanding of the problems associated with field measurements and will be able to estimate measurement errors as well as to evaluate field data using statistic methods.

Content
Literature Seminar and Tutorial:

- literature on experimental designs in the field, scaling and measurement uncertainties plausibility check and correction of measurement data Hydrologic

field course in an alpine catchment (Ebnit, Vorarlberg):

- introduction to the geology, geomorphology and pedology of the catchment
- characterisation of soil profiles
- monitoring of hydrologic state variables in the soil (soil moisture, hydraulic conductivity, soil temperature)
- infiltration and tracer experiments
- ground water levels
- monitoring of discharge using various methods
- meteorology

Remarks
Literature: Script avaible, 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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6224903	Aquatic Ecosystems (p. 249)	2/2	W	6	C. Kämpf

Learning Control / Examinations
graded:
examination Aquatic Ecosystems, study paper, critical literature review, introductory note
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
none

Learning Outcomes
To familiarize students with

- ecological theory
- microbial ecology
- chemical cycles
- renaturation strategies

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6224905	Environmental Communication (p. 359)	2/2	W	6	C. Kämpf

Learning Control / Examinations
graded:
examination Environmental Communication, study paper, group-edit, introductory note
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
none

Learning Outcomes
Knowledge: students will know various communication concepts, procedural steps, and actors of effective communication for appropriate social action in environmental protection and nature conservation. Skills: students choose relevant modes of communication for scientific research and project management respectively. Competence: students will act appropriatetly within transdisciplinary contexts such as in risk communication for flood protection.

Content

- Inter- and transdisciplinarity within the complex society-technology-ecosystems in academic research and in public relations
- various forms of knowledge; theories of decision making;
- various document types: proposals, reports, studies, visualization, online information;
- risk communication for flood protection; environmental information law (UIG)
- text production

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6221801	Groundwater Management (p. 259)	2	S	3	U. Mohrlok
6221901	Numerical Groundwater Modelling (p. 298)	1/1	W	3	U. Mohrlok

Learning Control / Examinations
graded:
partial exam Groundwater Management, oral
project report Numerical Groundwater Modelling with presentation
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

Learning Outcomes
Groundwater Management:
Participants receive the basic knowledge and definitions in hydrogeology, investigation methods for quantitative analysis of flow and transport processes in the subsurface. The application of assessment and management tools are discussed by means of examples such as irrigation, groundwater remediation and salt water intrusion.
Numerical Groundwater Modelling:
Participants receive an introduction to the application of numerical modelling of flow and transport processes in groundwater. They are capable of applying these models to simple examples of groundwater management by means of a project work.

Content
Groundwater Management:
Basics for the characterization of the development of groundwater quantity and quality are introduced. Particularly, the interaction of flow and transport processes in the heterogeneous subsurface environment as well as the reliability and uncertainty in measured data are discussed.
Numerical Groundwater Modelling:
The approximate description of numerical models is considered. The accuracy and reliability of numerical results are discussed.

Remarks
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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6222901	Studies of Development Projects in Water Resources Management (p. 379)	2/2	W	6	F. Nestmann

Learning Control / Examinations
graded:
examanition Studies of Development Projects in Water Resources Management, oral, 20 min.
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
none

Learning Outcomes
Students gain insight into planning and operation / maintenance of national and international research & development projects in the field of water resources management.

Content
University members and external lecturers will provide insight into actual projects. An excursion shall allow the students to gain an authetic impression about the procedural steps of a real water management project.

Remarks
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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6222903	Practical Use of Numerical Methods in Fluid Mechanics (p. 288)	2/2	W	6	P. Oberle, M. Musall

Learning Control / Examinations
graded:
examination Practical Use of Numerical Methods in Fluid Mechanics, written, 40 min.
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

Learning Outcomes
Knowledge: Student shall gain a solid understanding of the method applied. Skills: students will be firm handling numerical models developed for the simulation of flow.

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
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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6222801	Hydro Power Engineering (p. 222)	3/1	S	6	P. Oberle

Learning Control / Examinations
graded:
examniation Hydro Power Engineering, oral
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
Hydraulic Engineering and Water Management I

Learning Outcomes
Knowledge: students shall gain a practice-oriented basic understanding of the planning, operation and maintenance of hydropower plants. Competence: students will view the current political and legal framework as major context factor.

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6222803	Waterway Engineering (p. 369)	2/2	S	6	A. Kron

Learning Control / Examinations
graded:
examination Waterway Engineering, oral, 20 min.
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
Hydraulic Engineering and Water Management I

Learning Outcomes
Students are knowledgeable about the various types of navigable waterways and their hydraulic structures. Skills: They know the hydraulic basics for the design of these hydraulic structures and the interaction of ship and waterway Competence: students will consider the administrative structure of the waterways and shipping authorities in navigation projects.

Content

- inland waterways
- navigation locks
- ship lifts
- interaction ship-waterway

Remarks
Literature: course 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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6222805	Morphodynamics (p. 291)	1/1	S	3	F. Seidel
6222807	Flow Behavior (p. 347)	1/1	S	3	F. Seidel

Learning Control / Examinations
graded:
examination River Dynamics, oral
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
module Dynamics of Water and Mass Transport in River Basins

Learning Outcomes
Knowledge: Student shall gain a solid understanding of the method applied.

Content
The modul reports the interaction effects between flow-structures, flow-resistance and river-morphodynamics.

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6221802	Experimental Methods (p. 230)	1/2	S	4,5	C. Lang
6220901	Hydraulic Engineering Project (p. 376)	0/1	W	1,5	C. Lang, F. Seidel

Learning Control / Examinations
graded:
partial examination Experimental Methods, oral, 40 min.
partial examination Hydraulic Engineering Project, test protocoll and report
attested:
test protocol and report as prerequisite for partial examination Experimental Methods
grading:
grade of module is defined by weighted average according credit points of grades of the partial examinations

Conditions
none

Recommendations
courses Hydromechanics (0170304), Hydraulic Modelling Methods (0170609)

Learning Outcomes
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.

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
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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6221903	Interaction Flow - Building Structure (p. 380)	1/1	W	3	C. Lang
6221905	Building and Environmental Aerodynamics (p. 243)	1/1	W	3	B. Ruck

Learning Control / Examinations
graded:
partial examination Interaction Flow - Building Structure, oral, 30 min.
partial examination Building- and Environmental Aerodynamics, oral, 30 min.
grading:
grade of module is defined by weighted average according credit points of grades of the partial examinations

Conditions
none

Recommendations
course Hydromechanics (0170304),
modules Advanced Fluid Mechanics (bauiM2P1-AFM), Technical Hydraulics (bauiM2S17-SM3)

Learning Outcomes
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.

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6221804	Steady and Unsteady-state Operation of Hydraulic Systems (p. 342)	2/2	S	6	C. Lang

Learning Control / Examinations
graded:
examination Technical Hydraulics, oral, 40 min.
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
course Hydromechanics (0170304),
module Advanced Fluid Mechanics (bauiM2P1-AFM)

Learning Outcomes
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

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6221703	Flow Measuring Technique (p. 346)	1/1	W	3	B. Ruck
6221812	Signal Processing in Fluid Mechanics (p. 326)	1/1	S	3	B. Ruck

Learning Control / Examinations
graded:
partial examination Flow Measuring Technique, oral , 30 min.
partial examination Signal Processing in Fluid Mechanics, oral , 30 min.
grading:
grade of module is defined by weighted average according credit points of grades of the partial examinations

Conditions
none

Recommendations
none

Learning Outcomes
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.

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: N. N.
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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6221907	Environmental Fluid Mechanics (p. 224)	2/2	W	6	N. N.

Learning Control / Examinations
graded:
examination Environmental Fluid Mechanics, oral, 30 min.
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
core module Advanced Fluid Mechanics [bauiM2P1-AFM]

Learning Outcomes
The students gain understanding of physical processes that define mass transport (e.g. pollutants), energy transport (e.g. cooling water), and momentum transport (e.g. flows and waves) in surface water and atmosphere. They learn about method for quantifying these processes.

Content

- Mixing and transport processes in turbulent and stratified flows
- exchange processes at interfaces
- flows and transport processes in estuaries, lakes, rivers and canals
- atmospheric flows
- experimental and numerical methods
- application examples for contaminant transport
- mixing processes in reservoirs and lakes
- density driven flows
- inflows into water bodies

Remarks
This module can be taken as from WS 2014/15.
Literature:
Acheson, D.J. (1990), Elementary Fluid Dynamics, Oxford Applied Mathematics and Computing Science Series, Clarendon Press, Oxford, England.
Batchelor, G.K. (1967), An Introduction to Fluid Dynamics, Cambridge University Press, Cambridge, England.
Turner, J.S. (1973), Buoyancy Effects in Fluids, Cambridge University Press, Cambridge, England.
Csanady, G.T. (1973), Turbulent Diffusion in the Environment, D. Reidel Publishing Comany, Dordrecht, Holland.
Fischer, H.B., List, E.G., Koh, R.C.Y., Imberger, J. & Brooks, N.H. (1979), Mixing in Inland and Coastal Waters, Academic Press, New York, NY.
Kundu, P.K. & Cohen, I.M. (2002), Fluid Mechanics, 2nd Edition, Academic Press, San Diego, CA.
Mei, C.C. (1997), Mathematical Analysis in Engineering, Cambridge University Press, Cambridge, England.
Rutherford, J.C. (1994), River Mixing, John Wiley & Sons, Chichester, England.
van Dyke, M. (1982), An Album of Fluid Motion, The Parabolic Press, Stanford, California.
Wetzel, R.G. (1983), Limnology, Saunders Press, Philadelphia, PA.

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6221806	Fluid Mechanics of Turbulent Flows (p. 241)	2	S	3	M. Uhlmann
6221913	Modelling of Turbulent Flows - RANS and LES (p. 355)	2	W	3	M. Uhlmann

Learning Control / Examinations
graded:
partial examination Fluid Mechanics of Turbulent Flows, oral, 30 min.
partial examination Modelling of Turbulent Flows, oral, 30 min.
grading:
grade of module is defined by weighted average according credit points of grades of the partial examinations

Conditions
none

Recommendations
courses Hydromechanics (0170304), Mathematics (0131900, 0181300, 0132200)

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

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
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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6221807	Parallel Programming Techniques for Engineering Problems (p. 302)	1/1	S	3	M. Uhlmann
6221809	Numerical Fluid Mechanics II (p. 301)	1/1	S	3	M. Uhlmann

Learning Control / Examinations
graded:
partial examination Parallel Programming Techniques, written, 60min.
partial examination Numerical Fluid Mechanics II, oral, 30 min.
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]

Recommendations
Numerical treatment of partial differential equations, programming skills

Learning Outcomes
Parallel programming techniques:

- to acquire the basic knowledge about parallel computing possibilities and its limitations
- to enable the student to analyze a given problem from CFD (and beyond) and assess the potential for an efficient solution using parallel computing techniques
- to transmit the scope, syntax and practical application of the message passing paradigm using the standard "MPI"

Numerical Fluid Mechanics II:

- advanced skills in numerical simulation of fluid flow problems
- realisation of computations based upon the Navier-Stokes equations
- analysis, design and implementation of algorithms
- introduction to a program package for the simulation of complex fluid flow

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: Wastewater Analyses in Practice [bauiM2S22-IB1]

Coordination: J. Winter
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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6225801	Wastewater Analyses and Application (p. 304)	4	S	6	J. Winter, M. Bajaj

Learning Control / Examinations
graded:
examination Wastewater Analyses, report
grading:
grade of module is defined by grade of examination

Conditions
registration to module Mass Fluxes and Cycles [bauiM2P3-STK]

Recommendations
none

Learning Outcomes
Practical experience in analytical methods for determing sum parameters in wastewater treatment plants and comparison of different analytical methods (standard methods and rapid tests)

Content

- Analysis of sum parameters (COD, DOC, TKN, NH4+, NO3-, PO43-, heavy metals)
- toxicity test
- methane production
- potential of single treatement processes in a wastewater treatment plant
- comparison of different analytical methods (standard methods and test kits).

Remarks
Literature: Script of the Institute

Module: Technologies for Solid Waste Management [bauiM2S23-IB2]

Coordination: J. Winter
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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6225802	Processing of Wastes with Excursions (p. 362)	2/2	S	6	J. Winter

Learning Control / Examinations
graded:
examination Technologies for Solid Waste Management, oral
attested:
oral presentation as examination prerequisite
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
none

Learning Outcomes
Legal requirements and different technologies of solid waste management in Germany and Europe. The theoretical background will be supplemented with field trips.

Content
Technical processes of solid waste treatment and recycling of renewables (landfill, composting, digestion, MBT, incineration)
Field trips to different waste treatment plants in Karlsruhe and nearby cities

Remarks
Literature:
Abfallwirtschaft B. Bilitewski, G. Härdtle, K. Marek Springer-Verlag, Heidelberg, 1993
Abfallwirtschaft, Abfalltechnik O. Tabasaran Ernst & Sohn Verlag Berlin, 1994
Mechanische und biologische Verfahren der Abfallbehandlung ATV-Handbuch Ernst & Sohn Verlag Berlin, 2002
Biologische Abfallverwertung W. Bidlingmaier Eugen Ulmer GmbH, Stuttgart, 2000

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6223801	Process Technologies in Storm Water Treatment (p. 364)	1/1	S	3	S. Fuchs, E. Hoffmann
6223803	Process Technologies in Water Supply and Wastewater Disposal (p. 365)	1/1	S	3	E. Hoffmann

Learning Control / Examinations
graded:
partial examination Process Technologies in Storm Water Treatment, homework and presentation
partial examination Process Technologies in Water Supply and Wastewater Disposal, oral
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 (0170603) is recommended.

Learning Outcomes
Based on the lecture Sanitary Environmental Engineering the studends will get to know in detail about different plants for waste water and sorm water treatment by means of field trips. The functioning of single plant components are discussed and design principles are explained.

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6220902	Urban Water Management (p. 361)	2/2	W	6	S. Fuchs, P. Klingel, U. Mohrlok

Learning Control / Examinations
graded:
examination Urban Water Management, oral
attested:
report as examination prerequisite
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
course Sanitary Environmental Engineering (0170603),
modules Technical Hydraulics [bauiM2S17-SM3], Water Treatment Technologies [bauiM2S24-SW1]

Learning Outcomes
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.

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
Literature: lecture accompanying documents

Module: Water Quality of Surface Water Bodies 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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6223805	Surface Water Quality (p. 240)	1/2	S	4,5	S. Fuchs
6221811	Groundwater Quality (p. 258)	1/0	S	1,5	U. Mohrlok

Learning Control / Examinations
graded:
examination Water Quality of Surface Water Bodies and Groundwater, term paper and report on field excercise
grading:
grade of module is defined by grade of examination

Conditions
keine

Recommendations
The attendance of the courses Sanitary Environmental Engineering (0170603) and Groundwater Management (6221801) is recommended.

Learning Outcomes
Students will learn the theoretical background of surface and groundwater evaluation. They will further learn the priciples of physical, chemical and ecological analysis. Considering almost undisturbed and deteriorated systems they will practice their knowledges in a field course.

Content
surface waters:

- oxygen household
- sediment/water interactions
- biological water quality
- hydromorphological quality

groundwater:

- sampling methods
- measurement of pysical and chemical paramters
- data analysis

Remarks
Literature:
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: Applied Ecology [bauiM2S27-SW4]

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6223807	Principles of Applied Ecology (p. 219)	2	S	3	S. Fuchs
6223901	Seminar: Ecological Management of Water Bodies (p. 322)	2	W	3	S. Fuchs

Learning Control / Examinations
graded:
partial examination Principles of Applied Ecology, oral
partial examination Ecological Management of Water Bodies, presentation
grading:
grade of module is defined by weighted average according credit points of grades of the partial examinations

Conditions
none

Recommendations
none

Learning Outcomes
Based on case studies students will gain knowledge about the relevance and realisation of measures related to ecological theories and principles. Requirements and limitation will be derived having a closer look on several projects. The knowledge will be deepend by student's presentations in the course of the subsequent seminar.

Content
Ecological principles will be studied and appropriated measures will be discussed

Remarks
Literature:
Limnology, 3rd Edition, Wetzel, Academic Press 2001, kursbegleitende Materialien

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6223808	Water Treatment (p. 375)	1/1	S	3	E. Hoffmann
6222905	Water Distribution (p. 378)	1/1	W	3	P. Klingel

Learning Control / Examinations
graded:
partial examination Water Treatment, oral
partial examination Water Distribution, presentation and report
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 (0170603)

Learning Outcomes
Knowledge in operation and optimization of water distribution drainage and treatment systems

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
Literature: Fachbücher, Fachartikel, Schrifttum zur Vorlesung

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6223810	Cleaner Production – Closing the Loop (p. 276)	1/1	S	3	E. Hoffmann
6223902	Appropriated Technologies (p. 176)	1/1	W	3	E. Hoffmann

Learning Control / Examinations
graded:
examination Industrial Water Management, oral
attested:
report on lab work as examination prerequisite
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
course Sanitary Environmental Engineering (0170603)

Learning Outcomes
Students will gain knowledge in industrial production processes, emissons and evaluation of waste water compounds. In addition on legal requirements they will learn appropriated methods for emission reduction and substance recycling.

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: vorlesungsbegleitende Materialien

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6223812	Mass Fluxes in River Basins (p. 344)	2/0	S	3	S. Fuchs
6223904	Modelling Mass Fluxes in River Basins (p. 290)	0/2	W	3	S. Fuchs

Learning Control / Examinations
graded:
partial examination Mass Fluxes in River Basins, oral
partial examination Modelling Mass Fluxes in River Basins, report
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 (0170603)

Learning Outcomes
Students will gain knowledge in water driven massfluxes and the alteration of those by human activities. A model for quantifying the emissions into surface waters will be introduced. In practical excercises the student will develop model apadtion and scenarios.

Content
The module will present system theories, modeling tools and management strategies

Remarks
Literature: Modellwerkzeuge, vorlesungsbegleitende aktuelle Literatur

4.3 Modules Study Focus 3: Mobility and Infrastructure

Module: Urban and Regional Planning [bauiM3P1-PLSTAREG]

Coordination: W. Jung
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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6231701	Urban Planning (p. 336)	1/1	W	3	W. Jung
6231703	Regional Planning (p. 319)	2	W	3	W. Jung

Learning Control / Examinations
graded:
examination Urban and Regional Planning, oral
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
module Mobility and Infrastructure [bauiBFP5-MOBIN]

Learning Outcomes
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.

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: Literaturliste zum Modul

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6232701	Methods and Models in Transportation Planning (p. 198)	1/1	W	3	P. Vortisch, M. Kagerbauer
6232703	Traffic Engineering (p. 345)	1/1	W	3	P. Vortisch

Learning Control / Examinations
graded:
examination Models and Methods in Traffic Engineering and Transportation Planning, oral
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
none

Learning Outcomes
Knowledge about methods and approaches in transport planning and traffic engineering

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: Skriptum mit weiterführenden Literaturangaben / Übungsblätter

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6233801	Design and Construction of Highways (p. 223)	1/1	S	3	R. Roos
6233802	Operation and Maintenance of Highways (p. 203)	2	S	3	R. Roos

Learning Control / Examinations
graded:
examination Infrastructure Management, oral
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
none

Learning Outcomes
Main goal is the gain of methods in further tasks of highway design and road construction and leraning the steps of practical design of a real road

Content
The course is about junction layouts of roads and testing of highway designs as well as road construction materials and road construction types in theory and a practical design.

Remarks
Literature:

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6234701	Track Guided Transport Systems - Technical Design and Components (p. 333)	3/1	W	6	E. Hohnecker

Learning Control / Examinations
graded:
examination Track Guided Transport Systems - Technical Design & Components, written, 90 min.
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
none

Learning Outcomes
to know the complexity of the profession “track guided systems”

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6233803	Laws concerning Traffic and Roads (p. 367)	2/0	S	3	D. Hönig
6233804	Environmental Impact Assessment (p. 360)	1	S	1,5	R. Roos
6232801	Assessment and Evaluation Techniques (p. 206)	1/0	S	1,5	P. Vortisch, B. Chlond

Learning Control / Examinations
graded:
partial examination Verkehrs-, Planungs- und Wegerecht, oral
partial examination Umweltverträglichkeitsprüfung, oral
partial examination Bewertungs- und Entscheidungsverfahren, oral
grading:
grade of module is defined by weighted average according credit points of grades of the partial examinations

Conditions
none

Recommendations
none

Learning Outcomes
Understanding of the laws concerning construction and operating of roads, gaining of basic knowledge concerning the environmental impact of roads and financing in public privat partnership Basic knowledge about the assessment and evaluation techniques for the planning of infrastructure projects

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

Remarks
Literature:

Module: Urban Renewal [bauiM3S01-PLSTUMB]

Coordination: W. Jung
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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6231801	Urban Management (p. 335)	1/1	S	3	W. Jung
6231803	History of Urban Planning and the Built Environment (p. 337)	1	S	1,5	J. Vogt
6231804	Building Theory (p. 244)	1	S	1,5	Everts

Learning Control / Examinations
graded:
examination Urban Renewal, oral
grading:
grade of module is defined by grade of examination

Conditions
registration to core module Urban and Regional Planning [bauiM3P1-PLSTAREG]

Recommendations
none

Learning Outcomes
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.

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: Literaturliste zum Modul

Module: Space and Infrastructure [bauiM3S02-PLRAUMINF]

Coordination: W. Jung
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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6231805	Logistics, Supply and Disposal (p. 229)	1/1	S	3	M. Jehling
6231807	Planning Techniques and Planning Methods (p. 303)	1/1	S	3	S. Keller

Learning Control / Examinations
graded:
examination Space and Infrastructure, oral
grading:
grade of module is defined by grade of examination

Conditions
registration to core module Urban and Regional Planning [bauiM3P1-PLSTAREG]

Recommendations
none

Learning Outcomes
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.

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

Planning Techniques and Methods:

- foundations of information and communication theory
- spatial information on the Internet
- project presentation
- planning information systems
- technical information systems
- cartographic principles

Remarks
Literature:
Literaturliste zum Modul

Module: Traffic Management und 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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6232802	Traffic Management and Transport Telematics (p. 368)	1/1	S	3	P. Vortisch
6232804	Traffic Flow Simulation (p. 327)	1/1	S	3	P. Vortisch

Learning Control / Examinations
graded:
examination Traffic Management und Simulation Methods, oral
grading:
grade of module is defined by grade of examination

Conditions
registration to core module Model Approaches and Methodologies in transportation [bauiM3P2-VERMODELL]

Recommendations
none

Learning Outcomes
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.

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: Skripten, Richtlinienwerke (Handbuch zur Bemessung von Straßen, Richtlinien für Lichtsignalanlagen), Software-Handbücher

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6232806	Characteristics of Transportation Systems (p. 218)	2/0	S	3	P. Vortisch
6232807	Tendering, Planning and Financing in Public Transport (p. 381)	2/0	S	3	W. Weißkopf

Learning Control / Examinations
graded:
examination Planning of Transportation Systems, oral
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
none

Learning Outcomes
Understanding the complexity of the transport field in its disciplinarity between engineering science, politics, society, economy. Acquisition of the relevant knowledge and the methodologies for the evaluation of projects and measures. The module is rather transport planning than traffic engineering oriented.

Content
The module deals with the fundamentals which are necessary to understand the travel demand process and for the evaluation of measures. Furthermore knowledge will be presented, which is necessary to develop measures for influencing travel behaviour and the analyses of their efficiency. External effects of transportation and traffic. The emphasis in the second part is in Public Transport: Here the specific and systemic characteristics of Public Transport modes and their particularities in planning and operation will be considered.

Remarks
Literature: Skripten und Vorlesungsumdrucke stehen zum Download zur Verfügung.

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6233901	IT-based Road Design (p. 217)	1/1	W	3	M. Zimmermann
6233903	Highway Design Project Study (p. 312)	2	W	3	M. Zimmermann, R. Roos

Learning Control / Examinations
graded:
examination Highway Design, oral
attested:
attestation of project design of a rural road
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
preliminary attendance of core module Infrastructure Management [bauiM3P3-STRINFRA]

Learning Outcomes
Gaining the basics of practical working with the elements of highway design in horizontal alignment, vertical alignment and cross section, gaining the basics of data processed road design

Content
The method of data processed road design is theoretically and in practical examples aquired.

Remarks
Literature:

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6233904	Practical Laboratory Training in Road Construction (p. 277)	2	W	3	P. Plachkova-Dzhurova
6233905	Pavement Structural Design and Failure Analysis (p. 197)	2	W	3	P. Plachkova-Dzhurova

Learning Control / Examinations
graded:
examination Road Construction, oral
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
preliminary attendance of core module Infrastructure Management [bauiM3P3-STRINFRA]

Learning Outcomes
Gaining theoretical structural design basics of road constructions as well as carrying out of failure analysis including the concerning laboratory tests

Content

- theoretical design methods for pavement structures
- failure analysis of different road construction types
- typical laboratory tests for earthwork, binder and asphalt mixtures

Module: Track Guided Transport Systems - Basics of Operating Systems [bauiM3S07-EBBETRIEB]

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6234801	Operation (p. 202)	2	S	3	E. Hohnecker
6234802	Facilities and Rolling Stock (p. 179)	1/1	S	3	E. Hohnecker

Learning Control / Examinations
graded:
examination Track Guided Transport Systems - Basics of Operating Systems, written, 120 min.
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
preliminary attedance of core module Track Guided Transport Systems - Technical Design & Components [bauiM3P4-EBTECHNIK]

Learning Outcomes
to have basic knowledges of operation planning, of the construction of stations and railway vehicles

Content

- vehicles
- stations
- operation modi
- timetable

Remarks
Literature:
Fiedler: Grundlagen der Bahntechnik, Werner-Verlag, Düsseldorf

Module: Track Guided Transport Systems - Operational Logistics and Management [bauiM3S08-EBLOGISTIK]

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6234804	Operation Systems and Track Guided Infrastructure Capacity (p. 205)	2	S	3	E. Hohnecker
6234805	Management in Public Transport (p. 280)	2	S	3	E. Hohnecker

Learning Control / Examinations
graded:
examination Track guided transport systems - operational logistics & management, oral
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
preliminary attedance of core module Track Guided Transport Systems - Technical Design & Components [bauiM3P4-EBTECHNIK]

Learning Outcomes
to know how to plan and operate a public transport system

Content

- capacities of lines and stations
- new operation modi
- managment in public transport
- special transport systems

Remarks
Literature:
Pachl: Systemtechnik des Schienenverkehrs, Teubner-Verlag, Stuttgart

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6230901	Project Integrated Planning (p. 308)	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
attested:
integrated term paper of the whole group and 2 presentations of the results as examination prerequisite
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
preliminary attendance of at least 2 core modules in the Focus Mobility and Infrastructure

Learning Outcomes
With this project, the participating institutions offer students the possibility of practical application of their acquired expertise. The claim of the “integrated” planning is comprehensive planning considering various demands.

Content
In this course students work on a given, real example for a characteristic problem of spatial and infrastructure development. The central task is the development of integrated planning drafts in the field of spatial and infrastructure planning. The development of a convincing vision as the basis for a sustainable development leads to different demands on spatial planning, traffic engineering, highway engineering and public transport. To create a viable draft, the various requirements must be balanced against each other.

Remarks
Literature:

Module: Data Analysis and Transportation Modelling [bauiM3S10-VERDATAMOD]

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6232901	Transportation Data Analysis (p. 220)	1/1	W	3	M. Kagerbauer, T. Streit
6232903	Seminar in Transportation (p. 324)	2	W/S	3	P. Vortisch, B. Chlond

Learning Control / Examinations
graded:
partial examination Transportation Data Analysis, oral
partial examination Seminar Transportation, term paper and presentation
grading:
grade of module is defined by weighted average according credit points of grades of the partial examinations

Conditions
none

Recommendations
none

Learning Outcomes
The objective of this module is the generation of data (surveys in transport) and its scientific use in the sense of statistical modelling or the quantitative analysis by means of statistical Software (SAS/R). Application of this basic knowledge.

Content
In a first course advanced methods of survey methodologies in transportation, data generation, the processing and the analysis of data as well as statistical modelling with such data will be dealt with by using statistical analysis software (e.g. SAS/ R). The second part of the module will deal with the elaboration of a small scientific task by using the competences in the form of a seminar. The emphasis of this seminar will be based on the analyses of data by means of the software.

Remarks
Literature: Vorlesungsbegleitende Umdrucke Übungen am PC

Module: Intermodality in Long-distance, Freight 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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6232808	Freight Transport (p. 260)	1/1	S	3	B. Chlond
6232904	Long-distance and Air Traffic (p. 236)	2/0	W	3	B. Chlond, N.N., Wilko Manz

Learning Control / Examinations
graded:
examination Intermodality in Long-distance, Freight and Air Transport, written
grading:
grade of module is defined by grade of examination

Conditions
registration to core module Models and Methods in Traffic Engineering and Transportation Planning [bauiM3P2-VERMODELL]

Recommendations
none

Learning Outcomes
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.

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6233906	Safety Management in Highway Engineering (p. 325)	1/1	W	3	M. Zimmermann
6233908	Seminar in Highway Engineering (p. 323)	2	W	3	M. Zimmermann

Learning Control / Examinations
graded:
examination Road Safety, oral
attested:
integrated term paper and presentation of the results as examinatoin prerequisite
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
none

Learning Outcomes
Gaining the procedures to increase infrastructural road safety and appliance at regional accident black spots

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.

Remarks
Literature:

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6233805	Technical and Economic Management Tools in Highway Engineering (p. 348)	2	S	3	H. Rethage
6233806	Simulations and Analysis Methods in Highway Engineering (p. 328)	1	S	1,5	R. Roos, Mitarbeiter
6233807	Special Topics in Highway Engineering (p. 199)	1	S	1,5	R. Roos

Learning Control / Examinations
graded:
partial examination Technical and economical management tools in Highway Engineering, oral
partial examination Simulation, Analysis Methods, Special Chapters in Highway Engineering, oral
grading:
grade of module is defined by arithmetic average of grades of the partial examinations

Conditions
none

Recommendations
preliminary attendance of core module Infrastructure Management [bauiM3P3-STRINFRA]

Learning Outcomes
Learning the methodology of organisation and carrying out the road operation and maintenance

Content
In this course 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.

Remarks
Literature:

Module: Dimensioning and Construction of Railway Lines [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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6234806	Infrastructure Dimensioning and Railway Traffic (p. 267)	1/1	S	3	E. Hohnecker
6234808	Infrastructure Equipment of Railway Tracks (p. 266)	1	S	1,5	E. Hohnecker, Mitarbeiter
6234809	Construction and Maintenance of Track Infrastructure (p. 183)	1	S	1,5	E. Hohnecker, Mitarbeiter

Learning Control / Examinations
graded:
examination Dimensioning and construction of railway lines, oral
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
preliminary attedance of core module Track Guided Transport Systems - Technical Design & Components [bauiM3P4-EBTECHNIK]

Learning Outcomes
to know the methods of planning, dimensioning, construction and maintenance of railway lines

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6234901	Environmental Aspects of Guided Transport Systems (p. 358)	2	W	3	E. Hohnecker
6234902	Economic Efficiency of Guided Transport Systems (p. 382)	1	W	1,5	E. Hohnecker
6234903	Law Aspects of Guided Transport Systems (p. 318)	1	W	1,5	R. Schweinsberg

Learning Control / Examinations
graded:
examination Economics, Law and Environmental Aspects in Railway Transportation, oral
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
none

Learning Outcomes
to know the economic, judicial and environmental problems of track guided transport systems

Content

- basics of economy
- evalutation of planing
- economic and law in public transport
- customer orientation
- 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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6234810	Determination of Demand, Timetable Construction and Alignment (p. 193)	1/2	S	4,5	E. Hohnecker
6234904	Standard Valuation in Public Transport. Using an Example (p. 341)	0/1	W	1,5	E. Hohnecker

Learning Control / Examinations
graded:
examination Traffic Infrastructure, oral
ungraded:
term paper and presentation as examination prerequisite in each course
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]

Learning Outcomes
to know how to plan and evaluate a public transport project

Content
determination of demand, alignment, construction of timetable, cost estimate, evaluation of track guided public transport projects

Remarks
Literature:

4.4 Modules Study Focus 4: Technology and Management in Construction

Module: Construction Management and Work Planning [bauiM4P1-]

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6241701	"Arbeitsvorbereitung und Bauleitung" (p. 181)	2	W	3	S. Haghsheno, S. Beretitsch, P. Steffek
6241702	"Baubetriebliche Verfahrenstechnik" (p. 184)	2	W	3	S. Haghsheno, H. Schneider, M. Denzer

Learning Control / Examinations
graded:
examination Construction Management and Work Planning, written, 90 min.
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
none

Learning Outcomes
see German version

Content
see German version

Module: Construction Equipment and Machinery [bauiM4P2-]

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6241703	Fundamental Mechanics of Construction Equipment (p. 253)	1	W	1,5	S. Gentes, Mitarbeiter
6241704	Construction Equipment and Mechanical Process Engineering (p. 188)	2/1	W	4,5	H. Schneider, H. Schlick

Learning Control / Examinations
graded:
examination Construction Equipment and Machinery, written, 90 min.
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
none

Learning Outcomes
The students are able to assemble suitable machinery and equipment (method selection) for the selected construction method. They realise optimisation potential with the help of appropriate process engineering methods und will learn about the performance values and operation conditions of those methods.

Content
Within the frame of this module, various devices will be presented with the help of BGL. Moreover, an on-site induction with practical examples and performance calculations as well as practical workshops at the Institut's own test site with machine deployment will take place.

Remarks
Literature:
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: 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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6241801	Cost Estimation (p. 268)	1/1	S	3	S. Haghsheno
6241803	Financing / Investment / Controlling (p. 237)	1	S	1,5	K. Lennerts
6241804	Building Laws (p. 189)	1	S	1,5	S. Haghsheno, H. Miernik

Learning Control / Examinations
graded:
examination Economics and Management in Construction, written, 90 min.
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
none

Learning Outcomes
The students are able to independently create offers and standard pricing and will gain extensive knowledge of an appropriate software. module. Furthermore the students are able to make strategic investment decisions and to make a successful corporate controlling. They have a detailed knowledge in forms of organisations.

Content
This module covers the calculation of various factors (Mittellohn, EKT, BGK, AGK and W&G). After a manual example for tendering, the result will be transferred to currently applied software. Furthermore following topics are discussed within the lectures:

- financing
- investing
- basics of contolling
- forms of organisation

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6241805	Sustainability in Real Estate Management (p. 292)	1/1	S	3	K. Lennerts
6241807	Real Estate Life Cycle Management (p. 279)	1	S	1,5	K. Lennerts, Mitarbeiter
6241808	Facility and Real Estate Management II (p. 232)	1	S	1,5	K. Lennerts

Learning Control / Examinations
graded:
examination Sustainability in Real Estate Management, written, 90 min.
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
courses Facility und Real Estate Management I (0170513), Life Cycle Management (0170613)

Learning Outcomes
see German version

Content
see German version

Module: Business and Human Resource Management [bauiM4S01-]

Coordination: S. Haghsheno, 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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6241809	Business and Human Resource Management (p. 204)	2	S	3	S. Haghsheno, E. Eschen
6241810	Human Resources in the Real Estate Sector (p. 264)	1	S	1,5	K. Lennerts, K. Janowski
6241811	Contract and Employment Law (p. 371)	1	S	1,5	S. Haghsheno, R. Kohlhammer

Learning Control / Examinations
graded:
examination Business and Human Resource Management, oral, 40 min.
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
none

Learning Outcomes
see German version

Content
see German version

Module: Construction Process Engineering and Quality Management [bauiM4S04-]

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6241818	"Spannbeton in der baubetrieblichen Praxis" (p. 330)	1	S	1,5	S. Haghsheno, F. Kohlbecker
6241819	"Beton- und Stahlbetoninstandsetzung" (p. 200)	1	S	1,5	S. Haghsheno, F. Kohlbecker
6241820	Quality and Environmental Management (p. 317)	1	S	1,5	S. Haghsheno, Mitarbeiter
6241821	Test Procedures in Construction (p. 314)	1	S	1,5	H. Schneider

Learning Control / Examinations
graded:
examination Construction Process Engineering and Quality Management, oral, 40 min.
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
none

Learning Outcomes
see German version

Content
see German version

Module: Advanced Project Management [bauiM4S05-]

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6241822	Supplementary Claim Management (p. 293)	1	S	1,5	S. Gentes, R. Bartsch
6241823	Project Control (p. 311)	1	S	1,5	G. Schlick
6241824	Project Management II (p. 310)	1/1	S	3	S. Haghsheno, H. Schneider, K. Teizer

Learning Control / Examinations
graded:
examination Advanced Project Management, oral, 40 min.
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
none

Learning Outcomes
see German version

Content
see German version

Remarks
Literatur:
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.
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: 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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6241826	Project Studies (p. 313)	1/1	S	3	S. Gentes
6241828	Disassembly Process Engineering (p. 363)	1/1	S	3	S. Gentes

Learning Control / Examinations
graded:
examination Environmentally-friendly Recycling and Disassembly of Buildings, oral, 40 min.
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
none

Learning Outcomes
The students are able to choose a disassembly procedure considering current case-law and guidelines and to select appropriate methods for different materials, e.g. concrete, bricking, wood, etc.

Content
This module gives an overview of statutory provisions and guidelines, current demolition and recycling methods, as well as disassembly machines. Current projects will be visited and a dismantling plan for selected practical cases will be developed within the frame of this module.

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) Zeiher, Marco: Ein Entscheidungsunterstützungsmodell für den Rückbau massiver Betonstrukturen in kerntechnischen Anlagen, Karlsruhe, Univ., Diss., 2009

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6241901	Upgrading of Existing Buildings (p. 186)	2/1	W	4,5	K. Lennerts, Mitarbeiter
6241903	Energetic Refurbishment (p. 221)	1	W	1,5	K. Lennerts, Mitarbeiter

Learning Control / Examinations
graded:
examination Upgrading of Existing Buildings and Energetic Refurbishment, term paper with presentation, and oral, 30 min.
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
none

Learning Outcomes
see German version

Content
see German version

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6241904	Public Real Estate Management (p. 316)	1	W	1,5	K. Lennerts, Mitarbeiter
6241905	Public Private Partnership (p. 315)	1	W	1,5	K. Lennerts, Mitarbeiter
6241906	Project Development (p. 309)	1	W	1,5	K. Lennerts, Mitarbeiter
6241907	Corporate Real Estate Management (p. 214)	1	W	1,5	S. Beretitsch

Learning Control / Examinations
graded:
examination Real Estate Management, oral, 40 min.
attested:
term paper with presentation as examination prerequisite
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
none

Learning Outcomes
see German version

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6241908	Lean Construction (p. 278)	3/1	W	6	S. Haghsheno, Mitarbeiter

Learning Control / Examinations
graded:
examination prerequisite consisting of lecture accompanying project paper with presentation,
examniation Lean Construction, oral, 30 min.
grading:
grade of module is defined by weighted average of grades for examination (75 %) and examination prerequisite (25 %)

Conditions
none

Recommendations
none

Learning Outcomes
see German version

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6241910	Tunnel Construction and Blasting Engineering (p. 354)	2	W	3	S. Haghsheno, L. Scheuble, U. Matz
6241911	Operation Methods for Foundation and Marine Construction (p. 350)	1	W	1,5	H. Schneider
6241913	Operation Methods for Earthmoving (p. 225)	1	W	1,5	H. Schlick

Learning Control / Examinations
graded:
examination Advanced Studies in Construction Engineering, oral, 40 min.
grading:
grade of module is defined by grade of examination
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
none

Learning Outcomes
see German version

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6241917	Removal and Decontamination of Nuclear Facilities (p. 216)	1/1	W	3	S. Gentes, Mitarbeiter
6241919	New Development and Optimization of Decommissioning Machine Technology (p. 294)	1/1	W	3	S. Gentes, Mitarbeiter

Learning Control / Examinations
graded:
examination Decommissioning of Nuclear Facilities, oral
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
none

Learning Outcomes
see German version

Content
see German version

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.

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, Summer Term	2

Courses in module

ID	Course	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6241921	Facility Management in Hospitals (p. 231)	2/1	W	4,5	K. Lennerts, Mitarbeiter
2550493	Hospital Management (p. 275)	1	S	1,5	S. Nickel

Learning Control / Examinations
graded:
partial examination Facility Management in Hospitals, term paper
partial examination Hospital Management, oral
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 (0170513)

Learning Outcomes
see German version

Content
see German version

Module: Building Preservation in Concrete and Masonry Constructions [bauiM4S14-]

Coordination: E. Kotan
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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6211811	Protection, Rehabilitation and Reinforcement of Concrete and Masonry Constructions (p. 321)	2/1	S	4,5	E. Kotan, H. Müller, M. Günter
6211813	Building Analyses (p. 190)	1	S	1,5	E. Kotan, H. Müller, M. Vogel

Learning Control / Examinations
graded:
examination Building Preservation of Concrete and Masonry Constructions, oral, 30 min.
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
none

Learning Outcomes
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.

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-out as well as (selection):
[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

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6251801	Stress, Strain and Limit States in Soils (p. 331)	2/1	S	4,5	A. Niemunis
6251803	Triaxial Testing in Soil Mechanics (p. 210)	1	S	1,5	T. Wichtmann

Learning Control / Examinations
graded:
examination Theoretical Soil Mechanics, written, 90 min.
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]

Learning Outcomes
Understanding of the essential behaviour of soil under monotonic and cyclic load with and without effects of time regarding large and small deformations. Ability to describe mathematically and physically correct ralations in soil mechanics. Ability to understand the tensorial terminology of modern geotechnical literature. Self-dependent recognition of controlling mechanisms and limitations of simple engineering models.
Decision, preparation and self-dependent execution of triaxial tests in soil mechanics, definition of adequate boundary conditions, Test evaluation, controlling and drawing of appropriate engineering conclusions.

Content
Stress, Strain and Limit States in Soils:

- 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

Triaxial Testing in Soil Mechanics:

- test variants and boundary conditions
- sample preparation methods

- strain measurement
- typical stress-strain-relations for various soils (sand, gravel, silt, clay) for monotonous drained and undrained loading
- testing technique for cyclic loading, Strain accumulation for cyclic loading
- pore water pressure accumulation (liquefaction) for undrained cyclic loading
- discussion of relevant influence quantities (pressure, void ratio, preload) on the soil behaviour for monotonous and cyclic loading

Remarks
Literature:
Niemunis (2009): Über die Anwendung der Kontinuumstheorie auf bodenmechanische Probleme (download)
Zusätzliches Studienmaterial wird den Hörern zur Verfügung gestellt: Hausaufgaben, Programme (download)
Vorlesungsbegleitend wird ein Tutorium zu „Spannungs-, Deformations- und Grenzzuständen im Boden“ (19182) angeboten, dessen Besuch empfohlen wird.

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6251701	Foundation Types (p. 252)	1/1	W	3	T. Triantafyllidis
6251703	Basics in Earthworks and Embankment Dams (p. 254)	1/1	W	3	A. Bieberstein

Learning Control / Examinations
graded:
examination Earthworks and Foundation Engineering, written, 90 min.
attested:
Focus Geotechnical Engineering:
approved term paper “Earth Dams and Foundation Engineering” (monitored by Institute)
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
Basic knowledge of Soil Mechanics and Foundation Engineering

Learning Outcomes
The students should be able to select and apply suitable methods for investigation, modelling, dimensioning, execution and control for geotechnical requirements of average complexity. Acquirement of competences in resolving geotechnical problems also with respect to managerial organization, expense budgeting, use of documents and presentation of results. Identification of relevant questions in earthworks and embankment dam engineering. Basic knowledge of design principles, construction materials, earthworks, seepage, erosion and suffusion stability as well as static calculations in dams which can be used independently in general outlines.

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
- quay wall structures with sheetpiles
- stabilization and drainage of embankments
- retaining constructions with structural slope stabilisation
- ground anchors
- injections
- underpinning and supporting
- deformations of deep excavations
- 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 Tunneling [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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6251804	Stress, Strain and Limit States in Rock (p. 332)	1/1	S	3	E. Gerolymatou
6251806	Basics in Tunnel Construction (p. 256)	1/1	S	3	B. Fröhlich

Learning Control / Examinations
graded:
examination Basics of Rock Mechanics and Tunneling, written, 90 min.
attested:
Focus Geotechnical Engineering:
approved term paper Rock Engineering (monitored by Institute)
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
Basic knowledge of Engineering Geology

Learning Outcomes
Knowledge of essential strength and deformation properties of rock and of analytical methods for solving boundary value problems of surface and underground rock excavation. Application of fundamental methods of rock mechanics, static calculation and safety assessments on underground tunnel construction.

Content
Stress, Strain and Limit States in Rock:

- basics of petropraphy
- rocks and rock mass
- genity and tropy
- stress-strain-behaviour
- shear strength, compressive strength and tensile strength of compact and jointed rock
- basics and methods to determine compressibility parameters for rocks and rock mass
- circular tunnels in isotrope and biaxial primary stress fields (elastic)
- circular tunnels in elastoplastic ground
- elliptical cross sections
- shaft problem

Rock Mechanics and Tunneling:

- tunneling by drilling and blasting, driving by TBM
- measuring technologies in tunnel construction
- rock pressure and in-situ stress measurement
- stresses in lining
- introduction to tunnel constructions (types and purposes)
- tunnel construction methods

- rock classification
- deformations, plastification, ground reaction line method
- ground water influence
- tunnel maintenance, repair and rehabilitation
- tunnel collapse mechanisms

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, kostenloser Download unter: 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.

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6251705	Continuum Mechanics for Geotechnics (p. 273)	1/1	W	3	C. Hesch
6251707	Numerics in Geotechnics (p. 297)	2	W	3	A. Niemunis

Learning Control / Examinations
graded:
examination Basics of Numeric Modelling, oral, 60 min.
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
basic knowledge in continuum mechanics

Learning Outcomes
Continuum Mechanics for Geotechnics:
The purpose of this lecture is to familiarize with the general concepts of continuum mechanics (kinematics of deformation, balance relations, constitutive laws) as well as their application to engineering problems. Special emphasis is put on topics relevant in geotechnical applications.
Numerics in Geotechnics:
Knowledge of operative methods for the discretisation of typical differential equations (statics, consolidation, wave, seepage). Participants are aware of possible error of numerical computations num. stability, locking, etc.) and have decision-making ability in regard to the choice of commercial FE-Codes. Ability of critical interpretation of FE-results.

Content
Continuum Mechanics for Geotechnics:

- 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, dilatational 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 the 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: Design and Construction of Components in Reinforced Concrete [bauiM5P5-BEMISTB]

Coordination: L. Stempniewski
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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6211701	Design and Construction of Components in Reinforced Concrete (p. 196)	2/2	W	6	L. Stempniewski

Learning Control / Examinations
graded:
examination Design and Construction of Components in Reinforced Concrete, written, 90 min.
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
Basics of Reinforced Concrete I+II

Learning Outcomes
Achieving a higher level of insight into complex subjects of reinforced concrete

Content

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

Remarks
Literature: Vorlesungsskriptum

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6251901	Soil as Viscous Multi-phase System (p. 372)	1/1	W	3	A. Niemunis
6251903	Soil Dynamics (p. 187)	1/1	W	3	G. Huber

Learning Control / Examinations
graded:
examination Special Issues of Soil Mechanics, written, 90 min.
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
module Theoretical Soil Mechanics [bauiM5P1-THEOBM]

Learning Outcomes
Soil as Viscous Multi-phase System:
Enlargement of knowledge about mechanical, hydraulic and numerical tools to be able to handle specific soil mechanical problems. The students acquire the ability of operative handling with constitutive laws (recalculation and calibration of tests) and critical appraisal of results. Knowledge about the interrelation between hydraulic, mechanical and chemical processes for partial saturation. Overview of oscillations in the range from small strain tremors to earthquakes.
Soil Dynamics:
In-depth knowledge of the standards, design recommendations and computational procedures for special geotechnical constructions with interaction of superstructure, foundation and subsoil. Structural knowhow, design rules and codes of practice shall be cross-linked with the theoretical knowledge basis about soil mechanics. Numerical tools commonly used in the design process and the ability to evaluate the applicability of their results shall be familiar.

Content
Soil as Viscous Multi-phase System:

- Hypoplastic constitutive laws (1D, 3D): advantages, limitations, identification of parameters, intergranular strain, visco-hypoplasticity
- application: creeping embankments with shead dowelling
- soils under cyclic load, high-cycle-model
- natural soils in comparison to idealized models
- phenomena of shear localization
- soil liquefaction, catastrophic soil avalanches
- chemism in soils
- sounding, soil penetration and contact problems
- 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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6251808	Soil Mechanical Laboratory Exercises (p. 209)	2	S	3	G. Huber
6251809	Geomechanical Field Exercise (p. 247)	2	S	3	G. Huber

Learning Control / Examinations
graded:
examination Ground Investigation, oral, 40 min.
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
none

Learning Outcomes
Knowledge and self-dependent execution of standard tests in soil mechanics, definition of adequate boundary conditions, test evaluation, controlling and drawing of appropriate engineering conclusions. Knowledge of the most common geotechnical field testing methods in soil and rock in regard to planning, execution, evaluation and interpretation. Independent practical experience.

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:

- oedometer (compressibility)
- simple shear
- triaxial tests (drained, undrained)
- permeability
- in-situ determination of density
- dynamic probing
- pressuremeter testing 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

Remarks
Literature:

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6251810	Foundations and Retaining Structures (p. 251)	1/1	S	3	P. Kudella
6251812	Special Foundation Engineering and Design (p. 329)	1/1	S	3	P. Kudella

Learning Control / Examinations
graded:
examination Applied Geotechnics, written, 90 min.
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
module Earthworks and Foundation Engineering [bauiM5P2-ERDGB]

Learning Outcomes
Seld-dependent reasonable design decisions for pile foundations and excavations with regard to geological engineering, site managing and economical boundary conditions. In-depth understanding of the interaction between superstructure, foundation and subsoil. Structural know-how, design rules and codes of practice shall be cross-linked with the theoretical knowledge basis in soil mechanics. In-depth knowledge of the standards, design recommendations and computational procedures for special geotechnical constructions with interaction of superstructure, foundation and subsoil. Numerical tools commonly used in the design process and the ability to evaluate the applicability of their results shall be familiar.

Content

- pile types
- load bearing resistance and deformations of individual piles in axial and lateral direction
- negative skin friction
- subgrade reaction
- plastic flow resistance
- load bearing resistance and settlement of pile groups
- recommendations EA-Pfähle and pile tests
- 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
- geosynthetics and EBGEO recommendations on soil reinforcement
- 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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6251814	Geotechnical Ground Water Problems (p. 248)	1/1	S	3	A. Bieberstein
6251816	Embankment Dams (Advanced) (p. 227)	1/1	S	3	A. Bieberstein

Learning Control / Examinations
graded:
examination Ground Water and Earth Dams, oral, 40 min.
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
module Earthworks and Foundation Engineering [bauiM5P2-ERDGB]

Learning Outcomes
In-depth knowledge about different questions of ground water problems. Demonstration of the interrelations in sample calculations. In-depth study of Earthworks and Embankment Dams as well as of geotechnical construction technologies and verifications. Ability to develop self-dependent approaches for typical embankment dam construction problems.

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
- deformation of embankments
- safety against flaws
- earthquake design
- 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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6251905	Aboveground Rock Engineering (p. 234)	1/1	W	3	P. Kudella
6251907	Tunnel Construction in Soils and in Existence (p. 353)	1/1	W	3	B. Fröhlich, P. Kudella

Learning Control / Examinations
graded:
examination Rock Engineering and Underground Construction, written, 90 min.
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
module Rock Engineering and Tunneling [bauiM5P3-FMTUB]

Learning Outcomes
Overview of the planning, construction and design of safety systems for embankments and hillsides in rock. Recognition of critical failure mechanisms. Self-dependent realization of stability analysis and standard design exercises. In-depth and supplementary knowledge of strength and deformation properties of rocks as well as of rock testing in-situ and in laboratory. Knowledge of tunnel boring machines and the maintenance of tunnels. Outlook on tunnel boring in excursions.

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, lateral buckling
- 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
- rehabilitation of existing tunnels, safety analysis of existing tunnels
- open-face tunneling (cut-and-cover, sink tunnels, caisson tunnels)
- tunneling shield machines: compressed air tunneling, pipe and frame jacking, microtunneling and horizontal borings
- earth load, ground reaction and deformation prediction for surface-near tunneling in losse 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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6251818	Exercises in Numerical Modelling (p. 357)	2	S	3	A. Niemunis
6251819	FEM Applications in Geotechnical Modelling (p. 235)	2	S	3	A. Niemunis

Learning Control / Examinations
graded:
examination Numeric Modelling in Geotechnics, oral, 40 min., 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]

Learning Outcomes
Independent development of numerical approaches for typical boundary value problems. Practical realization (Fortran-Programming) of the FE-knowledge gained in “Numerics in Geotechnics”. Practical handling with the FE-Code ABAQUS (TM) for the modeling of geotechnical problems, exemplary application. Critical interpretation of the results of numerical simulations. Getting to know FE-Applications in different fields of geotechnics (foundation engineering, rock and tunnel engineering, embankment dam engineering).

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
- 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)

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 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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6251909	Rock Testing (p. 370)	1	W	1,5	G. Huber
6251910	Testing in Dam and Wastefill Engineering (p. 228)	1	W	1,5	A. Bieberstein
6251911	Geotechnical Measuring Technology (p. 208)	1/1	W	3	G. Huber

Learning Control / Examinations
graded:
examination Geotechnical Testing and Measuring Technology, oral, 40 min.
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
none

Learning Outcomes
In-depth understanding of the different procedures and methods for subsoil exploration and testing techniques (surpassing standard operations). Acquaintance with the special conditions for their application and the requirements of each procedure, choice of appropriate combinations. Basics knowledge about geophysical investigation methods. Basic knowledge of measuring methods and functional principles of sensors and data aquisition. Well-founded choice of suitable equipment in regard to limitation of resolution, accuracy, log-time-stability and interpretation. Familiarity using dataloggers, control elements, measuring and analysis precedures.

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, 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

Remarks
Literature:

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6251820	Ground Improvement, Grouting and Soil Freezing (p. 211)	1/1	S	3	W. Orth
6251822	Anchoring, Piling and Slurry Wall Technology (p. 178)	1/1	S	3	T. Triantafyllidis

Learning Control / Examinations
graded:
partial examination Ground Improvement, Grouting and Soil Freezing, oral, 20 min.
partial examination Anchoring, Piling and Slurry Wall Technology, oral, 20 min.
grading:
grade of module is defined by weighted average according credit points of grades of the partial examinations

Conditions
none

Recommendations
none

Learning Outcomes
Knowledge of the performance, ranges of application, necessary preliminary investigations and accompanying controls (monitoring) for special underground engineering technologies. The aim is to obtain the capability for independent selection of suitable procedures for certain tasks of building, establishment of necessary investigations, selection and definition of execution steps, indication of execution parameters, extent and kind of monitoring, quality management.

Content

- soil freezing: brine and nitrogen cooling, frost spreading under artificial and natural influence, frost heave and thaw settlement, mechanical behavior 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
- bar, strand and pipe anchors, anchor drilling and mounting, anchor tests, group effcets, dimensioning and design proofs
- piling and caisson technique, machines, suspension support
- slurry clays and testing, internal and external stability of open slurry trenches, corner trenches

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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6251913	Landfills (p. 356)	1/1	W	3	A. Bieberstein
6251915	Brownfield Sites - Investigation, Evaluation, Rehabilitation (p. 174)	2	W	3	A. Bieberstein, T. Neumann, H. Würdemann, S. Norra, U. Mohrlok, M. Reinhard

Learning Control / Examinations
graded:
partial examination Landfills, oral, 20 min.
partial examination Brownfield Sites, oral, 20 min.
grading:
grade of module is defined by weighted average according credit points of grades of the partial examinations

Conditions
none

Recommendations
none

Learning Outcomes
Knowledge of the legal requirements regarding the depositing of waste. Presentation of the geotechnical concerns in the construction of landfill sites depending on the particular landfill classification, landfill elements, their relevant requirements and necessary certifications. Knowledge of the permitted limits for brown-fields. Interdisciplinary cross-linking of chemical, mineralogical, biological, hydraulic and geotechnical aspects of the treatment of brown-fields. Knowledge of the relevant procedures of decontamination, their limitations and risks.

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 Geomechanic 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	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
6251916	Time-dependent Phenomena in Hard Rock (p. 383)	1/1	W	3	E. Gerolymatou
6251918	Coupled Phenomene in Geomechanics (p. 246)	1/1	W	3	T. Wichtmann

Learning Control / Examinations
graded:
examination Coupled Geomechanic Processes, written, 90 min.
grading:
grade of module is defined by grade of examination

Conditions
none

Recommendations
module Rock Engineering and Tunneling [bauiM5P3-FMTUB]

Learning Outcomes
In-depth and supplementary knowledge of strength and deformation properties of rocks as well as of rock testing in-situ and in laboratory.
Introduction to the basic physical and chemical phenomena that may alter the mechanical properties of geomaterials. Hydromechanical, chemomechanical, thermomechanical and biomechanical effects are considered. Ability to recognize the mechanisms involved from the physical point of view and express them mathematically.

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 (kostenloser Download unter http://www.rocscience.com/education/hoeks_corner)

5 Courses

5.1 All Courses

Course: Brownfield Sites - Investigation, Evaluation, Rehabilitation [6251915]

Coordinators: A. Bieberstein, T. Neumann, H. Würdemann, S. Norra, U. Mohrlok, M. Reinhard
Part of the modules: Environmental Geotechnics (p. 171)[bauiM5S09-UMGEOTEC]

ECTS Credits	Hours per week	Term	Instruction language
3	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. 67)[bauiM1S25-DAUERLEB]

ECTS Credits	Hours per week	Term	Instruction language
1,5	1	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Appropriated Technologies [6223902]

Coordinators: E. Hoffmann
Part of the modules: Industrial Water Management (p. 112)[bauiM2S29-SW6]

ECTS Credits	Hours per week	Term	Instruction language
3	1/1	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Applied Building Physics [6211909]

Coordinators: E. Kotan, J. Heiß, M. Vogel
Part of the modules: Building Physics I (p. 69)[bauiM1S27-BAUPH-I]

ECTS Credits	Hours per week	Term	Instruction language
3	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. 170)[bauiM5S08-SPEZTIEF]

ECTS Credits	Hours per week	Term	Instruction language
3	1/1	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Facilities and Rolling Stock [6234802]

Coordinators: E. Hohnecker
Part of the modules: Track Guided Transport Systems - Basics of Operating Systems (p. 125)[bauiM3S07-EBBETRIEB]

ECTS Credits	Hours per week	Term	Instruction language
3	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, P. Betsch
Part of the modules: Material Models in Solid Mechanics (p. 63)[bauiM1S22-MATTHEO]

ECTS Credits	Hours per week	Term	Instruction language
6	2/2	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: "Arbeitsvorbereitung und Bauleitung" [6241701]

Coordinators: S. Haghsheno, S. Beretitsch, P. Steffek
Part of the modules: Construction Management and Work Planning (p. 135)[bauiM4P1-]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Winter 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. 40)[bauiM1S01-STABISTB]

ECTS Credits	Hours per week	Term	Instruction language
6	2/2	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Construction and Maintenance of Track Infrastructure [6234809]

Coordinators: E. Hohnecker, Mitarbeiter
Part of the modules: Dimensioning and Construction of Railway Lines (p. 132)[bauiM3S14-EBBAU]

ECTS Credits	Hours per week	Term	Instruction language
1,5	1	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: ”Baubetriebliche Verfahrenstechnik” [6241702]

Coordinators: S. Haghsheno, H. Schneider, M. Denzer
Part of the modules: Construction Management and Work Planning (p. 135)[bauiM4P1-]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Winter 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. 38)[bauiM1P3-FTW-BD]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Upgrading of Existing Buildings [6241901]

Coordinators: K. Lennerts, Mitarbeiter
Part of the modules: Upgrading of Existing Buildings and Energetic Refurbishment (p. 143)[bauiM4S07-]

ECTS Credits	Hours per week	Term	Instruction language
4,5	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. 159)[bauiM5S01-SPEZBM]

ECTS Credits	Hours per week	Term	Instruction language
3	1/1	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Construction Equipment and Mechanical Process Engineering [6241704]

Coordinators: H. Schneider, H. Schlick
Part of the modules: Construction Equipment and Machinery (p. 136)[bauiM4P2-]

ECTS Credits	Hours per week	Term	Instruction language
4,5	2/1	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 (Baugeräteliste 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: Building Laws [6241804]

Coordinators: S. Haghsheno, H. Miernik
Part of the modules: Economics and Management in Construction (p. 137)[bauiM4P3-]

ECTS Credits	Hours per week	Term	Instruction language
1,5	1	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Building Analyses [6211813]

Coordinators: E. Kotan, H. Müller, M. Vogel
Part of the modules: Building Preservation of Concrete and Masonry Constructions (p. 68)[bauiM1S26-BBM], Building Preservation in Concrete and Masonry Constructions (p. 149)[bauiM4S14-]

ECTS Credits	Hours per week	Term	Instruction language
1,5	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. 51)[bauiM1S11-BAUING-BSH]

ECTS Credits	Hours per week	Term	Instruction language
3	1/1	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. 51)[bauiM1S11-BAUING-BSH]

ECTS Credits	Hours per week	Term	Instruction language
3	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. 134)[bauiM3S16-EBVERKEHR]

ECTS Credits	Hours per week	Term	Instruction language
4,5	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: L. Stempniewski
Part of the modules: Anchorage in Concrete (p. 44)[bauiM1S05-BEFTECH]

ECTS Credits	Hours per week	Term	Instruction language
3	1/1	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Anchorage in Concrete II [6211905]

Coordinators: L. Stempniewski
Part of the modules: Anchorage in Concrete (p. 44)[bauiM1S05-BEFTECH]

ECTS Credits	Hours per week	Term	Instruction language
3	1/1	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

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. 158)[bauiM5P5-BEMISTB], Design and Construction of Components in Reinforced Concrete (p. 36)[bauiM1P1-BEMISTB]

ECTS Credits	Hours per week	Term	Instruction language
6	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. 124)[bauiM3S06-STRBAUT]

ECTS Credits	Hours per week	Term	Instruction language
3	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. 115)[bauiM3P2-VERMODELL]

ECTS Credits	Hours per week	Term	Instruction language
3	1/1	Winter term	de

Learning Control / Examinations
The assessment consists of an oral exam (15 minutes) 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. 131)[bauiM3S13-STRSPEZ]

ECTS Credits	Hours per week	Term	Instruction language
1,5	1	Summer term	

Learning Control / Examinations
See module description.

Conditions
See corresponding module information.

Learning Outcomes

Content

Course: ”Beton- und Stahlbetoninstandsetzung” [6241819]

Coordinators: S. Haghsheno, F. Kohlbecker
Part of the modules: Construction Process Engineering and Quality Management (p. 140)[bauiM4S04-]

ECTS Credits	Hours per week	Term	Instruction language
1,5	1	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Concrete Technology [6211809]

Coordinators: M. Haist, V. Kvitsel
Part of the modules: Concrete Construction Technology (p. 66)[bauiM1S24-BETONTECH]

ECTS Credits	Hours per week	Term	Instruction language
4,5	2/1	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Operation [6234801]

Coordinators: E. Hohnecker
Part of the modules: Track Guided Transport Systems - Basics of Operating Systems (p. 125)[bauiM3S07-EBBETRIEB]

ECTS Credits	Hours per week	Term	Instruction language
3	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. 116)[bauiM3P3-STRINFRA]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Summer term	de

Learning Control / Examinations
See module description.

Conditions
See corresponding module information.

Learning Outcomes

Content

Course: Business and Human Resource Management [6241809]

Coordinators: S. Haghsheno, E. Eschen
Part of the modules: Business and Human Resource Management (p. 139)[bauiM4S01-]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Operation Systems and Track Guided Infrastructure Capacity [6234804]

Coordinators: E. Hohnecker
Part of the modules: Track Guided Transport Systems - Operational Logistics and Management (p. 126)[bauiM3S08-EBLOGISTIK]

ECTS Credits	Hours per week	Term	Instruction language
3	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. 118)[bauiM3P5-VERFRECHT]

ECTS Credits	Hours per week	Term	Instruction language
1,5	1/0	Summer term	de

Learning Control / Examinations
The assessment consists of an oral exam (15 minutes) according to §4(2), 2 of the examination regulation.

Conditions
None.

Learning Outcomes

Content

Course: Bioprocess Engineering [6225701]

Coordinators: J. Winter
Part of the modules: Mass Fluxes and Cycles (p. 82)[bauiM2P3-STK]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Geotechnical Measuring Technology [6251911]

Coordinators: G. Huber
Part of the modules: Geotechnical Testing and Measuring Technology (p. 168)[bauiM5S07-VERSMESS]

ECTS Credits	Hours per week	Term	Instruction language
3	1/1	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. 161)[bauiM5S02-BERKUND]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Triaxial Testing in Soil Mechanics [6251803]

Coordinators: T. Wichtmann
Part of the modules: Theoretical Soil Mechanics (p. 150)[bauiM5P1-THEOBM]

ECTS Credits	Hours per week	Term	Instruction language
1,5	1	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. 170)[bauiM5S08-SPEZTIEF]

ECTS Credits	Hours per week	Term	Instruction language
3	1/1	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. 62)[bauiM1S21-BRUCHMECH]

ECTS Credits	Hours per week	Term	Instruction language
6	2/2	Winter term	

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. 56)[bauiM1S15-CTWM]

ECTS Credits	Hours per week	Term	Instruction language
6	2/2	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Corporate Real Estate Management [6241907]

Coordinators: S. Beretitsch
Part of the modules: Real Estate Management (p. 144)[bauiM4S08-]

ECTS Credits	Hours per week	Term	Instruction language
1,5	1	Winter term	

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. 86)[bauiM2S04-HY4]

ECTS Credits	Hours per week	Term	Instruction language
6	2/2	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Removal and Decontamination of Nuclear Facilities [6241917]

Coordinators: S. Gentes, Mitarbeiter
Part of the modules: Decommissioning of Nuclear Facilities (p. 147)[bauiM4S12-]

ECTS Credits	Hours per week	Term	Instruction language
3	1/1	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: IT-based Road Design [6233901]

Coordinators: M. Zimmermann
Part of the modules: Highway Design (p. 123)[bauiM3S05-STRENTW]

ECTS Credits	Hours per week	Term	Instruction language
3	1/1	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. 122)[bauiM3S04-VERPLAN]

ECTS Credits	Hours per week	Term	Instruction language
3	2/0	Summer term	de

Learning Control / Examinations
The assessment consists of an oral exam (15 minutes) according to §4(2), 2 of the examination regulation.

Conditions
See module description.

Learning Outcomes

Content

Course: Principles of Applied Ecology [6223807]

Coordinators: S. Fuchs
Part of the modules: Applied Ecology (p. 110)[bauiM2S27-SW4]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Summer term	

Learning Control / Examinations

Conditions

None.

Learning Outcomes

Content

Course: Transportation Data Analysis [6232901]

Coordinators: M. Kagerbauer, T. Streit
Part of the modules: Data Analysis and Transportation Modelling (p. 128)[bauiM3S10-VERDATAMOD]

ECTS Credits	Hours per week	Term	Instruction language
3	1/1	Winter term	de

Learning Control / Examinations
The assessment consists of an oral exam (15 minutes) according to §4(2), 2 of the examination regulation.

Conditions
See module description.

Learning Outcomes

Content

Course: Energetic Refurbishment [6241903]

Coordinators: K. Lennerts, Mitarbeiter
Part of the modules: Upgrading of Existing Buildings and Energetic Refurbishment (p. 143)[bauiM4S07-]

ECTS Credits	Hours per week	Term	Instruction language
1,5	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. 93)[bauiM2S11-WB3]

ECTS Credits	Hours per week	Term	Instruction language
6	3/1	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. 116)[bauiM3P3-STRINFRA]

ECTS Credits	Hours per week	Term	Instruction language
3	1/1	Summer term	de

Learning Control / Examinations
See module description.

Conditions
See corresponding module information.

Learning Outcomes

Content

Course: Environmental Fluid Mechanics [6221907]

Coordinators: N. N.
Part of the modules: Environmental Fluid Mechanics (p. 101)[bauiM2S19-SM5]

ECTS Credits	Hours per week	Term	Instruction language
6	2/2	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. 146)[bauiM4S10-]

ECTS Credits	Hours per week	Term	Instruction language
1,5	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. 43)[bauiM1S04-BAUDYN]

ECTS Credits	Hours per week	Term	Instruction language
3	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. 164)[bauiM5S04-GWDAMM]

ECTS Credits	Hours per week	Term	Instruction language
3	1/1	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. 168)[bauiM5S07-VERSMESS]

ECTS Credits	Hours per week	Term	Instruction language
1,5	1	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Logistics, Supply and Disposal [6231805]

Coordinators: M. Jehling
Part of the modules: Space and Infrastructure (p. 120)[bauiM3S02-PLRAUMINF]

ECTS Credits	Hours per week	Term	Instruction language
3	1/1	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. 96)[bauiM2S15-SM1]

ECTS Credits	Hours per week	Term	Instruction language
4,5	1/2	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Facility Management in Hospitals [6241921]

Coordinators: K. Lennerts, Mitarbeiter
Part of the modules: Facility Management in Hospitals and Hospital Management (p. 148)[bauiM4S13-]

ECTS Credits	Hours per week	Term	Instruction language
4,5	2/1	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. 138)[bauiM4P4-]

ECTS Credits	Hours per week	Term	Instruction language
1,5	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. 57)[bauiM1S16-FE-PRAXIS]

ECTS Credits	Hours per week	Term	Instruction language
6	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. 166)[bauiM5S05-FELSHOHL]

ECTS Credits	Hours per week	Term	Instruction language
3	1/1	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. 167)[bauiM5S06-NUMMOD]

ECTS Credits	Hours per week	Term	Instruction language
3	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 Long-distance, Freight and Air Transport (p. 129)[bauiM3S11-VERINTER]

ECTS Credits	Hours per week	Term	Instruction language
3	2/0	Winter term	de

Learning Control / Examinations
The assessment consists of an oral exam (15 minutes) according to §4(2), 2 of the examination regulation.

Conditions
None.

Learning Outcomes

Content

Course: Financing / Investment / Controlling [6241803]

Coordinators: K. Lennerts
Part of the modules: Economics and Management in Construction (p. 137)[bauiM4P3-]

ECTS Credits	Hours per week	Term	Instruction language
1,5	1	Summer term	

Learning Control / Examinations

Conditions

None.

Learning Outcomes

Content

Course: Finite Elements for Field and Time Dependent Problems [6215905]

Coordinators: P. Betsch
Part of the modules: Finite Elements for Field and Time Dependent Problems (p. 73)[bauiM1S30-FE2]

ECTS Credits	Hours per week	Term	Instruction language
6	2/2	Summer term	

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. 38)[bauiM1P3-FTW-BD]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Winter term	

Learning Control / Examinations

Conditions

None.

Learning Outcomes

Content

Course: Surface Water Quality [6223805]

Coordinators: S. Fuchs
Part of the modules: Water Quality of Surface Water Bodies and Groundwater (p. 109)[bauiM2S26-SW3]

ECTS Credits	Hours per week	Term	Instruction language
4,5	1/2	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Fluid Mechanics of Turbulent Flows [6221806]

Coordinators: M. Uhlmann
Part of the modules: Turbulent Flows (p. 102)[bauiM2S20-NS1]

ECTS Credits	Hours per week	Term	Instruction language
3	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: Advanced Fluid Mechanics [6221701]

Coordinators: N. N.
Part of the modules: Advanced Fluid Mechanics (p. 79)[bauiM2P1-AFM]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Building and Environmental Aerodynamics [6221905]

Coordinators: B. Ruck
Part of the modules: Interaction Flow - Building Structure (p. 97)[bauiM2S16-SM2]

ECTS Credits	Hours per week	Term	Instruction language
3	1/1	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Building Theory [6231804]

Coordinators: Everts
Part of the modules: Urban Renewal (p. 119)[bauiM3S01-PLSTUMB]

ECTS Credits	Hours per week	Term	Instruction language
1,5	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. 69)[bauiM1S27-BAUPH-I]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Coupled Phenomene in Geomechanics [6251918]

Coordinators: T. Wichtmann
Part of the modules: Coupled Geomechanic Processes (p. 173)[bauiM5S10-GEKOPPRO]

ECTS Credits	Hours per week	Term	Instruction language
3	1/1	Winter term	de

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Geomechanical Field Exercise [6251809]

Coordinators: G. Huber
Part of the modules: Ground Investigation (p. 161)[bauiM5S02-BERKUND]

ECTS Credits	Hours per week	Term	Instruction language
3	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. 164)[bauiM5S04-GWDAMM]

ECTS Credits	Hours per week	Term	Instruction language
3	1/1	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Aquatic Ecosystems [6224903]

Coordinators: C. Kämpf
Part of the modules: Aquatic Ecosystems (p. 88)[bauiM2S06-HY6]

ECTS Credits	Hours per week	Term	Instruction language
6	2/2	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. 48)[bauiM1S09- GlaKunSe]

ECTS Credits	Hours per week	Term	Instruction language
6	3/1	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Foundations and Retaining Structures [6251810]

Coordinators: P. Kudella
Part of the modules: Applied Geotechnics (p. 162)[bauiM5S03-ANGEOTEC]

ECTS Credits	Hours per week	Term	Instruction language
3	1/1	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. 152)[bauiM5P2-ERDGB]

ECTS Credits	Hours per week	Term	Instruction language
3	1/1	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Fundamental Mechanics of Construction Equipment [6241703]

Coordinators: S. Gentes, Mitarbeiter
Part of the modules: Construction Equipment and Machinery (p. 136)[bauiM4P2-]

ECTS Credits	Hours per week	Term	Instruction language
1,5	1	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: Basics in Earthworks and Embankment Dams [6251703]

Coordinators: A. Bieberstein
Part of the modules: Earthworks and Foundation Engineering (p. 152)[bauiM5P2-ERDGB]

ECTS Credits	Hours per week	Term	Instruction language
3	1/1	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. 41)[bauiM1S02-GDLSPANNB]

ECTS Credits	Hours per week	Term	Instruction language
6	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 Tunneling (p. 154)[bauiM5P3-FMTUB]

ECTS Credits	Hours per week	Term	Instruction language
3	1/1	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Basics of Finite Elements [6215901]

Coordinators: P. Betsch
Part of the modules: Basics of Finite Elements (p. 61)[bauiM1S20-GRUNDFE]

ECTS Credits	Hours per week	Term	Instruction language
6	2/2	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Groundwater Quality [6221811]

Coordinators: U. Mohrlok
Part of the modules: Water Quality of Surface Water Bodies and Groundwater (p. 109)[bauiM2S26-SW3]

ECTS Credits	Hours per week	Term	Instruction language
1,5	1/0	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Groundwater Management [6221801]

Coordinators: U. Mohrlok
Part of the modules: Groundwater Management (p. 90)[bauiM2S08-HY8]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Freight Transport [6232808]

Coordinators: B. Chlond
Part of the modules: Intermodality in Long-distance, Freight and Air Transport (p. 129)[bauiM3S11-VERINTER]

ECTS Credits	Hours per week	Term	Instruction language
3	1/1	Summer term	de

Learning Control / Examinations
The assessment consists of an oral exam (15 minutes) 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. 47)[bauiM1S08-HOHLPROFIL]

ECTS Credits	Hours per week	Term	Instruction language
6	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. 54)[bauiM1S13-BAUING-HHW]

ECTS Credits	Hours per week	Term	Instruction language
6	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. 53)[bauiM1S12-BAUING-HB]

ECTS Credits	Hours per week	Term	Instruction language
6	2/2	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Human Resources in the Real Estate Sector [6241810]

Coordinators: K. Lennerts, K. Janowski
Part of the modules: Business and Human Resource Management (p. 139)[bauiM4S01-]

ECTS Credits	Hours per week	Term	Instruction language
1,5	1	Summer term	

Learning Control / Examinations

Conditions

None.

Learning Outcomes

Content

Course: Hydrology Field Exercise and Literature Seminar [6224807]

Coordinators: J. Wienhöfer, U. Ehret
Part of the modules: Experimental Hydrology and Process Monitoring in Environmental Systems (p. 87)[bauiM2S05-HY5]

ECTS Credits	Hours per week	Term	Instruction language
6	0/4	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Infrastructure Equipment of Railway Tracks [6234808]

Coordinators: E. Hohnecker, Mitarbeiter
Part of the modules: Dimensioning and Construction of Railway Lines (p. 132)[bauiM3S14-EBBAU]

ECTS Credits	Hours per week	Term	Instruction language
1,5	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 Railway Traffic [6234806]

Coordinators: E. Hohnecker
Part of the modules: Dimensioning and Construction of Railway Lines (p. 132)[bauiM3S14-EBBAU]

ECTS Credits	Hours per week	Term	Instruction language
3	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: Cost Estimation [6241801]

Coordinators: S. Haghsheno
Part of the modules: Economics and Management in Construction (p. 137)[bauiM4P3-]

ECTS Credits	Hours per week	Term	Instruction language
3	1/1	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Theory of Kinetic Stability for Structures [6215910]

Coordinators: P. Betsch, T. Seelig
Part of the modules: Model Formulation in Strength of Materials and Theory of Kinetic Stability for Structures (p. 78)[bauiM1S34-MOFEKIST]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Contact Mechanics I - Statics [6215803]

Coordinators: C. Hesch, A. Konyukhov
Part of the modules: Contact Mechanics I - Statics (p. 64)[bauiM1S23-KONTMECH-I]

ECTS Credits	Hours per week	Term	Instruction language
6	2/2	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Contact Mechanics II - Dynamics [6215907]

Coordinators: A. Konyukhov
Part of the modules: Contact Mechanics II - Dynamics (p. 74)[bauiM1S31-KONTMECH-II]

ECTS Credits	Hours per week	Term	Instruction language
6	2/2	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Continuum Mechanics [6215702]

Coordinators: T. Seelig, P. Betsch
Part of the modules: Continuum Mechanics of Heterogeneous Solids (p. 76)[bauiM1S32-KONTIMECH]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Continuum Mechanics for Geotechnics [6251705]

Coordinators: C. Hesch
Part of the modules: Basics in Numerical Modelling (p. 156)[bauiM5P4-NUMGRUND]

ECTS Credits	Hours per week	Term	Instruction language
3	1/1	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Corrosion Processes and Life Time [6211907]

Coordinators: J. Eckhardt, M. Haist, M. Vogel
Part of the modules: Durability and Service Life Design (p. 67)[bauiM1S25-DAUERLEB]

ECTS Credits	Hours per week	Term	Instruction language
4,5	2/1	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Hospital Management [2550493]

Coordinators: S. Nickel
Part of the modules: Facility Management in Hospitals and Hospital Management (p. 148)[bauiM4S13-]

ECTS Credits	Hours per week	Term	Instruction language
1,5	1	Summer 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. 112)[bauiM2S29-SW6]

ECTS Credits	Hours per week	Term	Instruction language
3	1/1	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. 124)[bauiM3S06-STRBAUT]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Lean Construction [6241908]

Coordinators: S. Haghsheno, Mitarbeiter
Part of the modules: Lean Construction (p. 145)[bauiM4S09-]

ECTS Credits	Hours per week	Term	Instruction language
6	3/1	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Real Estate Life Cycle Management [6241807]

Coordinators: K. Lennerts, Mitarbeiter
Part of the modules: Sustainability in Real Estate Management (p. 138)[bauiM4P4-]

ECTS Credits	Hours per week	Term	Instruction language
1,5	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 - Operational Logistics and Management (p. 126)[bauiM3S08-EBLOGISTIK]

ECTS Credits	Hours per week	Term	Instruction language
3	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: Solid Construction Bridges [6211901]

Coordinators: L. Stempniewski
Part of the modules: Solid Construction Bridges (p. 42)[bauiM1S03-MASSBRUE]

ECTS Credits	Hours per week	Term	Instruction language
6	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. 71)[bauiM1S29-MATPRÜF]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Micromechanics of Heterogeneous Solids [6215805]

Coordinators: T. Seelig, P. Betsch
Part of the modules: Continuum Mechanics of Heterogeneous Solids (p. 76)[bauiM1S32-KONTIMECH]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Multi-Phase Flow [6222701]

Coordinators: F. Nestmann
Part of the modules: Dynamics of Water and Mass Transport in River Basins (p. 81)[bauiM2P2-WSF]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Laboratory Course on Structural Vibrations I [6215703]

Coordinators: T. Seelig, P. Betsch
Part of the modules: Laboratory Course on Structural Vibrations (p. 77)[bauiM1S33-MESSPRAK]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Laboratory Course on Structural Vibrations II [6215806]

Coordinators: T. Seelig, P. Betsch
Part of the modules: Laboratory Course on Structural Vibrations (p. 77)[bauiM1S33-MESSPRAK]

ECTS Credits	Hours per week	Term	Instruction language
3	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. 71)[bauiM1S29-MATPRÜF]

ECTS Credits	Hours per week	Term	Instruction language
3	1/1	Winter term	

Learning Control / Examinations

Conditions
None.

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. 92)[bauiM2S10-WB2]

ECTS Credits	Hours per week	Term	Instruction language
6	2/2	Winter term	

Learning Control / Examinations

Conditions

None.

Learning Outcomes

Content

Course: Model Formulation in Strength of Materials [6215807]

Coordinators: P. Betsch, T. Seelig
Part of the modules: Model Formulation in Strength of Materials and Theory of Kinetic Stability for Structures (p. 78)[bauiM1S34-MOFEKIST]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Summer term	

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. 113)[bauiM2S30-SW7]

ECTS Credits	Hours per week	Term	Instruction language
3	0/2	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Morphodynamics [6222805]

Coordinators: F. Seidel
Part of the modules: River Dynamics (p. 95)[bauiM2S13-WB5]

ECTS Credits	Hours per week	Term	Instruction language
3	1/1	Summer term	

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. 138)[bauiM4P4-]

ECTS Credits	Hours per week	Term	Instruction language
3	1/1	Summer term	

Learning Control / Examinations

Conditions

None.

Learning Outcomes

Content

Course: Supplementary Claim Management [6241822]

Coordinators: S. Gentes, R. Bartsch
Part of the modules: Advanced Project Management (p. 141)[bauiM4S05-]

ECTS Credits	Hours per week	Term	Instruction language
1,5	1	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: New Development and Optimization of Decommissioning Machine Technology [6241919]

Coordinators: S. Gentes, Mitarbeiter
Part of the modules: Decommissioning of Nuclear Facilities (p. 147)[bauiM4S12-]

ECTS Credits	Hours per week	Term	Instruction language
3	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. 60)[bauiM1S19-NILI-FTW]

ECTS Credits	Hours per week	Term	Instruction language
6	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. 55)[bauiM1S14-NILI-STAB]

ECTS Credits	Hours per week	Term	Instruction language
6	2/2	Winter term	

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. 156)[bauiM5P4-NUMGRUND]

ECTS Credits	Hours per week	Term	Instruction language
3	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. 90)[bauiM2S08-HY8]

ECTS Credits	Hours per week	Term	Instruction language
3	1/1	Winter term	

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. 59)[bauiM1S18-FEM-BS]

ECTS Credits	Hours per week	Term	Instruction language
6	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: Advanced Fluid Mechanics (p. 79)[bauiM2P1-AFM]

ECTS Credits	Hours per week	Term	Instruction language
3	1/1	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. 103)[bauiM2S21-NS2]

ECTS Credits	Hours per week	Term	Instruction language
3	1/1	Summer term	

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. 103)[bauiM2S21-NS2]

ECTS Credits	Hours per week	Term	Instruction language
3	1/1	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Planning Techniques and Planning Methods [6231807]

Coordinators: S. Keller
Part of the modules: Space and Infrastructure (p. 120)[bauiM3S02-PLRAUMINF]

ECTS Credits	Hours per week	Term	Instruction language
3	1/1	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Wastewater Analyses and Application [6225801]

Coordinators: J. Winter, M. Bajaj
Part of the modules: Wastewater Analyses in Practice (p. 105)[bauiM2S22-IB1]

ECTS Credits	Hours per week	Term	Instruction language
6	4	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. 43)[bauiM1S04-BAUDYN]

ECTS Credits	Hours per week	Term	Instruction language
3	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. 70)[bauiM1S28-BAUPH-II]

ECTS Credits	Hours per week	Term	Instruction language
3	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. 70)[bauiM1S28-BAUPH-II]

ECTS Credits	Hours per week	Term	Instruction language
3	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. 127)[bauiM3S09-PROJEKTIP]

ECTS Credits	Hours per week	Term	Instruction language
6	4	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Project Development [6241906]

Coordinators: K. Lennerts, Mitarbeiter
Part of the modules: Real Estate Management (p. 144)[bauiM4S08-]

ECTS Credits	Hours per week	Term	Instruction language
1,5	1	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Project Management II [6241824]

Coordinators: S. Haghsheno, H. Schneider, K. Teizer
Part of the modules: Advanced Project Management (p. 141)[bauiM4S05-]

ECTS Credits	Hours per week	Term	Instruction language
3	1/1	Summer term	

Learning Control / Examinations

Conditions

None.

Learning Outcomes

Content

Course: Project Control [6241823]

Coordinators: G. Schlick
Part of the modules: Advanced Project Management (p. 141)[bauiM4S05-]

ECTS Credits	Hours per week	Term	Instruction language
1,5	1	Summer term	

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. 123)[bauiM3S05-STRENTW]

ECTS Credits	Hours per week	Term	Instruction language
3	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. 142)[bauiM4S06-]

ECTS Credits	Hours per week	Term	Instruction language
3	1/1	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Test Procedures in Construction [6241821]

Coordinators: H. Schneider
Part of the modules: Construction Process Engineering and Quality Management (p. 140)[bauiM4S04-]

ECTS Credits	Hours per week	Term	Instruction language
1,5	1	Summer 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

- Have extensive knowledge in soil examination.
- Can conduct soil examinations independently.
- Can evaluate examination results and assess their reliability.

Content
The lecture comprises

- Foundations of soil examination regarding processing of samples.
- Norms, classifications, and criteria necessary to plan the scope of examinations and sampling.
- Applied examinations at the laboratory and in the field, boundaries of examination methods.
- Possible sources of error and reliability of examination results.

Media
Lecture supplements.

Course: Public Private Partnership [6241905]

Coordinators: K. Lennerts, Mitarbeiter
Part of the modules: Real Estate Management (p. 144)[bauiM4S08-]

ECTS Credits	Hours per week	Term	Instruction language
1,5	1	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Public Real Estate Management [6241904]

Coordinators: K. Lennerts, Mitarbeiter
Part of the modules: Real Estate Management (p. 144)[bauiM4S08-]

ECTS Credits	Hours per week	Term	Instruction language
1,5	1	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Quality and Environmental Management [6241820]

Coordinators: S. Haghsheno, Mitarbeiter
Part of the modules: Construction Process Engineering and Quality Management (p. 140)[bauiM4S04-]

ECTS Credits	Hours per week	Term	Instruction language
1,5	1	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Law Aspects of Guided Transport Systems [6234903]

Coordinators: R. Schweinsberg
Part of the modules: Economics, Law and Environmental Aspects in Railway Transportation (p. 133)[bauiM3S15-EBUMWELT]

ECTS Credits	Hours per week	Term	Instruction language
1,5	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: W. Jung
Part of the modules: Urban and Regional Planning (p. 114)[bauiM3P1-PLSTAREG]

ECTS Credits	Hours per week	Term	Instruction language
3	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. 58)[bauiM1S17-STABISHELL]

ECTS Credits	Hours per week	Term	Instruction language
3	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, M. Günter
Part of the modules: Building Preservation of Concrete and Masonry Constructions (p. 68)[bauiM1S26-BBM], Building Preservation in Concrete and Masonry Constructions (p. 149)[bauiM4S14-]

ECTS Credits	Hours per week	Term	Instruction language
4,5	2/1	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Seminar: Ecological Management of Water Bodies [6223901]

Coordinators: S. Fuchs
Part of the modules: Applied Ecology (p. 110)[bauiM2S27-SW4]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Seminar in Highway Engineering [6233908]

Coordinators: M. Zimmermann
Part of the modules: Road Safety (p. 130)[bauiM3S12-STRVSICH]

ECTS Credits	Hours per week	Term	Instruction language
3	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: Data Analysis and Transportation Modelling (p. 128)[bauiM3S10-VERDATAMOD]

ECTS Credits	Hours per week	Term	Instruction language
3	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. 130)[bauiM3S12-STRVSICH]

ECTS Credits	Hours per week	Term	Instruction language
3	1/1	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. 100)[bauiM2S18-SM4]

ECTS Credits	Hours per week	Term	Instruction language
3	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 und Simulation Methods (p. 121)[bauiM3S03-VERMANAGE]

ECTS Credits	Hours per week	Term	Instruction language
3	1/1	Summer term	de

Learning Control / Examinations
The assessment consists of an oral exam (15 minutes) 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, Mitarbeiter
Part of the modules: Special Topics in Highway Engineering (p. 131)[bauiM3S13-STRSPEZ]

ECTS Credits	Hours per week	Term	Instruction language
1,5	1	Summer term	

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. 162)[bauiM5S03-ANGEOTEC]

ECTS Credits	Hours per week	Term	Instruction language
3	1/1	Summer term	

Learning Control / Examinations

Conditions

None.

Learning Outcomes

Content

Course: ”Spannbeton in der baubetrieblichen Praxis” [6241818]

Coordinators: S. Haghsheno, F. Kohlbecker
Part of the modules: Construction Process Engineering and Quality Management (p. 140)[bauiM4S04-]

ECTS Credits	Hours per week	Term	Instruction language
1,5	1	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Stress, Strain and Limit States in Soils [6251801]

Coordinators: A. Niemunis
Part of the modules: Theoretical Soil Mechanics (p. 150)[bauiM5P1-THEOBM]

ECTS Credits	Hours per week	Term	Instruction language
4,5	2/1	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Stress, Strain and Limit States in Rock [6251804]

Coordinators: E. Gerolymatou
Part of the modules: Rock Mechanics and Tunneling (p. 154)[bauiM5P3-FMTUB]

ECTS Credits	Hours per week	Term	Instruction language
3	1/1	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. 117)[bauiM3P4-EBTECHNIK]

ECTS Credits	Hours per week	Term	Instruction language
6	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. 58)[bauiM1S17-STABISHELL]

ECTS Credits	Hours per week	Term	Instruction language
3	1/1	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Urban Management [6231801]

Coordinators: W. Jung
Part of the modules: Urban Renewal (p. 119)[bauiM3S01-PLSTUMB]

ECTS Credits	Hours per week	Term	Instruction language
3	1/1	Summer term	

Learning Control / Examinations

Conditions

None.

Learning Outcomes

Content

Course: Urban Planning [6231701]

Coordinators: W. Jung
Part of the modules: Urban and Regional Planning (p. 114)[bauiM3P1-PLSTAREG]

ECTS Credits	Hours per week	Term	Instruction language
3	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. 119)[bauiM3S01-PLSTUMB]

ECTS Credits	Hours per week	Term	Instruction language
1,5	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. 37)[bauiM1P2-STAHLBAU]

ECTS Credits	Hours per week	Term	Instruction language
6	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. 46)[bauiM1S07- STAHLBRÜ]

ECTS Credits	Hours per week	Term	Instruction language
6	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. 45)[bauiM1S06-SCHWEISSEN]

ECTS Credits	Hours per week	Term	Instruction language
6	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. 134)[bauiM3S16-EBVERKEHR]

ECTS Credits	Hours per week	Term	Instruction language
1,5	0/1	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. 99)[bauiM2S17-SM3]

ECTS Credits	Hours per week	Term	Instruction language
6	2/2	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Mass Fluxes [6223701]

Coordinators: S. Fuchs
Part of the modules: Mass Fluxes and Cycles (p. 82)[bauiM2P3-STK]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Winter 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. 113)[bauiM2S30-SW7]

ECTS Credits	Hours per week	Term	Instruction language
3	2/0	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. 115)[bauiM3P2-VERMODELL]

ECTS Credits	Hours per week	Term	Instruction language
3	1/1	Winter term	de

Learning Control / Examinations
The assessment consists of an oral exam (15 minutes) according to §4(2), 2 of the examination regulation.

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. 100)[bauiM2S18-SM4]

ECTS Credits	Hours per week	Term	Instruction language
3	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. 95)[bauiM2S13-WB5]

ECTS Credits	Hours per week	Term	Instruction language
3	1/1	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. 131)[bauiM3S13-STRSPEZ]

ECTS Credits	Hours per week	Term	Instruction language
3	2	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. 84)[bauiM2S02-HY2]

ECTS Credits	Hours per week	Term	Instruction language
6	2/2	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. 146)[bauiM4S10-]

ECTS Credits	Hours per week	Term	Instruction language
1,5	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. 50)[bauiM1S10-BAUING-TSH]

ECTS Credits	Hours per week	Term	Instruction language
3	1/1	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. 50)[bauiM1S10-BAUING-TSH]

ECTS Credits	Hours per week	Term	Instruction language
3	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. 166)[bauiM5S05-FELSHOHL]

ECTS Credits	Hours per week	Term	Instruction language
3	1/1	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. 146)[bauiM4S10-]

ECTS Credits	Hours per week	Term	Instruction language
3	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: Turbulent Flows (p. 102)[bauiM2S20-NS1]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Landfills [6251913]

Coordinators: A. Bieberstein
Part of the modules: Environmental Geotechnics (p. 171)[bauiM5S09-UMGEOTEC]

ECTS Credits	Hours per week	Term	Instruction language
3	1/1	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. 167)[bauiM5S06-NUMMOD]

ECTS Credits	Hours per week	Term	Instruction language
3	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. 133)[bauiM3S15-EBUMWELT]

ECTS Credits	Hours per week	Term	Instruction language
3	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. 89)[bauiM2S07-HY7]

ECTS Credits	Hours per week	Term	Instruction language
6	2/2	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. 118)[bauiM3P5-VERFRECHT]

ECTS Credits	Hours per week	Term	Instruction language
1,5	1	Summer term	

Learning Control / Examinations
See module description

Conditions
See corresponding module information

Learning Outcomes

Content

Course: Urban Water Management [6220902]

Coordinators: S. Fuchs, P. Klingel, U. Mohrlok
Part of the modules: Urban Water Management (p. 108)[bauiM2S25-SW2]

ECTS Credits	Hours per week	Term	Instruction language
6	2/2	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Processing of Wastes with Excursions [6225802]

Coordinators: J. Winter
Part of the modules: Technologies for Solid Waste Management (p. 106)[bauiM2S23-IB2]

ECTS Credits	Hours per week	Term	Instruction language
6	2/2	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Disassembly Process Engineering [6241828]

Coordinators: S. Gentes
Part of the modules: Environmentally-friendly Recycling and Disassembly of Buildings (p. 142)[bauiM4S06-]

ECTS Credits	Hours per week	Term	Instruction language
3	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. 107)[bauiM2S24-SW1]

ECTS Credits	Hours per week	Term	Instruction language
3	1/1	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. 107)[bauiM2S24-SW1]

ECTS Credits	Hours per week	Term	Instruction language
3	1/1	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. 66)[bauiM1S24-BETONTECH]

ECTS Credits	Hours per week	Term	Instruction language
1,5	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. 118)[bauiM3P5-VERFRECHT]

ECTS Credits	Hours per week	Term	Instruction language
3	2/0	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 und Simulation Methods (p. 121)[bauiM3S03-VERMANAGE]

ECTS Credits	Hours per week	Term	Instruction language
3	1/1	Summer term	de

Learning Control / Examinations
The assessment consists of an oral exam (15 minutes) 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. 94)[bauiM2S12-WB4]

ECTS Credits	Hours per week	Term	Instruction language
6	2/2	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Rock Testing [6251909]

Coordinators: G. Huber
Part of the modules: Geotechnical Testing and Measuring Technology (p. 168)[bauiM5S07-VERSMESS]

ECTS Credits	Hours per week	Term	Instruction language
1,5	1	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Contract and Employment Law [6241811]

Coordinators: S. Haghsheno, R. Kohlhammer
Part of the modules: Business and Human Resource Management (p. 139)[bauiM4S01-]

ECTS Credits	Hours per week	Term	Instruction language
1,5	1	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Soil as Viscous Multi-phase System [6251901]

Coordinators: A. Niemunis
Part of the modules: Special Issues of Soil Mechanics (p. 159)[bauiM5S01-SPEZBM]

ECTS Credits	Hours per week	Term	Instruction language
3	1/1	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. 85)[bauiM2S03-HY3]

ECTS Credits	Hours per week	Term	Instruction language
6	2/2	Summer term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Terrestrial Water Flows and Mass Transport [6224701]

Coordinators: E. Zehe
Part of the modules: Dynamics of Water and Mass Transport in River Basins (p. 81)[bauiM2P2-WSF]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Winter 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. 111)[bauiM2S28-SW5]

ECTS Credits	Hours per week	Term	Instruction language
3	1/1	Summer term	

Learning Control / Examinations

Conditions

None.

Learning Outcomes

Content

Course: Hydraulic Engineering Project [6220901]

Coordinators: C. Lang, F. Seidel
Part of the modules: Experimental Techniques I: Small Scale Experiments (p. 96)[bauiM2S15-SM1]

ECTS Credits	Hours per week	Term	Instruction language
1,5	0/1	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Water Resources and River Basin Management [6224801]

Coordinators: U. Ehret, J. Ihringer
Part of the modules: Water Resources and River Basin Management (p. 83)[bauiM2S01-HY1]

ECTS Credits	Hours per week	Term	Instruction language
6	2/2	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. 111)[bauiM2S28-SW5]

ECTS Credits	Hours per week	Term	Instruction language
3	1/1	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. 91)[bauiM2S09-WB1]

ECTS Credits	Hours per week	Term	Instruction language
6	2/2	Winter term	

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. 97)[bauiM2S16-SM2]

ECTS Credits	Hours per week	Term	Instruction language
3	1/1	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Tendering, Planning and Financing in Public Transport [6232807]

Coordinators: W. Weißkopf
Part of the modules: Planning of Transportation Systems (p. 122)[bauiM3S04-VERPLAN]

ECTS Credits	Hours per week	Term	Instruction language
3	2/0	Summer term	de

Learning Control / Examinations
The assessment consists of an oral exam (15 minutes) according to §4(2), 2 of the examination regulation.

Conditions
See module description.

Learning Outcomes

Content

Course: Economic Efficiency of Guided Transport Systems [6234902]

Coordinators: E. Hohnecker
Part of the modules: Economics, Law and Environmental Aspects in Railway Transportation (p. 133)[bauiM3S15-EBUMWELT]

ECTS Credits	Hours per week	Term	Instruction language
1,5	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.

Course: Time-dependent Phenomena in Hard Rock [6251916]

Coordinators: E. Gerolymatou
Part of the modules: Coupled Geomechanic Processes (p. 173)[bauiM5S10-GEKOPPRO]

ECTS Credits	Hours per week	Term	Instruction language
3	1/1	Winter term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Studien- und Prüfungsordnung des Karlsruher Instituts für Technologie (KIT) für den Masterstudiengang Bauingenieurwesen

In einer Zusammenstellung der StudienKommission Bauingenieure vom 15.05.2012

Zugrunde liegen die am 8. Sept. 2009 ausgegebene Fassung der SPO (Amtliche Bekanntmachung Nr. 78) und die Änderungssatzung vom 19. März 2012 (Amtliche Bekanntmachung Nr. 6).

Diese Zusammenstellung wurde mit größter Sorgfalt erstellt, trotzdem kann für eventuell vorhandene Fehler keine Gewähr übernommen werden. Maßgebend sind die Amtlichen Bekanntmachungen des KIT (http://www.kit.edu/studieren/amtlicheBekanntmachungen.php).

Inhaltsverzeichnis

Die Universität Karlsruhe (TH) hat sich im Rahmen der Umsetzung des Bolognaprozesses zum Aufbau eines Europäischen Hochschulraumes zum Ziel gesetzt, dass am Abschluss der Studierendenausbildung an der Universität Karlsruhe (TH) der Mastergrad stehen soll. Die Universität Karlsruhe (TH) sieht daher die an der Universität Karlsruhe (TH) angebotenen konsekutiven Bachelor- und Masterstudiengänge als Gesamtkonzept mit konsekutivem Curriculum. In dieser Satzung ist nur die männliche Sprachform gewählt worden. Alle personenbezogenen Aussagen gelten jedoch stets für Männer und Frauen gleichermaßen.

I. Allgemeine Bestimmungen

§ 1 Geltungsbereich, Ziele

(1) Diese Masterprüfungsordnung regelt Studienablauf, Prüfungen und den Abschluss des Studiums im Masterstudiengang Bauingenieurwesen an der Universität Karlsruhe (TH).

(2) Im Masterstudium sollen die im Bachelorstudium erworbenen wissenschaftlichen Qualifikationen weiter vertieft oder ergänzt werden. Der Student soll in die Lage versetzt werden, wissenschaftliche Erkenntnisse und Methoden selbstständig anzuwenden und ihre Bedeutung und Reichweite für die Lösung komplexer wissenschaftlicher und gesellschaftlicher Problemstellungen zu bewerten.

§ 2 Akademischer Grad

Aufgrund der bestandenen Masterprüfung wird der akademische Grad „Master of Science“ (abgekürzt: „M.Sc.“) verliehen.

§ 3 Regelstudienzeit, Studienaufbau, Leistungspunkte

(1) Die Regelstudienzeit beträgt vier Semester. Sie umfasst neben den Lehrveranstaltungen Prüfungen und das Modul Masterarbeit.

(2) Die im Studium zu absolvierenden Lehrinhalte sind in Module gegliedert, die jeweils aus einer oder mehreren, thematisch und zeitlich aufeinander bezogenen Lehrveranstaltungen bestehen. Art, Umfang und Zuordnung der Module zu einem Fach sowie die Möglichkeit, Module untereinander zu kombinieren, beschreibt der Studienplan. Die Module und ihr Umfang werden in § 17 definiert.

(3) Der für das Absolvieren von Lehrveranstaltungen und Modulen vorgesehene Arbeitsaufwand wird in Leistungspunkten (LP) ausgewiesen. Die Maßstäbe für die Zuordnung von Leistungspunkten entsprechen dem ECTS (European Credit Transfer System). Ein Leistungspunkt entspricht einem Arbeitsaufwand von etwa 30 Zeitstunden.

(4) Der Umfang der für den erfolgreichen Abschluss des Studiums erforderlichen Studienleistungen wird in Leistungspunkten gemessen und beträgt insgesamt 120 Leistungspunkte.

(5) Die Verteilung der Leistungspunkte im Studienplan auf die Semester hat in der Regel gleichmäßig zu erfolgen.

(6) Lehrveranstaltungen können auch in englischer Sprache angeboten werden.

§ 4 Aufbau der Prüfungen

(1) Die Masterprüfung besteht aus Modulprüfungen und einer Masterarbeit, jede Modulprüfung aus einer oder mehreren Modulteilprüfungen. Eine Modulteilprüfung besteht aus mindestens einer Erfolgskontrolle.

(2) Erfolgskontrollen sind:

1. schriftliche Prüfungen,
2. mündliche Prüfungen oder
3. Erfolgskontrollen anderer Art.

Erfolgskontrollen anderer Art sind z.B. testierte Hausarbeiten, die aus einer semesterbegleitenden schriftlichen Bearbeitung von Aufgaben bestehen, sowie Studienarbeiten, Vorträge, Projekte, schriftliche Arbeiten, Seminararbeiten, mündliche oder schriftliche Befragungen und Klausuren, sofern sie nicht als schriftliche oder mündliche Prüfung in der Modul- oder Lehrveranstaltungsbeschreibung im Studienplan ausgewiesen sind.

(3) In der Regel sind mindestens 50 % einer Modulprüfung in Form von schriftlichen oder mündlichen Prüfungen (Absatz 2, Nr. 1 und 2) abzulegen, die restlichen Prüfungen erfolgen durch Erfolgskontrollen anderer Art (Absatz 2, Nr. 3).

§ 5 Anmeldung und Zulassung zu den Prüfungen

(1) Um an den Modulprüfungen teilnehmen zu können, muss sich der Student schriftlich oder per Online-Anmeldung beim Studienbüro anmelden. Hierbei sind die gemäß dem Studienplan für die jeweilige Modulprüfung notwendigen Studienleistungen nachzuweisen. Darüber hinaus muss sich der Student für jede einzelne Modulteilprüfung, die in Form einer schriftlichen oder mündlichen Prüfung (§ 4 Abs. 2, Nr. 1 und 2) durchgeführt wird, beim Studienbüro anmelden. Dies gilt auch für die Anmeldung zur Masterarbeit.

(2) Um zu Erfolgskontrollen gemäß § 4 Abs. 2, Nr. 1 bis 3 in einem bestimmten Modul zugelassen zu werden, muss der Student vor der ersten Erfolgskontrolle in diesem Modul beim Studienbüro eine bindende Erklärung über die Wahl des betreffenden Moduls abgeben.

(3) Die Zulassung darf nur abgelehnt werden, wenn der Student in einem mit dem Masterstudiengang Bauingenieurwesen vergleichbaren oder einem verwandten Studiengang bereits eine Diplomvorprüfung, Diplomprüfung, Bachelor- oder Masterprüfung endgültig nicht bestanden hat, sich in einem Prüfungsverfahren befindet oder den Prüfungsanspruch in einem solchen Studiengang verloren hat. In Zweifelsfällen entscheidet der Prüfungsausschuss.

(4) Die Anmeldung zu einer schriftlichen oder mündlichen Modulprüfung oder Modulteilprüfung gilt zugleich als bedingte Anmeldung für die Wiederholung dieser Prüfung.

§ 6 Durchführung von Prüfungen und Erfolgskontrollen

(1) Erfolgskontrollen werden studienbegleitend, in der Regel im Verlauf der Vermittlung der Lehrinhalte der einzelnen Module oder zeitnah danach, durchgeführt.

(2) Die Art der Erfolgskontrolle (§ 4 Abs. 2, Nr. 1 bis 3) der einzelnen Lehrveranstaltungen wird vom Prüfer der betreffenden Lehrveranstaltung in Bezug auf die Lehrinhalte der Lehrveranstaltung und die Lehrziele des Moduls oder Modulteils festgelegt. Der Prüfer, die Art der Erfolgskontrollen, ihre Häufigkeit, Reihenfolge und Gewichtung und die Bildung der Lehrveranstaltungsnote müssen mindestens sechs Wochen vor Semesterbeginn bekannt gegeben werden. Im Einvernehmen zwischen Prüfer und Student kann die Art der

Erfolgskontrolle auch nachträglich geändert werden. Dabei ist jedoch § 4 Abs. 3 zu berücksichtigen.

(3) Eine schriftlich durchzuführende Prüfung kann auch mündlich, eine mündlich durchzuführende Prüfung kann auch schriftlich abgenommen werden. Diese Änderung muss mindestens sechs Wochen vor der Prüfung bekannt gegeben werden.

(4) Weist ein Student nach, dass er wegen länger andauernder oder ständiger körperlicher Behinderung nicht in der Lage ist, die Erfolgskontrollen ganz oder teilweise in der vorgeschriebenen Form abzulegen, kann der zuständige Prüfungsausschuss – in dringenden Angelegenheiten, deren Erledigung nicht bis zu einer Sitzung des Ausschusses aufgeschoben werden kann, dessen Vorsitzender – gestatten, Erfolgskontrollen in einer anderen Form zu erbringen.

(5) Bei Lehrveranstaltungen in englischer Sprache können mit Zustimmung des Studenten die entsprechenden Erfolgskontrollen in englischer Sprache abgenommen werden.

(6) Schriftliche Prüfungen (§ 4 Abs. 2, Nr. 1) sind in der Regel von einem Prüfer nach § 15 Abs. 2 oder § 15 Abs. 3 zu bewerten. Die Note ergibt sich aus dem entsprechend den Leistungspunkten gewichteten arithmetischen Mittel der Einzelbewertungen. Entspricht das arithmetische Mittel keiner der in § 7 Abs. 2, Satz 2 definierten Notenstufen, so ist auf die nächstliegende Notenstufe zu runden. Bei gleichem Abstand ist auf die nächstbessere Notenstufe zu runden. Ergibt das arithmetische Mittel einen Wert von 4.1 oder schlechter, so wird die Prüfung mit „nicht ausreichend“ bewertet. Das Bewertungsverfahren soll sechs Wochen nicht überschreiten. Schriftliche Einzelprüfungen dauern mindestens 60 und höchstens 240 Minuten.

(7) Mündliche Prüfungen (§ 4 Abs. 2, Nr. 2) sind von mehreren Prüfern (Kollegialprüfung) oder von einem Prüfer in Gegenwart eines Beisitzenden als Gruppen- oder Einzelprüfungen abzunehmen und zu bewerten. Vor der Festsetzung der Note hört der Prüfer die anderen an der Kollegialprüfung mitwirkenden Prüfer an. Mündliche Prüfungen dauern in der Regel mindestens 15 Minuten und maximal 45 Minuten pro Student.

(8) Die wesentlichen Gegenstände und Ergebnisse der mündlichen Prüfung in den einzelnen Modulen sind in einem Protokoll festzuhalten. Das Ergebnis der Prüfung ist dem Studenten im Anschluss an die mündliche Prüfung bekannt zu geben.

(9) Für Erfolgskontrollen anderer Art sind angemessene Bearbeitungsfristen einzuräumen und Abgabetermine festzulegen. Dabei ist durch die Art der Aufgabenstellung und durch entsprechende Dokumentation sicherzustellen, dass die erbrachte Studienleistung dem Studenten zurechenbar ist. Die wesentlichen Gegenstände und Ergebnisse einer solchen Erfolgskontrolle sind in einem Protokoll festzuhalten.

(10) Schriftliche Arbeiten im Rahmen einer Erfolgskontrolle anderer Art haben dabei die folgende Erklärung zu tragen: „Ich versichere wahrheitsgemäß, die Arbeit selbstständig angefertigt, alle benutzten Hilfsmittel vollständig und genau angegeben und alles kenntlich gemacht zu haben, was aus Arbeiten anderer unverändert oder mit Abänderungen entnommen wurde.“ Trägt die Arbeit diese Erklärung nicht, wird diese Arbeit nicht angenommen. Die wesentlichen Gegenstände und Ergebnisse einer solchen Erfolgskontrolle sind in einem Protokoll festzuhalten.

(11) Bei mündlich durchgeführten Erfolgskontrollen anderer Art muss neben dem Prüfer ein Beisitzender anwesend sein. Auf die Anfertigung eines Protokolls kann verzichtet werden.

§ 7 Bewertung von Prüfungen und Erfolgskontrollen

(1) Das Ergebnis einer Erfolgskontrolle wird von den jeweiligen Prüfern in Form einer Note festgesetzt.

(2) Im Masterzeugnis dürfen nur folgende Noten verwendet werden:

1 : sehr gut (very good) : hervorragende Leistung,

2 : gut (good) : eine Leistung, die erheblich über den durchschnittlichen Anforderungen liegt,

3 : befriedigend (satisfactory) : eine Leistung, die durchschnittlichen Anforderungen entspricht,

4 : ausreichend (sufficient) : eine Leistung, die trotz ihrer Mängel noch den Anforderungen genügt,

5 : nicht ausreichend (failed) : eine Leistung, die wegen erheblicher Mängel nicht den Anforderungen genügt.

Für die Masterarbeit, Modulteilprüfungen und für Modulprüfungen sind zur differenzierten Bewertung nur folgende Noten zugelassen:

1 : 1.0, 1.3 : sehr gut

2 : 1.7, 2.0, 2.3 : gut

3 : 2.7, 3.0, 3.3 : befriedigend

4 : 3.7, 4.0 : ausreichend

5 : 4.7, 5.0 : nicht ausreichend

Diese Noten müssen in den Protokollen und in den Anlagen (Transcript of Records und Diploma Supplement) verwendet werden.

(3) Für Erfolgskontrollen anderer Art kann im Studienplan die Benotung mit „bestanden" (passed) oder „nicht bestanden" (failed) vorgesehen werden.

(4) Bei der Bildung der gewichteten Durchschnitte der Modulnoten und der Gesamtnote wird nur die erste Dezimalstelle hinter dem Komma berücksichtigt; alle weiteren Stellen werden ohne Rundung gestrichen.

(5) Jedes Modul, jede Lehrveranstaltung und jede Erfolgskontrolle darf in demselben Studiengang nur einmal angerechnet werden. Die Anrechnung eines Moduls, einer Lehrveranstaltung oder einer Erfolgskontrolle ist darüber hinaus ausgeschlossen, wenn das betreffende Modul, die Lehrveranstaltung oder die Erfolgskontrolle bereits in einem grundständigen Bachelorstudiengang angerechnet wurde, auf dem dieser Masterstudiengang konsekutiv aufbaut.

(6) Erfolgskontrollen anderer Art dürfen in Modulteilprüfungen oder Modulprüfungen nur eingerechnet werden, wenn die Benotung nicht nach Absatz 3 erfolgt ist. Die zu dokumentierenden Erfolgskontrollen und die daran geknüpften Bedingungen werden im Studienplan festgelegt.

(7) Eine Modulteilprüfung ist bestanden, wenn die Note mindestens „ausreichend" (4.0) ist.

(8) Eine Modulprüfung ist dann bestanden, wenn die Modulnote mindestens „ausreichend" (4.0) ist. Die Modulprüfung und die Bildung der Modulnote werden im Studienplan geregelt. Die differenzierten Lehrveranstaltungsnoten (Absatz 2) sind bei der Berechnung der Modulnoten als Ausgangsdaten zu verwenden. Enthält der Studienplan keine Regelung darüber, wann eine Modulprüfung bestanden ist, so ist diese Modulprüfung dann endgültig nicht bestanden, wenn eine dem Modul zugeordnete Modulteilprüfung endgültig nicht bestanden wurde.

(9) Die Ergebnisse der Masterarbeit, der Modulprüfungen bzw. der Modulteilprüfungen, der Erfolgskontrollen anderer Art sowie die erworbenen Leistungspunkte werden durch das Studienbüro der Universität erfasst.

(10) Die Gesamtnote der Masterprüfung und die Modulnoten lauten:

bis 1.5 = sehr gut
1.6 bis 2.5 = gut
2.6 bis 3.5 = befriedigend
3.6 bis 4.0 = ausreichend

§ 8 Erlöschen des Prüfungsanspruchs, Wiederholung von Prüfungen und Erfolgskontrollen

(1) Studenten können eine nicht bestandene schriftliche Prüfung (§ 4 Abs. 2, Nr. 1) einmal wiederholen. Wird eine schriftliche Wiederholungsprüfung mit „nicht ausreichend" bewertet, so findet eine mündliche Nachprüfung im zeitlichen Zusammenhang mit dem Termin der nicht bestandenen Prüfung statt. Die Note ergibt sich gemäß § 6 Abs. 6 aus dem arithmetischen Mittel der Noten der schriftlichen Prüfung und der mündlichen Nachprüfung.

(2) Studenten können eine nicht bestandene mündliche Prüfung (§ 4 Abs. 2, Nr. 2) einmal wiederholen. Die mündliche Nachprüfung ist keine mündliche Prüfung nach § 4 Abs. 2, Nr. 2.

(3) Wiederholungsprüfungen nach Absatz 1 und 2 müssen in Inhalt, Umfang und Form (mündlich oder schriftlich) der ersten entsprechen. Ausnahmen kann der zuständige Prüfungsausschuss auf Antrag zulassen. Fehlversuche an anderen Hochschulen sind anzurechnen. Wird eine Wiederholungsprüfung nicht bis zum Ablauf des Prüfungszeitraums des übernächsten auf die Prüfung folgenden Semesters erfolgreich abgelegt, verliert der Studierende den Prüfungsanspruch, es sei denn, dass er die Fristüberschreitung nicht zu vertreten hat. Hierüber entscheidet der Prüfungsausschuss.

(4) Studenten können eine nicht bestandene Erfolgskontrolle anderer Art (§ 4 Abs. 2, Nr. 3) einmal wiederholen. Wird diese Wiederholung mit „nicht bestanden" bewertet, so findet eine zusätzliche mündliche Erfolgskontrolle im zeitlichen Zusammenhang mit dem Termin dieser Wiederholung statt. Wird die Wiederholung der Erfolgskontrolle anderer Art nicht bis zum Ablauf des Prüfungszeitraums des übernächsten auf die Erfolgskontrolle folgenden Semesters erfolgreich abgelegt, verliert der Studierende den Prüfungsanspruch, es sei denn, dass er die Fristüberschreitung nicht zu vertreten hat.

(5) Eine zweite Wiederholung derselben Erfolgskontrolle gemäß § 4 Abs. 2, Nr. 1 bis 3 ist nur in Ausnahmefällen zulässig. Einen Antrag auf Zweitwiederholung hat der Student schriftlich beim Prüfungsausschuss zu stellen. Über den ersten Antrag eines Studenten auf Zweitwiederholung entscheidet der Prüfungsausschuss, wenn er den Antrag genehmigt. Wenn der Prüfungsausschuss diesen Antrag ablehnt, entscheidet der Präsident. Über weitere Anträge auf Zweitwiederholung entscheidet nach Stellungnahme des Prüfungsausschusses der Präsident. Absatz 1, Sätze 2 und 3 gelten entsprechend.

(6) Die Wiederholung einer bestandenen Erfolgskontrolle ist nicht zulässig. Absatz 7 bleibt unberührt.

(7) Der Student hat die Möglichkeit, nach der ersten Teilnahme an einer schriftlichen Modulprüfung nach Bekanntgabe des Ergebnisses unverzüglich eine freiwillige mündliche Zusatzprüfung abzulegen. Die Prüfungsdauer ergibt sich aus der Äquivalenz von 60 Minuten schriftlicher Prüfung zu 15 Minuten mündlicher Prüfung. Die Note wird aus dem arithmetischen

Mittel der Noten der schriftlichen Prüfung und der mündlichen Zusatzprüfung gemäß § 6 Abs. 6 errechnet.

(8) Die Masterarbeit kann bei einer Bewertung mit „nicht ausreichend“ einmal wiederholt werden. Eine zweite Wiederholung der Masterarbeit ist ausgeschlossen.

(9) Ist gemäß § 34 Abs. 2, Satz 3 LHG die Masterprüfung bis zum Ende des achten Fachsemesters dieses Studiengangs einschließlich etwaiger Wiederholungen nicht vollständig erfolgreich abgelegt, so erlischt der Prüfungsanspruch im Studiengang, es sei denn, dass der Student die Fristüberschreitung nicht zu vertreten hat. Die Entscheidung darüber trifft der Prüfungsausschuss. Die Entscheidung über eine Fristverlängerung und über Ausnahmen von der Fristregelung trifft der Prüfungsausschuss.

§ 9 Versäumnis, Rücktritt, Täuschung, Ordnungsverstoß

(1) Der Student kann bei schriftlichen Modulprüfungen ohne Angabe von Gründen bis zur Ausgabe der Prüfungsaufgaben zurücktreten (Abmeldung). Bei mündlichen Modulprüfungen muss der Rücktritt spätestens drei Werktage vor dem betreffenden Prüfungstermin erklärt werden (Abmeldung). Ein Rücktritt von einer mündlichen Prüfung weniger als drei Werktage vor dem betreffenden Prüfungstermin ist nur unter den Voraussetzungen des Absatzes 3 möglich. Die Abmeldung kann schriftlich beim Prüfer oder per Online-Abmeldung beim Studienbüro erfolgen. Eine durch Widerruf abgemeldete Prüfung gilt als nicht angemeldet. Der Rücktritt von mündlichen Nachprüfungen im Sinne von § 8 Abs. 2 ist grundsätzlich nur unter den Voraussetzungen von Absatz 3 möglich.

(2) Eine Modulprüfung gilt als mit „nicht ausreichend“ (5.0) bewertet, wenn der Student einen Prüfungstermin ohne triftigen Grund versäumt oder wenn er nach Beginn der Prüfung ohne triftigen Grund von der Prüfung zurücktritt. Dasselbe gilt, wenn die Masterarbeit nicht innerhalb der vorgesehenen Bearbeitungszeit erbracht wird, es sei denn, der Student hat die Fristüberschreitung nicht zu vertreten.

(3) Der für den Rücktritt nach Beginn der Prüfung oder das Versäumnis geltend gemachte Grund muss dem Prüfer unverzüglich schriftlich angezeigt und glaubhaft gemacht werden. Bei Krankheit des Studenten bzw. eines von ihm allein zu versorgenden Kindes oder pflegebedürftigen Angehörigen kann die Vorlage eines ärztlichen Attestes und in Zweifelsfällen ein amtsärztliches Attest verlangt werden. Die Anerkennung des Rücktritts ist ausgeschlossen, wenn bis zum Eintritt des Hinderungsgrundes bereits Prüfungsleistungen erbracht worden sind und nach deren Ergebnis die Prüfung nicht bestanden werden kann. Wird der Grund anerkannt, wird ein neuer Termin anberaumt. Die bereits vorliegenden Prüfungsergebnisse sind in diesem Fall anzurechnen. Bei Modulprüfungen, die aus mehreren Prüfungen bestehen, werden die Prüfungsleistungen dieses Moduls, die bis zu einem anerkannten Rücktritt bzw. einem anerkannten Versäumnis einer Prüfungsleistung dieses Moduls erbracht worden sind, angerechnet.

(4) Versucht der Student das Ergebnis seiner Prüfung durch Täuschung oder Benutzung nicht zugelassener Hilfsmittel zu beeinflussen, gilt die betreffende Prüfung als mit „nicht ausreichend“ (5.0) bewertet.

(5) Ein Student, der den ordnungsgemäßen Ablauf der Prüfung stört, kann vom jeweiligen Prüfer oder Aufsicht Führenden von der Fortsetzung der Modulprüfung ausgeschlossen werden. In diesem Fall gilt die betreffende Prüfungsleistung als mit „nicht ausreichend“ (5.0) bewertet. In schwerwiegenden Fällen kann der Prüfungsausschuss den Studenten von der Erbringung weiterer Prüfungsleistungen ausschließen.

(6) Der Student kann innerhalb einer Frist von einem Monat verlangen, dass Entscheidungen gemäß Absatz 4 und 5 vom Prüfungsausschuss überprüft werden. Belastende Entscheidungen des Prüfungsausschusses sind dem Studenten unverzüglich schriftlich mitzuteilen. Sie sind zu begründen und mit einer Rechtsbehelfsbelehrung zu versehen. Dem Studenten ist vor einer Entscheidung die Gelegenheit zur Äußerung zu geben.

(7) Näheres regelt die Allgemeine Satzung der Universität Karlsruhe (TH) zur Redlichkeit bei Prüfungen und Praktika.

§ 10 Mutterschutz, Elternzeit, Wahrnehmung von Familienpflichten

(1) Auf Antrag einer Studentin sind die Mutterschutzfristen, wie sie im jeweils gültigen Gesetz zum Schutz der erwerbstätigen Mutter (MuSchG) festgelegt sind, entsprechend zu berücksichtigen. Dem Antrag sind die erforderlichen Nachweise beizufügen. Die Mutterschutzfristen unterbrechen jede Frist nach dieser Prüfungsordnung. Die Dauer des Mutterschutzes wird nicht in die Frist eingerechnet.

(2) Gleichfalls sind die Fristen der Elternzeit nach Maßgabe des jeweils gültigen Gesetzes (BErzGG) auf Antrag zu berücksichtigen. Der Student muss bis spätestens vier Wochen vor dem Zeitpunkt, ab dem er die Elternzeit antreten will, dem Prüfungsausschuss unter Beifügung der erforderlichen Nachweise schriftlich mitteilen, in welchem Zeitraum er Elternzeit in Anspruch nehmen will. Der Prüfungsausschuss hat zu prüfen, ob die gesetzlichen Voraussetzungen vorliegen, die bei einem Arbeitnehmer den Anspruch auf Elternzeit auslösen würden, und teilt dem Studenten das Ergebnis sowie die neu festgesetzten Prüfungszeiten unverzüglich mit. Die Bearbeitungszeit der Masterarbeit kann nicht durch Elternzeit unterbrochen werden. Die gestellte Arbeit gilt als nicht vergeben. Nach Ablauf der Elternzeit erhält der Student ein neues Thema.

(3) Der Prüfungsausschuss entscheidet auf Antrag über die flexible Handhabung von Prüfungsfristen entsprechend den Bestimmungen des Landeshochschulgesetzes, wenn Studierende Familienpflichten wahrzunehmen haben. Die Bearbeitungszeit der Masterarbeit kann nicht durch die Wahrnehmung von Familienpflichten unterbrochen oder verlängert werden. Die gestellte Arbeit gilt als nicht vergeben. Der Student erhält ein neues Thema, das innerhalb der in § 11 festgelegten Bearbeitungszeit zu bearbeiten ist.

§ 11 Modul Masterarbeit

(1) Zur Masterarbeit wird zugelassen, wer die erforderlichen Modulprüfungen erfolgreich erbracht hat. Der Antrag auf Zulassung zur Masterarbeit ist spätestens drei Monate nach Ablegung der letzten Modulprüfung zu stellen. Versäumt der Student diese Frist ohne triftige Gründe, so gilt die Masterarbeit im ersten Versuch als mit „nicht ausreichend“ (5.0) bewertet. Im Übrigen gilt § 16 entsprechend. Auf Antrag des Studenten sorgt ausnahmsweise der Prüfungsausschuss dafür, dass der Student zeitnah von einem Betreuer ein Thema für die Masterarbeit erhält.

(2) Thema, Aufgabenstellung und Umfang der Masterarbeit sind vom Betreuer so zu begrenzen, dass sie mit dem in Absatz 3 festgelegten Arbeitsaufwand bearbeitet werden kann.

(3) Die Masterarbeit soll zeigen, dass der Student in der Lage ist, ein Problem aus seinem Fach selbstständig und in begrenzter Zeit nach wissenschaftlichen Methoden, die dem Stand der Forschung entsprechen, zu bearbeiten. Der Masterarbeit werden 30 Leistungspunkte zugeordnet. Die Bearbeitungsdauer beträgt sechs Monate. Die Masterarbeit kann auch auf Englisch geschrieben werden.

(4) Das Modul Masterarbeit muss von einem Hochschullehrer oder habilitierten Mitglied der Fakultät vergeben werden. Soll die Masterarbeit außerhalb des Studiengangs Bauingenieurwesen angefertigt werden, so bedarf dies der Genehmigung des Prüfungsausschusses. Dem Studenten ist Gelegenheit zu geben, für das Thema Vorschläge zu machen. Die Masterarbeit kann auch in Form einer Gruppenarbeit zugelassen werden, wenn der als Prüfungsleistung zu bewertende Beitrag des einzelnen Studenten aufgrund objektiver Kriterien, die eine eindeutige Abgrenzung ermöglichen, deutlich unterscheidbar ist und die Anforderung nach Absatz 3 erfüllt.

(5) Bei der Abgabe der Masterarbeit hat der Student schriftlich zu versichern, dass er die Arbeit selbstständig verfasst hat und keine anderen als die von ihm angegebenen Quellen und Hilfsmittel benutzt hat, die wörtlich oder inhaltlich übernommenen Stellen als solche kenntlich gemacht und die Satzung der Universität Karlsruhe (TH) zur Sicherung guter wissenschaftlicher Praxis in der jeweils gültigen Fassung beachtet hat. Wenn diese Erklärung nicht enthalten ist, wird die Arbeit nicht angenommen. Bei Abgabe einer unwahren Versicherung wird die Masterarbeit mit „nicht ausreichend“ (5.0) bewertet.

(6) Der Zeitpunkt der Ausgabe des Themas der Masterarbeit und der Zeitpunkt der Abgabe der Masterarbeit sind aktenkundig zu machen. Der Student kann das Thema der Masterarbeit nur einmal und nur innerhalb der ersten zwei Monate der Bearbeitungszeit zurückgeben. Auf begründeten Antrag des Studenten kann der Prüfungsausschuss die in Absatz 3 festgelegte Bearbeitungszeit um höchstens drei Monate verlängern. Wird die Masterarbeit nicht fristgerecht abgeliefert, gilt sie als mit „nicht ausreichend“ (5.0) bewertet, es sei denn, dass der Student dieses Versäumnis nicht zu vertreten hat. § 8 gilt entsprechend.

(7) Die Masterarbeit ist innerhalb eines Monats nach Abgabe durch einen Vortrag abzuschließen, der in die Bewertung eingeht.

(8) Die Masterarbeit wird vom Betreuer und einem weiteren Hochschullehrer oder habilitierten Mitglied der Fakultät begutachtet und bewertet. Bei nicht übereinstimmender Beurteilung der beiden Prüfer setzt der Prüfungsausschuss im Rahmen der Bewertung der beiden Prüfer die Note der Masterarbeit fest. Der Bewertungszeitraum soll acht Wochen nicht überschreiten.

§ 12 Baupraktische Tätigkeit

(1) Um innerhalb des Masterstudiums zu Prüfungen zugelassen zu werden, ist eine mindestens achtwöchige baupraktische Tätigkeit nachzuweisen, welche geeignet ist, dem Studenten eine Anschauung von der beruflichen Praxis im Bereich des Bauwesens zu vermitteln. Die Tätigkeit muss in geeigneten Betrieben oder Unternehmen der Bauwirtschaft erbracht worden sein, die mit der Planung, Berechnung, Ausführung oder dem Betrieb baulicher Maßnahmen oder Anlagen operativ befasst sind. Dem Praktikum sind keine Leistungspunkte zugeordnet.

(2) Für den Nachweis der baupraktischen Tätigkeit sind ein Bericht und Praktikumszeugnisse dem vom Fakultätsrat bestimmten Prüfer nach § 15 Abs. 2 abzugeben. Der Bericht muss kurze Beschreibungen der ausgeübten Tätigkeiten und ergänzende Skizzen zu den wesentlichen Arbeitsvorgängen und Arbeitsverfahren in übersichtlicher Form beinhalten. Die Praktikumszeugnisse müssen von den jeweiligen Betrieben oder Unternehmen ausgestellt sein und deren Stempel und Unterschrift tragen.

(3) Einschlägige berufspraktische Tätigkeiten, die in einem dem Studium vorangehenden oder es begleitenden erlernten baubezogenen Beruf erbracht wurden, können zu Teilen oder im Ganzen auf die baupraktische Tätigkeit angerechnet werden.

(4) Baupraktische Tätigkeiten, die im Rahmen oder als Bestandteil eines vorausgegangenen Studiums erbracht wurden, können zu Teilen oder im Ganzen auf die baupraktische Tätigkeit angerechnet werden, sofern sie die Voraussetzungen nach Absatz 1 erfüllen.

§ 13 Zusatzleistungen, Zusatzmodule, Schlüsselqualifikationen

(1) Innerhalb des Masterstudiums können weitere Leistungspunkte (Zusatzleistungen) im Umfang von höchstens 20 Leistungspunkten erworben werden. § 3 und 4 der Prüfungsordnung bleiben davon unberührt. Diese Zusatzleistungen gehen nicht in die Festsetzung der Gesamt- und Modulnoten ein. Die bei der Festlegung der Gesamtnote nicht berücksichtigten Leistungspunkte werden als Zusatzleistungen automatisch im Transcript of Records aufgeführt und als Zusatzleistungen gekennzeichnet. Zusatzleistungen werden mit den nach § 7 vorgesehenen Noten gelistet.

(2) Der Student hat bereits bei der Anmeldung zu einer Prüfung in einem Modul diese als Zusatzleistung zu deklarieren.

(3) Die Ergebnisse maximal dreier Module, die jeweils mindestens 6 Leistungspunkte umfassen müssen, werden auf Antrag des Studenten in das Masterzeugnis als Zusatzmodule aufgenommen und als Zusatzmodule gekennzeichnet. Zusatzmodule werden bei der Festsetzung der Gesamtnote nicht mit einbezogen. Nicht in das Zeugnis aufgenommene Zusatzmodule werden im Transcript of Records automatisch aufgenommen und als Zusatzmodule gekennzeichnet. Zusatzmodule werden mit den nach § 7 vorgesehenen Noten gelistet.

(4) Neben den verpflichtenden fachwissenschaftlichen Modulen sind Module zu den überfachlichen Schlüsselqualifikationen im Umfang von mindestens 6 Leistungspunkten Bestandteil eines Masterstudiums. Der Studienplan legt fest, welche Module im Rahmen des Angebots zur Vermittlung der additiven Schlüsselqualifikationen belegt werden können.

§ 14 Prüfungsausschuss

(1) Für den Masterstudiengang Bauingenieurwesen wird ein Prüfungsausschuss gebildet. Er besteht aus sechs stimmberechtigten Mitgliedern: vier Professoren, Juniorprofessoren, Hochschul- oder Privatdozenten, zwei Vertretern der Gruppe der akademischen Mitarbeiter nach § 10 Abs. 1, Satz 2, Nr. 2 LHG und einem Vertreter der Studenten mit beratender Stimme. Im Falle der Einrichtung eines gemeinsamen Prüfungsausschusses für den Bachelor- und den Masterstudiengang Bauingenieurwesen erhöht sich die Anzahl der Vertreter der Studenten auf zwei Mitglieder mit beratender Stimme, wobei je ein Vertreter aus dem Bachelor- und aus dem Masterstudiengang stammt. Die Amtszeit der nichtstudentischen Mitglieder beträgt zwei Jahre, die des studentischen Mitglieds ein Jahr.

(2) Der Vorsitzende, sein Stellvertreter, die weiteren Mitglieder des Prüfungsausschusses sowie deren Stellvertreter werden vom Fakultätsrat bestellt, die Mitglieder der Gruppe der akademischen Mitarbeiter nach § 10 Abs. 1, Satz 2, Nr. 2 LHG und der Vertreter der Studenten auf Vorschlag der Mitglieder der jeweiligen Gruppe; Wiederbestellung ist möglich. Der Vorsitzende und dessen Stellvertreter müssen Professoren der Fakultät sein. Der Vorsitzende des Prüfungsausschusses nimmt die laufenden Geschäfte wahr.

(3) Der Prüfungsausschuss ist zuständig für die Organisation der Modulprüfungen und die Durchführung der ihm durch diese Studien- und Prüfungsordnung zugewiesenen Aufgaben. Er achtet auf die Einhaltung der Bestimmungen dieser Studien- und Prüfungsordnung und fällt die Entscheidung in Prüfungsangelegenheiten. Er entscheidet über die Anrechnung von Studienzeiten, Studienleistungen und Modulprüfungen und übernimmt die Gleichwertigkeitsfeststellung. Er berichtet der Fakultät regelmäßig über die Entwicklung der Prüfungs- und Studienzeiten, einschließlich der Bearbeitungszeiten für die Masterarbeiten und die Verteilung der Modul- und Gesamtnoten.

(4) Der Prüfungsausschuss kann die Erledigung seiner Aufgaben für alle Regelfälle auf den Vorsitzenden des Prüfungsausschusses übertragen.

(5) Die Mitglieder des Prüfungsausschusses haben das Recht, der Abnahme von Prüfungen beizuwohnen. Die Mitglieder des Prüfungsausschusses, die Prüfer und die Beisitzenden unterliegen der Amtsverschwiegenheit. Sofern sie nicht im öffentlichen Dienst stehen, sind sie durch den Vorsitzenden zur Verschwiegenheit zu verpflichten.

(6) In Angelegenheiten des Prüfungsausschusses, die eine an einer anderen Fakultät zu absolvierende Prüfungsleistung betreffen, ist auf Antrag eines Mitgliedes des Prüfungsausschusses ein fachlich zuständiger und von der betroffenen Fakultät zu nennender Professor, Juniorprofessor, Hochschul- oder Privatdozent hinzuziehen. Er hat in diesem Punkt Stimmrecht.

(7) Belastende Entscheidungen des Prüfungsausschusses sind dem Studenten schriftlich mitzuteilen. Sie sind zu begründen und mit einer Rechtsbehelfsbelehrung zu versehen. Widersprüche gegen Entscheidungen des Prüfungsausschusses sind innerhalb eines Monats nach Zugang der Entscheidung schriftlich oder zur Niederschrift beim Rektorat der Universität Karlsruhe (TH) einzulegen.

§ 15 Prüfer und Beisitzende

(1) Der Prüfungsausschuss bestellt die Prüfer und die Beisitzenden. Er kann die Bestellung dem Vorsitzenden übertragen.

(2) Prüfer sind Hochschullehrer und habilitierte Mitglieder sowie akademische Mitarbeiter der Fakultät, denen die Prüfungsbefugnis übertragen wurde. Externen Hochschullehrern oder habilitierten Wissenschaftlern kann der Prüfungsausschuss im Einzelfall die Prüfungsbefugnis befristet übertragen. Bestellt werden darf nur, wer mindestens die dem jeweiligen Prüfungsgegenstand entsprechende fachwissenschaftliche Qualifikation erworben hat.

(3) Soweit Lehrveranstaltungen von anderen als den unter Absatz 2 genannten Personen durchgeführt werden, sollen diese zu Prüfern bestellt werden, wenn die Fakultät ihnen eine diesbezügliche Prüfungsbefugnis erteilt hat.

(4) Zum Beisitzenden darf nur bestellt werden, wer einen akademischen Abschluss in einem Studiengang des Bauingenieurwesens oder einen gleichwertigen akademischen Abschluss erworben hat.

§ 16 Anrechnung von Studienzeiten, Anerkennung von Studienleistungen und Modulprüfungen

(1) Studienzeiten und Studienleistungen und Modulprüfungen, die in gleichen oder anderen Studiengängen an der Universität Karlsruhe (TH) oder an anderen Hochschulen erbracht wurden, werden angerechnet, soweit Gleichwertigkeit besteht. Gleichwertigkeit ist festzustellen, wenn Leistungen in Inhalt, Umfang und in den Anforderungen denjenigen des Studiengangs im Wesentlichen entsprechen. Dabei ist kein schematischer Vergleich, sondern eine Gesamtbetrachtung vorzunehmen. Bezüglich des Umfangs einer zur Anerkennung vorgelegten Studienleistung und Modulprüfung werden die Grundsätze des ECTS herangezogen; die inhaltliche Gleichwertigkeitsprüfung orientiert sich an den Qualifikationszielen des Moduls.

(2) Werden Leistungen angerechnet, können die Noten – soweit die Notensysteme vergleichbar sind – übernommen werden und in die Berechnung der Modulnoten und der Gesamtnote einbezogen werden. Liegen keine Noten vor, muss die Leistung nicht anerkannt werden. Der Student hat die für die Anrechnung erforderlichen Unterlagen vorzulegen.

(3) Bei der Anrechnung von Studienzeiten und der Anerkennung von Studienleistungen und Modulprüfungen, die außerhalb der Bundesrepublik erbracht wurden, sind die von der Kultusministerkonferenz und der Hochschulrektorenkonferenz gebilligten Äquivalenzvereinbarungen sowie Absprachen im Rahmen der Hochschulpartnerschaften zu beachten.

(4) Absatz 1 gilt auch für Studienzeiten, Studienleistungen und Modulprüfungen, die in staatlich anerkannten Fernstudien- und an anderen Bildungseinrichtungen, insbesondere an staatlichen oder staatlich anerkannten Berufsakademien erworben wurden.

(5) Die Anerkennung von Teilen der Masterprüfung kann versagt werden, wenn in einem Studiengang mehr als die Hälfte aller Erfolgskontrollen und/oder in einem Studiengang mehr als die Hälfte der erforderlichen Leistungspunkte und/oder die Masterarbeit anerkannt werden soll/en. Dies gilt insbesondere bei einem Studiengangwechsel sowie bei einem Studienortwechsel.

(6) Zuständig für die Anrechnungen ist der Prüfungsausschuss. Vor Feststellungen über die Gleichwertigkeit sind die zuständigen Fachvertreter zu hören. Der Prüfungsausschuss entscheidet in Abhängigkeit von Art und Umfang der anzurechnenden Studien- und Prüfungsleistungen über die Einstufung in ein höheres Fachsemester.

(7) Zusatzleistungen, die ein Student für den Bachelorstudiengang Bauingenieurwesen erbracht hat und die im Studienplan des Masterstudiengangs Bauingenieurwesen vorgesehen sind, werden auf Antrag des Studenten an den Prüfungsausschuss anerkannt.

II. Masterprüfung

§ 17 Umfang und Art der Masterprüfung

(1) Die Masterprüfung besteht aus Modulprüfungen nach Absatz 3 bis 5 sowie der Masterarbeit (§ 11).

(2) Mit dem Antrag auf Zulassung zum Masterstudium muss sich der Student für zwei der fünf folgenden Schwerpunkte entscheiden:

1. Konstruktiver Ingenieurbau,
2. Wasser und Umwelt,
3. Mobilität und Infrastruktur,
4. Technologie und Management im Baubetrieb,
5. Geotechnisches Ingenieurwesen.

(3) Innerhalb der gewählten Schwerpunkte sind Prüfungen in den im Studienplan festgelegten Pflicht- und Wahlpflichtmodulen abzulegen (Schwerpunktstudium). Dabei sind in jedem der beiden Schwerpunkte 30 Leistungspunkte nachzuweisen.

(4) Im Ergänzungsstudium sind weitere fachwissenschaftliche Module im Umfang von 24 Leistungspunkten zu wählen und darin Prüfungen abzulegen. Hierfür können Pflicht- und Wahlpflichtmodule aus dem Angebot aller fünf Schwerpunkte gewählt werden, sofern sie nicht schon Bestandteil des Schwerpunktstudiums sind.

(5) Neben den fachwissenschaftlichen Modulen nach Absatz 2 und 3 sind Module zu den Schlüsselqualifikationen im Umfang von 6 Leistungspunkten nach § 13 Abs. 4. zu wählen und darin Prüfungen abzulegen.

(6) Die Pflicht- und Wahlpflichtmodule der jeweiligen Schwerpunkte und die ihnen zugeordneten Leistungspunkte sind im Studienplan festgelegt. Zur entsprechenden Modulprüfung kann nur zugelassen werden, wer die Anforderungen nach § 5 erfüllt.

(7) Die Festlegung der Module im Schwerpunkt- und Ergänzungsstudium ist, soweit der Studienplan Wahlmöglichkeiten vorsieht, vom Studenten rechtzeitig im Einvernehmen mit einem gewählten Mentor (Professor, Hochschul- oder Privatdozent der gewählten Schwerpunkte) zu treffen. Näheres regelt der Studienplan.

(8) Als weitere Prüfungsleistung ist eine Masterarbeit gemäß § 11 anzufertigen.

§ 18 Bestehen der Masterprüfung, Bildung der Gesamtnote

(1) Die Masterprüfung ist bestanden, wenn alle in § 17 genannten Prüfungsleistungen mindestens mit „ausreichend" bewertet wurden.

(2) Die Gesamtnote der Masterprüfung errechnet sich als ein mit Leistungspunkten gewichteter Notendurchschnitt. Dabei werden alle Prüfungsleistungen nach § 17 mit ihren Leistungspunkten gewichtet.

(3) Hat der Student die Masterarbeit mit der Note 1.0 und die Masterprüfung mit einem Durchschnitt von 1.2 oder besser abgeschlossen, so wird das Prädikat „mit Auszeichnung" (with distinction) verliehen.

§ 19 Masterzeugnis, Masterurkunde, Diploma Supplement und Transcript of Records

(1) Über die Masterprüfung werden nach Bewertung der letzten Prüfungsleistung eine Masterurkunde und ein Zeugnis erstellt. Die Ausfertigung von Masterurkunde und Zeugnis soll nicht später als sechs Wochen nach der Bewertung der letzten Prüfungsleistung erfolgen. Masterurkunde und Masterzeugnis werden in deutscher und englischer Sprache ausgestellt. Masterurkunde und Masterzeugnis tragen das Datum der erfolgreichen Erbringung der letzten Prüfungsleistung. Sie werden dem Studenten gleichzeitig ausgehändigt. In der Masterurkunde wird die Verleihung des akademischen Mastergrades beurkundet. Die Masterurkunde wird vom Präsidenten und vom Dekan unterzeichnet und mit dem Siegel der Universität versehen."

(2) Das Zeugnis enthält die Bezeichnung der gewählten Schwerpunkte, die in den Modulprüfungen und der Masterarbeit erzielten Noten, deren zugeordnete Leistungspunkte und die Gesamtnote. Das Zeugnis ist vom Dekan und vom Vorsitzenden des Prüfungsausschusses zu unterzeichnen.

(3) Weiterhin erhält der Student als Anhang ein Diploma Supplement in deutscher und englischer Sprache, das den Vorgaben des jeweils gültigen ECTS User's Guide entspricht. Daneben erhält der Student ein Transcript of Records (eine Abschrift seiner Studiendaten).

(4) Das Transcript of Records enthält in strukturierter Form alle vom Studenten erbrachten Prüfungsleistungen. Dies beinhaltet alle Module, Modulnoten sowie die den Modulen zugeordneten Lehrveranstaltungen samt Noten und zugeordneten Leistungspunkten. Aus dem Transcript of Records soll die Zugehörigkeit von Lehrveranstaltungen zu den einzelnen Modulen deutlich erkennbar sein. Angerechnete Studienleistungen sind im Transcript of Records aufzunehmen. Alle Zusatzleistungen werden im Transcript of Records aufgeführt.

(5) Die Masterurkunde, das Masterzeugnis und das Diploma Supplement einschließlich des Transcript of Records werden vom Studienbüro des KIT ausgestellt.

III. Schlussbestimmungen

§ 20 Bescheid über Nicht-Bestehen, Bescheinigung von Prüfungsleistungen

(1) Der Bescheid über die endgültig nicht bestandene Masterprüfung wird dem Studenten durch den Prüfungsausschuss in schriftlicher Form erteilt. Der Bescheid ist mit einer Rechtsbehelfsbelehrung zu versehen.

(2) Hat der Student die Masterprüfung endgültig nicht bestanden, wird ihm auf Antrag und gegen Vorlage der Exmatrikulationsbescheinigung eine schriftliche Bescheinigung ausgestellt, die die erbrachten Prüfungsleistungen und deren Noten sowie die zur Prüfung noch fehlenden Prüfungsleistungen enthält und erkennen lässt, dass die Prüfung insgesamt nicht bestanden ist. Dasselbe gilt, wenn der Prüfungsanspruch erloschen ist.

§ 21 Ungültigkeit der Masterprüfung, Entziehung des Mastergrades

(1) Hat der Student bei einer Prüfungsleistung getäuscht und wird diese Tatsache nach der Aushändigung des Zeugnisses bekannt, so können die Noten der Modulprüfungen, bei deren Erbringung der Student getäuscht hat, berichtigt werden. Gegebenenfalls kann die Modulprüfung für „nicht ausreichend“ (5.0) und die Masterprüfung für „nicht bestanden“ erklärt werden.

(2) Waren die Voraussetzungen für die Zulassung zu einer Prüfung nicht erfüllt, ohne dass der Student darüber täuschen wollte, und wird diese Tatsache erst nach Aushändigung des Zeugnisses bekannt, wird dieser Mangel durch das Bestehen der Prüfung geheilt. Hat der Student die Zulassung vorsätzlich zu Unrecht erwirkt, so kann die Modulprüfung für „nicht ausreichend“ (5.0) und die Masterprüfung für „nicht bestanden“ erklärt werden.

(3) Vor einer Entscheidung des Prüfungsausschusses ist Gelegenheit zur Äußerung zu geben.

(4) Das unrichtige Zeugnis ist zu entziehen und gegebenenfalls ein neues auszustellen. Mit dem unrichtigen Zeugnis ist auch die Masterurkunde einzuziehen, wenn die Masterprüfung aufgrund einer Täuschung für „nicht bestanden“ erklärt wurde.

(5) Eine Entscheidung nach Absatz 1 und Absatz 2, Satz 2 ist nach einer Frist von fünf Jahren ab dem Datum des Zeugnisses ausgeschlossen.

(6) Die Aberkennung des akademischen Grades richtet sich nach den gesetzlichen Vorschriften.

§ 22 Einsicht in die Prüfungsakten

(1) Nach Abschluss der Masterprüfung wird dem Studenten auf Antrag innerhalb eines Jahres Einsicht in seine Masterarbeit, die darauf bezogenen Gutachten und in die Prüfungsprotokolle gewährt.

(2) Für die Einsichtnahme in die schriftlichen Modulprüfungen, schriftlichen Modulteilprüfungen bzw. Prüfungsprotokolle gilt eine Frist von einem Monat nach Bekanntgabe des Prüfungsergebnisses.

(3) Der Prüfer bestimmt Ort und Zeit der Einsichtnahme.

(4) Prüfungsunterlagen sind mindestens fünf Jahre aufzubewahren.

Inkrafttreten und Übergangsregelungen

Ausgabe am 08. Sept. 2009

§ 23 In-Kraft-Treten

(1) Diese Studien- und Prüfungsordnung tritt am 1. Oktober 2009 in Kraft.

(2) Studierende, die auf Grundlage der Prüfungsordnung der Universität Karlsruhe (TH) für den Diplomstudiengang Bauingenieurwesen vom 12. April 2002 (Amtliche Bekanntmachung der Universität Karlsruhe (TH) Nr. 10 vom 25. April 2002) in der Fassung der dritten Änderungssatzungen vom 29. März 2005 (Amtliche Bekanntmachungen der Universität Karlsruhe (TH) Nr. 18 vom 8. April 2005 und Nr. 21 vom 25. Mai 2005) ihr Studium an der Universität Karlsruhe (TH) aufgenommen haben, können einen Antrag auf Zulassung zur Prüfung letztmalig am 30. September 2015 stellen.

1. Änderung vom 19. März 2012

Artikel 2

Diese (Änderungs-) Satzung tritt am Tage nach ihrer Veröffentlichung in den Amtlichen Bekanntmachungen des Karlsruher Instituts für Technologie (KIT) in Kraft.

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