Karlsruhe Institute of Technology

Module Handbook
Water Science and Engineering (M.Sc.)

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KIT-Department of Civil Engineering, Geo and Environmental Sciences

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This module handbook is the relevant document describing the structure and the contents of the master's degree program Water Science & Engineering, and thus provides helpful information and guidance for planning the studies. The degree program and its subjects and modules are described in detail, thus providing the necessary information for planning an interdisciplinary course of studies tailored to each student's personal interests and needs.
Within the curriculum (Part I) the organization of the degree program and further formalities in addition to the general examination regulations (ER/SPO) are specified. For example, the assignments of modules to the compulsory and compulsory elective subjects are listed. The current examination regulation (ER/SPO) and potential amendments of these regulations can be found on the web page http://www.sle.kit.edu/imstudium/master-water-science-engineering.php (in German).
Another key function of the module handbook is the collection of module descriptions (Part II), which provide information on the requirements and recommendations for the modules. Details about the learning controls are described at the so-called 'Teilleistungen' (Part III). There, also links are given to the respective courses in the online course catalog which shall be attended for taking the learning controls.

1 Objectives of the master degree program

The master's degree program **Water Science & Engineering** offers an interdisciplinary, research-oriented education at the interface of water-related engineering and natural sciences. Graduates are able to develop strategies and technical solutions for sustainable water resources management. This includes an efficient use of limited water resources, implementing increasing requirements for the protection of water bodies, handling of hydro-meteorological extreme events, and mitigating the impacts of global change on the water cycle and related material cycles. Graduates are qualified for a responsible position in planning offices and engineering companies, industrial enterprises, public authorities, international development cooperation, and research and development. They acquire qualifications that allow pursuing doctoral studies.
Graduates acquire broad and in-depth knowledge of water-related scientific and engineering fundamentals, extending their prior knowledge acquired during the bachelor degree program. The lectures and classes on 'Advanced Fundamentals' are complemented by lectures and classes on engineering and scientific methods as well as interdisciplinary competencies ('Cross Cutting Methods & Competencies'). Graduates are able to transform their theoretical knowledge into quantitative approaches for the balancing of systems and to solve them analytically and numerically. They can precisely describe relevant circumstances in the environment, and represent specialized solutions to both experts as well as laypersons in an understandable form. Through practical exercises in laboratories, in computer pools or field work, graduates acquire the ability to apply methods on their own in specific contexts. They have sound knowledge of the analysis of time- and space-related data, the design of experiments, and the assessment of uncertainties of measurement and model results. The methods and practices used can be reflected and adapted to changing conditions.
The specialization area is made up of the four profiles 'Water Technologies & Urban Water Cycle', 'Fluid Mechanics & Hydraulic Engineering', 'Environmental System Dynamics & Management', and 'Water Resources Engineering', which are oriented towards current job profiles. Within the 'Profile Studies', graduates acquire the competence to link the fundamental and advanced knowledge with engineering applications in their selected field. They are thus able to transfer their expertise into the development of innovative technologies and management concepts. Supplementary modules also offer the possibility to complement the specialization with skills from neighboring scientific and engineering disciplines.
The competence to work out structured solutions is further promoted by an interdisciplinary 'Study Project', in which the theoretical knowledge and skills are applied to deal with a specific problem.
Graduates in Water Science & Engineering have a broad knowledge and in-depth expertise in their subject, comprehensive methodological competences, and a sound understanding of complex interactions in environmental systems. They are able to apply a range of analytical, experimental, technical and planning methods to fulfill their tasks in solving water-related problems in consideration of social and economic criteria. They deal autonomously with the current state of research and are able to analyze complex problems and select adequate methods for target-oriented solutions. As teaching is predominantly in English and students collaborate in international teams, graduates are also able to communicate their research findings in an international framework.

2 Structure of the master degree program

The master degree program Water Science & Engineering comprises 120 credit points (CP) and is structured in the subjects

- Advanced Fundamentals, AF (27 CP)
- Cross-Cutting Methods & Competencies, CC (12 CP)
- Profile Studies, P (36 CP)

  PA Water Technologies & Urban Water Cycle
  PB Fluid Mechanics & Hydraulic Engineering
  PC Environmental System Dynamics & Management
  PD Water Resources Engineering

- Study Project, SP (15 CP)

as well as the preparation of the Master Thesis in extent of 30 CP (Figure 1).

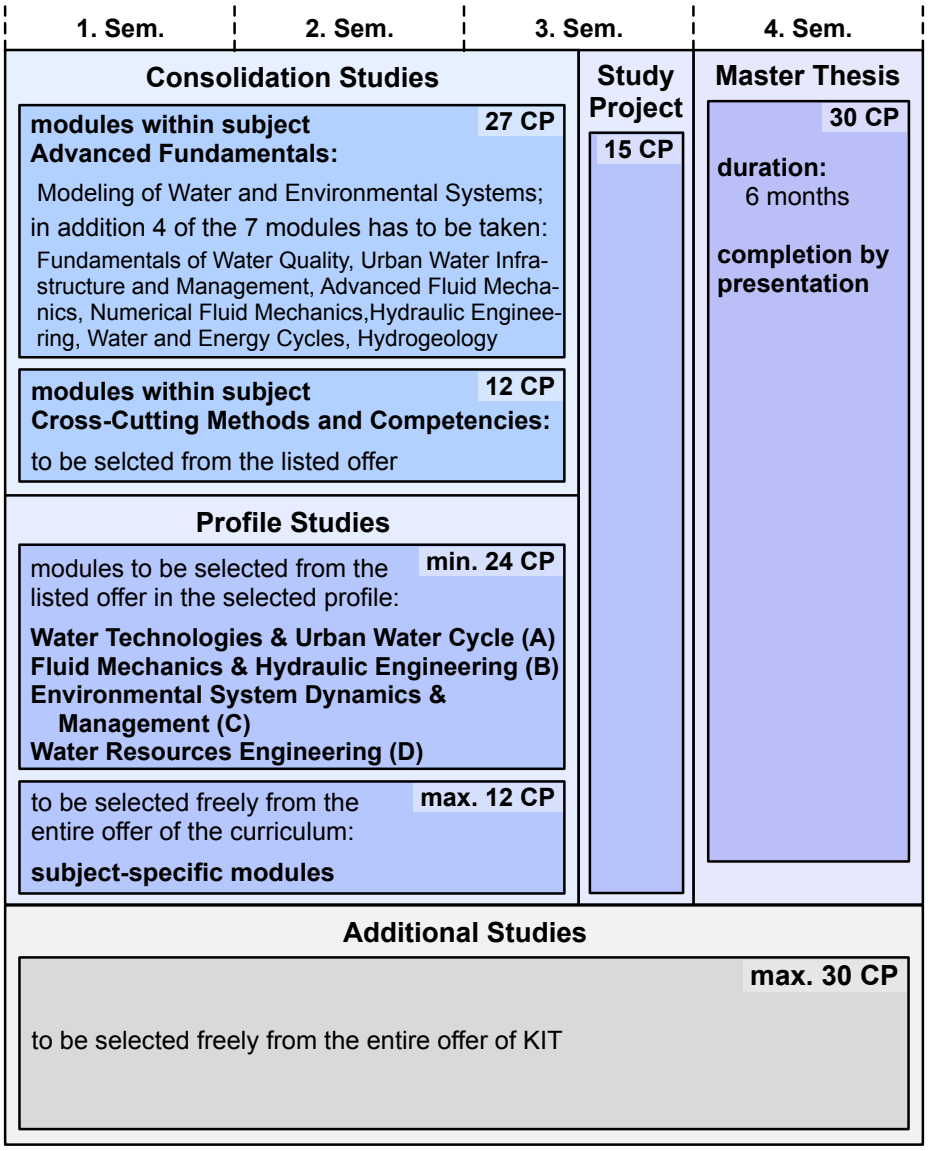

Figure 1: Structure of the master degree program Water Science & Engineering.

2.1 Advanced Fundamentals (AF), compulsory subject

In this subject, 'Advanced Fundamentals' of water-related engineering and natural sciences are taught in extent of 27 CP. The modules assigned to this subject are listed in Table 1. The module 'Modeling of Water and Environmental Systems (AF101)' is compulsory for all students. They further choose four out of seven subject-specific modules – according to their fields of interest and their selected specialization (cf. 'Profile Studies'). It is advisable to include the basic modules for the chosen profile; which are:

- for Profile A: AF201 and AF301
- for Profile B: AF401, AF501 and AF601
- for Profile C: AF701 and AF801

Table 1: Modules AF – Advanced Fundamentals

Module			Course				LC	
Code (WSEM-)	Name	CP	Name (Language)	Type	HpW / SWS W	SWS S	Type	CP
AF101:	Modeling of Water and Environmental Systems (p. 91)*	3	Modeling of Water and Environmental Systems (E)	L	2		ngA	3
AF201:	Fundamentals of Water Quality (p. 54)	6	Fundamentals of Water Quality (E)	L/E	3		wE	6
AF301:	Urban Water Infrastructure and Management (p. 117)	6	Urban Water Infrastructure and Management (E)	L/E	4		wE	6
AF401:	Advanced Fluid Mechanics (p. 27)	6	Advanced Fluid Mechanics (E)	L/E		4	wE	6
AF501:	Numerical Fluid Mechanics (p. 94)	6	Numerical Fluid Mechanics I (E)	L/E	4		wE	6
AF601:	Hydraulic Engineering (p. 60)	6	Multiphase Flow in Hydraulic Engineering (E)	L/E		2	wE	6
			Design of Hydraulic Structures (E)	L/E		2		
AF701:	Water and Energy Cycles (p. 125)	6	Water and Energy Cycles in Hydrological Systems: Processes, Predictions and Management (E)	L/E	4		wE	6
AF801:	Hydrogeology (p. 64)	6	General and Applied Hydrogeology (E)	L/E		2	wE	6
			Field Methods in Hydrogeology (E)	L/E		1		

* compulsory module

explanations to Table 1:

general:

LC	learning control
CP	credit point
HpW / SWS	hours per week
W / S	winter term / summer term
G / E	language German / English

type of course:

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

type of learning control:

wE	written examination
oE	oral examination
ngA	not graded accomplishment

2.2 Cross-Cutting Methods & Competencies (CC), compulsory subject

The scientific education is complemented by a comprehensive education in interdisciplinary methods and technical skills. Students select modules of at least 12 CP in total from the options in Table 2. In line with the international orientation of the program, language courses of up to 6 CP can be taken in the module 'Language Skills CC949'.

Table 2: Modules CC - Cross-Cutting Methods & Competencies

Module			Course				LC	
Code (WSEM-)	Name	CP	Name (Language)	Type	HpW	SWS	Type	CP
CC471:	Experiments in Fluid Mechanics (p. 47)	6	Experimental Methods and Physical Experiments (E)	L/E		4	EoT	6
CC773:	Analysis of Spatial Data [1] (p. 28)	6	Geostatistics (E)	L/E		4	oE	6
CC774:	Introduction to Environmental Data Analysis and Statistical Learning [3] (p. 76)	6	Introduction to Environmental Data Analysis and Statistical Learning (E)	L/E	4		ngA [4] wE	2 4
CC371:	Freshwater Ecology [1] (p. 51)	6	Applied Ecology and Water Quality (E)	L/S		3	EoT	3
			Field Training Water Quality (E)	E		1	EoT	3
CC921:	Instrumental Analysis (p. 72)	6	Instrumental Analysis (E)	L		2	oE	4
			Organic Trace Analysis of Aqueous Samples (E)	P		2	ngA [4]	2
CC922:	Microbial Diversity (p. 105)	8	Microbial Diversity (G)	L	2		wE	1
			Practical course: Microbial Diversity (G)	P	6		EoT	7
CC925:	Mass Transfer and Reaction Kinetics [1] (p. 85)	4	Mass Transfer and Reaction Kinetics (E)	L		2	wE	4
CC791:	Integrated Infrastructure Planning [2] (p. 74)	6	Infrastructure Planning – Socio-economic & Ecological Aspects (E)	L/S/E	4		ngA [4] wE	0 6
CC792:	Environmental Communication [2] (p. 39)	6	Environmental Communication (G)	S	2		ngA [4] EoT	0 6
CC772:	Introduction to Matlab (p. 79)	3	Introduction to Matlab (E)	L/E	2		ngA	3
CC571:	Fundamentals of Numerical Algorithms for Engineers [3] (p. 53)	3	Fundamentals of Numerical Algorithms for Engineers (E)	L	2		wE	3
CC911:	Probability and Statistics (p. 98)	3	Probability and Statistics (E)	L		2	oE	3
CC931:	Remote Sensing and Positioning (p. 103)	6	Terrestrial & Satellite Positioning (E)	L/E	2		oE	6
			Remote Sensing & Geo-Information Systems (E)	L/E	2			

continuing next page

Table 2: Modules CC - Cross-Cutting Methods & Competencies, continued

Module			Course				LC	
Code (WSEM-)	Name	CP	Name (Language)	Type	HpW / SWS W	SWS S	Type	CP
CC933:	Introduction to GIS for Students of Natural, Engineering and Geo Sciences (p. 78)	6	Introduction to GIS for Students of Natural, Engineering and Geo Sciences (G)	L/E	4		ngA [4)] wE	3 3
CC935:	Geodata Infrastructures and Web-Services (p. 57)	4	Geodata Infrastructures and Web-Services (G)	L/E		3	ngA [4)] oE	3 1
CC912:	Numerical Mathematics for Students of Computer Science and Engineering (p. 95)	6	Numerical Mathematics for Students of Computer Science and Engineering (G)	L/E		3	wE	6
CC949:	Language Skills (p. 81)	2-6	Language Skills ()	S			ngA	2-6

explanations to Table 2:

general:

LC	learning control
CP	credit point
HpW / SWS	hours per week
W / S	winter term / summer term
G / E	language German / English
1)	Module will be offered newly as from summer term 2019.
2)	Module will not be offered anymore as from winter term 2019/20.
3)	Module will be offered newly as from winter term 2019/20.

type of course:

L	lecture
L/E	lecture and exercise, separate or integrated
L/S	lecture and seminar integrated
E	exercise
S	seminar
P	practical course

type of learning control:

wE	written examination
oE	oral examination
EoT	examination of other type
ngA	not graded accomplishment
ngA [4)]	not graded accomplishment as examination prerequisite

2.3 Profile Studies (P)

The degree program provides opportunity for specialization within three areas of expertise in the sectoral profiles A - C. In addition, an education of generalists in water engineering is possible in the cross-sectoral profile D.
Within the profile, modules of 36 CP have to be completed, of which at least 24 CP need to be covered by modules specific to the chosen profile (Tables 3 - 5). In addition, further modules of the profile or 'Supplementary Modules' (p. 18) can be chosen.
Students choose one of the four profiles at the beginning of their studies. The choice of a profile is results from the online registration for the first profile-specific exam.

2.3.1 Profile A: Water Technologies & Urban Water Cycle (PA), compulsory elective subject

The focus of this profile is on innovative technologies for the treatment of drinking water and wastewater, as well as the sustainable design of urban and decentralized water systems. This includes biological, chemical and physical processes of water treatment, as well as planning and dimensioning of infrastructure and facilities for water supply and wastewater disposal. In addition to the basic and advanced technological principles and applications, energy efficiency and economics are important aspects.
Students in the profile 'Water Technologies & Urban Water' select modules of at least 24 CP in total from the options in Table 3, and additional 'Supplementary Modules' if desired (s. p. 18).

Table 3: Modules PA - Water Technologies & Urban Water Cycle

Module			Course				LC	
Code (WSEM-)	Name	CP	Name (Language)	Type	HpW / W	SWS S	Type	CP
PA221:	Water Technology (p. 131)	6	Water Technology (E)	L/E	3		oE	6
PA222:	Membrane Technologies and Excursions (p. 87)	6	Membrane Technologies in Water Treatment (E)	L		2	oE	6
			Waste Water Disposal and Drinking Water Supply - Introduction and Excursions (E)	L/F		1	ngA [3)]	0
PA982:	Applied Microbiology (p. 33)	8	Microbiology for Engineers (E)	L		2	oE	4
			Environmental Biotechnology (E)	V	2		oE	4
PA223:	Practical Course in Water Technology (p. 96)	4	Practical Course in Water Technology (E)	L/P		2	EoT	4
PA321:	Wastewater Treatment Technologies [2)] (p. 123)	6	Municipal Wastewater Treatment (E)	L/E	2		ngA [3)] wE	6
			International Sanitary Engineering (E)	L/E	2			
PA322:	Wastewater and Storm Water Treatment Facilities [1)] (p. 121)	6	Wastewater and Storm Water Treatment Facilities (E)	L/E		4	EoT	6
PA323:	Industrial Water Management (p. 71)	6	Industrial Water Management (E)	L/E		4	ngA [3)] oE	1 5
PA621:	Water Distribution Systems (p. 127)	6	Water Distribution Systems (E)	L/E	4		ngA [3)] oE	2 4
PA224:	Biofilm Systems (p. 35)	4	Biofilm Systems (E)	L		2	oE	4

explanations to Table 3:

general:

LC	learning control
CP	credit point
HpW / SWS	hours per week
W / S	winter term / summer term
G / E	language German / English
1)	Module will be offered newly as from summer term 2019.
2)	Module will be offered newly as from winter term 2019/20.

type of course:

L	lecture
L/E	lecture and exercise, separate or integrated
L/F	lecture and field trip integrated
L/P	lecture and practical course integrated

type of learning control:

wE	written examination
oE	oral examination
EoT	examination of other type
ngA 3)	not graded accomplishment as examination prerequisite

2.3.2 Profile B: Fluid Mechanics & Hydraulic Engineering (PB), compulsory elective subject

The aim of this profile is to deepen advanced hydrodynamic principles, and amplify their application for flows in the environment as well as for planning and dimensioning of hydraulic structures for water management. Emphasis is laid on the preservation and regeneration of the structural quality of water bodies, under consideration of ecological aspects. Profound knowledge in physical and numerical modeling is imparted.
Students in the profile 'Fluid Mechanics & Hydraulic Engineering' select modules of at least 24 CP in total from the options in Table 4, and additional 'Supplementary Modules' if desired (s. p. 18).

Table 4: Modules PB - Fluid Mechanics & Hydraulic Engineering

Module			Course				LC	
Code (WSEM-)	Name	CP	Name (Language)	Type	HpW	SWS	Type	CP
PB421:	Environmental Fluid Mechanics (p. 40)	6	Environmental Fluid Mechanics (E)	L/E	4		wE	6
PB521:	Analysis of Turbulent Flows [1)] (p. 30)	6	Fluid Mechanics of Turbulent Flows (E)	L		2	oE	6
			Modeling of Turbulent Flows – RANS and LES (E)	L	2			
PB522:	Advanced Computational Fluid Dynamics (p. 25)	6	Numerical Fluid Mechanics II (E)	L/E		2	oE	3
			Parallel Programming Techniques for Engineering Problems (E)	L/E	2		oE	3
PB431:	Technical Hydraulics (p. 112)	6	Steady and Unsteady Operation of Hydraulic Systems**) (G)	L/E		4	wE	6
PB641:	Experimental Hydraulics and Measuring Techniques (p. 43)	6	Flow Measuring Techniques (G)	L/E	2		oE	3
			Experimental Hydraulics II (G)	L/E	2		EoT	3
PB631:	Hydraulic Structures (p. 61)	6	Groundwater Flow around Structures (E)	L/E		2	oE	3
			Interaction Flow - Hydraulic Structures (G)	L/E	2		oE	3
PB651:	Numerical Flow Modeling in Hydraulic Engineering (p. 93)	6	Numerical Flow Modeling in Hydraulic Engineering (G)	L/E	4		oE	6
PB653:	Hydro Power Engineering (p. 63)	6	Hydro Power Engineering (G)	L/E		4	oE	6
PB655:	Waterway Engineering (p. 132)	6	Waterway Engineering (G)	L/E		4	ngA [2)] oE	1 5
PB633:	Flow and Sediment Dynamics in Rivers (p. 49)	6	Morphodynamics (E)	L/E		2	ngA [2)] oE	2 4
			Flow Behavior of Rivers (E)	L/E		2		
PB661:	Project Studies in Water Resources Management (p. 101)	6	Project Studies in Water Resources Management (G)	L/E	4		EoT	6

**) Course will not be offered in summer term 2019.

explanations to Table 4:

general:

LC	learning control
CP	credit point
HpW / SWS	hours per week
W / S	winter term / summer term
G / E	language German / English
1)	Beginning the module in summer term (S) is recommended.

type of course:

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

type of learning control:

wE	written examination
oE	oral examination
EoT	examination of other type
ngA 2)	not graded accomplishment as examination prerequisite

2.3.3 Profile C: Environmental System Dynamics & Management (PC), compulsory elective subject

This profile focuses on the processes of the water cycle in terrestrial systems and related matter and energy cycles. It also includes all aspects of integrated management of river basins, such as management strategies for the protection of surface and ground waters, the prediction of water-related extreme events, and the development of prevention and mitigation measures.
Students in the profile 'Environmental System Dynamics & Management' select modules of at least 24 CP in total from the options in Table 5, and additional 'Supplementary Modules' if desired (s. p. 18).

Table 5: Modules PC - Environmental System Dynamics & Management

Module			Course				LC	
Code (WSEM-)	Name	CP	Name (Language)	Type	HpW	SWS	Type	CP
PC721:	Management of Water Resources and River Basins (p. 83)	6	Management of Water Resources and River Basins (E)	L/E		4	EoT	6
PC725:	Subsurface Flow and Contaminant Transport [3] (p. 109)	6	Transport and Transformation of Contaminants in Hydrological Systems (E)	L/E		4	oE	6
PC732:	Hydrological Measurements in Environmental Systems [3] (p. 69)	6	Hydrological Measurements in Environmental Systems (E)	L/E/P		4	EoT	6
PC341:	River Basin Modeling [1] (p. 106)	6	Mass Fluxes in River Basins (E)	L		2	EoT	6
			Modeling Mass Fluxes in River Basins (E)	E	2			
PC761:	Aquatic Ecosystems [4] (p. 34)	6	Aquatic Ecosystems (G)	L/S/F	4		ngA [5] EoT	0 6
PC762:	Protection and Use of Riverine Systems (p. 102)	6	Protection and Use of Riverine Systems (E)	S/F		4	ngA [5] EoT	1 5
PC561:	Groundwater Management [1] (p. 58)	6	Groundwater Hydraulics (E)	L/E		2	oE	3
			Numerical Groundwater Modeling (E)	Pj	2		EoT	3
PC821:	Hydrogeology: Field and Laboratory Methods (p. 66)	6	Preparatory Seminar (G)	S		1	EoT	6
			Field and Laboratory Excercises (G)	E		2		
PC831:	Hydrogeology: Groundwater Modeling (p. 67)	6	Hydrogeology: Groundwater Modeling (G)	L/E	4		EoT	6
PC841:	Hydrogeology: Karst and Isotopes [2] (p. 68)	6	Karst Hydrogeology (G)	V/Ü	2		wE	6
			Field Trip Karst Hydrogeology (G)	F		2		
			Isotope Methods in Hydrogeology (G)	L/E/F		2		
PC986:	Management of River and Wetland Ecosystems [2] (p. 111)	6	Ecology of Rivers and Wetlands (G)	L	2		wE	3
			Ecosystem Management (G)	S		2	EoT	3

explanations to Table 5:

general:

LC	learning control
CP	credit point
HpW / SWS	hours per week
W / S	winter term / summer term
G / E	language German / English
1)	Beginning the module in summer term (S) is recommended.
2)	Beginning the module in winter term (W) is recommended.
3)	Module will be offered newly as from summer term 2019.
4)	Module will not be offered anymore as from winter term 2019/20.

type of course:

L	lecture
L/E	lecture and exercise, separate or integrated
L/S	lecture and seminar integrated
E	exercise
S	seminar
S/E	seminar and field trips integrated
F	field trips
Pj	study project

type of learning control:

wE	written examination
oE	oral examination
EoT	examination of other type
ngA 5)	not graded accomplishment as examination prerequisite

2.3.4 Profile D: Water Resources Engineering (PD), compulsory elective subject

This profile aims at training generalists as the individual specialization. Consequently, it features a diversification into the topics of the three profiles A to C.
Students in the profile 'Water Resources Engineering' select modules of at least 24 CP in total from the options in Tables 3 to 5, and additional 'Supplementary Modules' if desired (s. p. 18). At least one module from each of the three profiles A to C has to be chosen.

2.3.5 Supplementary Modules (SM)

The individual specialization within the profile studies can be complemented by electives in order to individualize the profile studies. For that purpose, 'Supplementary Modules' can be selected in addition to the respective profile-specific modules (at least 24 CP), in order to get the 36 CP within the Profile Studies.
All subject-specific modules of the program for which an examination has not already been taken can be chosen as 'Supplementary Modules'. These could thus be further modules from the chosen profile, from other profiles, or from the subjects AF and CC (with the exception of the module 'Language Skills CC949'). Alternatively, modules from related disciplines at KIT can be chosen, such as Geoecology, Meteorology, Civil Engineering (e.g. Geotechnical Engineering), Applied Geosciences (e.g. Engineering Geology), or Chemical and Process Engineering. Available 'further Supplementary Modules' from other disciplines are listed in Table 6.
The choice of 'Supplementary Modules' should be coordinated with the mentor. The mentor advises on suitable modules for the chosen orientation. Other modules from related disciplines compatible to the profile and not listed in Tables 1 to 6 in this handbook might come into consideration as 'Supplementary Modules'. This requires the compilation of an individual curriculum for the student, which needs to be approved by the mentor.

Table 6: Additional Supplementary Modules

Module			Course				LC	
Code (WSEM-)	Name	CP	Name (Language)	Type	HpW	SWS	Type	CP
Engineering Geology								
SM879:	Thermal Use of Groundwater (p. 113)	3	Thermal Use of Groundwater (E)	L/E	2		oE	3
Geotechnics								
SM961:	Earthwork and Embankment Dams[2)] (p. 38)	6	Basics in Earthworks and Embankment Dams (G)	L/E	2		oE	6
			Embankment Dams (Advanced) (G)	L/E		2		
SM962:	Environmental Geotechnics (p. 41)	6	Landfills (G)	L/E	2		oE	3
			Brownfield Sites - Investigation, Evaluation, Rehabilitation (G)	L	2		oE	3
Meteorology								
SM971:	General Meteorology (p. 56)	6	General Meteorology (G)	L/E	5		ngA	6
SM972:	Meteorological Hazards and Climate Change[1)] (p. 89)	6	Meteorological Hazards**) (G)	V		2	ngA[3)] oE	0 3
			Seminar on IPCC Assessment Report (E)	S	2		EoT	3
SM973:	Applied Meteorology: Turbulent Diffusion (p. 32)	6	Turbulent Diffusion (E)	L/E		2/1	ngA[3)] oE	0 6

**) Course will not be offered in summer term 2019.

explanations to Table 6:

general:

LC	learning control
CP	credit point
HpW / SWS	hours per week
W / S	winter term / summer term
G / E	language German / English
1)	Beginning the module in summer term (S) is recommended.
2)	Beginning the module in winter term (W) is recommended.

type of course:

L	lecture
L/E	lecture and exercise, separate or integrated
S	seminar

type of learning control:

oE	oral examination
EoT	examination of other type
ngA	not graded accomplishment
ngA 3)	not graded accomplishment as examination prerequisite

2.4 Study Project

Students carry out an interdisciplinary '**Study Project**' (p. 108). The project prepares students for independent scientific working and writing, and introduces skills in project management. The topics for the 'Study Project' should be especially located at the interfaces between the water-research disciplines of the KIT. In addition to the competence of combining approaches from different fields, they acquire abilities for team work and critical evaluation of results in the context of the project. 15 CP are credited for the 'Study Project'.
It is highly recommended to have acquired the necessary subject-specific and interdisciplinary competencies needed to work on the 'Study Project' beforehand.
The assignment of a research topic, supervision and evaluation of the 'Study Project' is carried out by a full-time faculty member of the KIT-Department of Civil Engineering, Geo and Environmental Sciences or of the KIT-Department of Chemical and Process Engineering, who offers courses in the master's degree program *Water Science & Engineering* and is authorized to conduct the respective examination. Students look for a supervisor from the field they are interested in. In exceptional cases and at request of the student, the spokesperson of the study program ensures that a topic is assigned within a four week period.
For registration the respective form (http://www.wasser.kit.edu/downloads/Pruef_ZulAnmeld_StudyProject_engl.pdf) with the admission by the Study Program Service of the department ('Studiengangservice Bau-Geo-Umwelt'; s. p. 23) is handed over to the supervisor when starting the 'Study Project'.

2.5 Master's Thesis

The **Master Thesis** is an independent scientific study and includes the theoretical and/or experimental work on a complex problem. Students deal with the current state of research and apply the expertise and scientific methods acquired during the studies. They can document, discuss and evaluate the obtained results. Furthermore, they are able to present and defend the essential findings. The topic of the 'Master's Thesis' depends on the subject area that is chosen for the thesis. In case that the master thesis shall be prepared outside of KIT the leaflet 'Merkblatt - Externe Abschlussarbeiten' (http://www.haa.kit.edu/downloads/KIT_ALLGEMEIN_Merkblatt_Externe_Abschlussarbeiten.pdf) has to be considered.
Generally, the 'Master's Thesis' is written during the 4$^{th)}$ semester. In order to be admitted to the 'Master's Thesis', students must have successfully completed modules of at least 42 CP in the master's degree program *Water Science & Engineering* (p. 92). It is highly recommended to have acquired the necessary subject-specific and interdisciplinary competencies needed to work on the 'Master's Thesis' beforehand.
Students look for a supervisor and a further examiner from the field they are interested in. The research topic for the 'Master's Thesis' is assigned by the supervisor, who has to be a professor, a habilitated faculty member, or an entitled research associate, and who has to be a member of the KIT-Department of Civil Engineering, Geo and Environmental Sciences, or of the KIT-Department of Chemical and Process Engineering. Generally, the supervisor and a second examiner evaluate the thesis. For the assignment of the research topic, the interests of the student can be taken into account. In exceptional cases, the assignment of a research topic for the 'Master's Thesis' is arranged by the chairperson of the examination board.
Admission to the module 'Master's Thesis' requires online registration and sending a current transcript to the Students' Advisory Service (s. p. 23), who grants admission online if the requirements are fulfilled. Then, registration of the master's thesis with the administration ('Studierendenservice') is required using the form http://www.sle.kit.edu/downloads/Sonstige/Pruefungszulassung-Abschlussarbeit.pdf (in German).
The processing time is six months. The 'Master's Thesis' can be written in English or German, and has to be completed with a presentation within one month after submission of the thesis. The presentation is part of the examination and is considered within the evaluation.

2.6 Interdisciplinary Qualifications

Generic qualifications are taught along with the modules, especially in the subjects 'Cross Cutting Methods & Competencies' and 'Study Project'.

2.7 Additional accomplishments

An **additional accomplishment** is a voluntarily taken examination, which is not considered in the overall grade (comp. ER/SPO § 15). In total, additional accomplishments can be taken in extent of 30 CP at maximum from the entire offer of KIT. An additional accomplishment has to be admitted as such by the Study Program Service of the department ('Studiengangservice Bau-Geo-Umwelt'; s. p. 23) with the examination form available there. The examination form has to be delivered to the examiner as registration and for the transfer of the obtained grade within the registration period.

By request to the examination committee the assignment can by changed subsequently.
All taken additional accomplishments are listed in the transcript of records. If a module, as described in the study program in which it is offered, is completed this module can be included in the master degree certificate as additional modules on request by the student. This applies also to additional accomplishments which were recognized by the examination committee.

3 Module selection, individual curriculum & mentoring

The compulsory and compulsory elective subjects are developed by the selection of modules within a specified framework. Each module consists of one or more interrelated courses and is completed by one or more examinations. The extent of a module is determined by credit points (CP) which are credited by successful passing of the module. In addition to the descriptions in the module handbook, the course catalog (online) and the postings and web pages of the institutes inform about the current details every semester (e.g. time and location of courses).
The selection options within the studies require that each student compiles an individual curriculum. The selection of the modules have to be made with care. This selection is supervised by a mentor chosen by the student at the beginning of the studies.
The mentor has to be a professor of the KIT-Department Civil Engineering, Geo and Environmental Sciences or of the KIT-Department of Chemical and Process Engineering and to be involved in the degree program *Water Science & Engineering*.
If modules shall be selected within the compulsory and compulsory elective subjects others than listed in Tables 1 to 6 the individual curriculum need to be approved by the mentor and to be announced to the Study Advisor.
Exemplary curricula can be found in the appendix.

4 Exams and Learning Controls

The successful completion of modules is checked with learning controls, which can be graded or not graded. Graded learnings controls are written exams (wE), oral exams (oE), or examinations of other type (EoT). Not graded accomplishments (ngA) are course-related performances in written, oral or practical form.

4.1 Registration

The students must register for learning controls at the online student portal. The examiners can define prerequisites and deadlines for the registration. Upon registration, students have to declare the assignment of the respective module to a subject, as far as options exist. In case of an oral examination the online registration is to be combined directly with the negotiation of an examination date with the examiner.
A successful online registration covers the admission to the examination. A confirmation for this is provided by the online student portal and can serve as proof for a made registration in case of doubts. If there occurs a problem with an attempt of an online registration the Study Program Service of the department ('Studiengangservice Bau-Geo-Umwelt'; s. p. 23) has to be informed as soon as possible in addition to the examiner.
A registered examination is either to be taken or a cancellation has to be made in advance to the deadline of cancellation.

4.2 Cancellation

Students may cancel their registration for written exams (wE) without giving reasons until the examination questions are handed out. When canceling oral examinations (oE), the examiner must be informed at least three working days prior to the examination date.
Canceling of examinations of other type (EoT) as well as of not graded accomplishments (ngA) is possible up to the rendering of the respective performance or the first part of the performance. The submission of a written work (report, homework or similar) or the beginning of an oral exam (presentation, colloquium or similar) counts as rendering the performance. If deadlines are set, a cancellation can only be made in advance.
A later cancellation or withdrawal must be justified by valid grounds, and requires submitting a written declaration to the examination committee immediately.

4.3 Repetition

A failed examination (wE, oE, EoT) can be repeated once in the same form. If the retake of a written exam is failed again, an oral examination takes place, in which at best the grade Passed can be achieved. Failed exams have to be retaken by the end of the examination period of the semester after the following semester.
Not graded accomplishments (ngA) may be repeated several times.

5 Recognition of accomplishments

5.1 Recognition of external credits

The recognition of external accomplishments, for example credits obtained in other master's programs or at other universities, have to be requested by the respective recognition form of the examination committee. The respective lecturers confirm if the accomplishments are equivalent to their modules in the curriculum.
Accomplishments that are not equivalent to modules in the curriculum can be accredited if the acquired competences contribute to the qualification goals of the master's program. If necessary, an individual curriculum has to be compiled and approved by the mentor.
The examination committee decides on which accomplishments are accredited and which parts of the curriculum may be replaced. The form for recognition has to be submitted to the study advisor (s. p. 23), who will transfer it to the examination committee and the Study Program Service of the department ('Studiengangservice Bau-Geo-Umwelt'; s. p. 23).

5.2 Accomplishments obtained outside of the Higher Education System

Accomplishments made outside of the higher education system, as for example vocational training, can be accredited if the acquired competences contribute to the qualification goals of the master's program. At maximum, 50 % of the university education can be replaced. Recognition is requested with the respective form of the examination committee. The examination committee verifies to which extent the acquired knowledge and capabilities can be recognized, and which parts of the program they can replace.

6 Special circumstances

6.1 Students with physical challenges or chronic illness

Students with physical challenges or chronic illness can get compensation for possible disadvantages ('Nachteilsausgleich'). They may be granted preferential access to place-limited courses, modification of the sequence of courses according to their needs, or modifications of the form or conditions of exams. Students should contact the study advisor in order to prepare a request in writing to the exam committee including supporting documents. The exam committee decides on the modified details of the courses and exams, respectively, in accordance with the student and the examiners.
Examples of possible compensations of disadvantages:

- Modified form of exams, for instance oral exams instead of written exams, and vice versa
- Conducting exams in a separate room
- Allowing necessary utilities and assistance, e.g. sign language interpreter
- Additional breaks during time-limited exams
- Extension of the periods between exams

6.2 Maternity leave, parental leave and family commitments

Maternity leave according to the legal regulations interrupts any time period set by the examination regulations. Parental leave and family commitments, for example time needed for caring of family members, can also be handled with modified time periods for exams. In all these cases, a request in writing including supporting documents is to be submitted to the exams committee via the study advisor.
In the case of parental leave, the exam committee has to be informed in writing at least four weeks in advance about the duration of the parental leave. If the conditions are met that would allow parental leave for employees, the student is informed about the modified time periods for exams.
The time period for the master's thesis cannot be interrupted due to parental leave or family commitments. In these cases, the registration of the master's thesis is cancelled, and a new topic will be assigned to the student.

7 Contact persons

Dean of Study Affairs:

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

Study Advisor/Coordination:

Dr. Jan Wienhöfer
Institute for Water and River Basin Management, Hydrology, Bldg. 10.81, R. 420.3
consultation: on appointment
Phone: 0721/608-41932
Email: jan.wienhoefer@kit.edu

Examination Committee Master:

Prof. Dr.-Ing. Kunibert Lennerts (chairperson)
Dr. Gunnar Adams (person in charge)
Institute of Technology and Management in Construction, Bldg. 50.31, R. 005 (EG)
consultation: Fr. 14.00 – 15.00 h
Phone: 0721/608-46008
Email: pam@bgu.kit.edu
Web: https://www.tmb.kit.edu/PAM.php

Study Program Service ('Studiengangservice Bau-Geo-Umwelt'):

Department of Civil Engineering, Geo and Environmental Sciences, Bldg. 10.81, R. 312
consultation: s. http://www.bgu.kit.edu/studiengangservice.php
Email: studiengangservice@bgu.kit.edu
Web: http://www.bgu.kit.edu/studiengangservice.php

Fachschaft:

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

8 Current changes

In the following, the important changes are listed as from summer term 2019. Although this process was done with great care, other/minor changes may exist.

modules not offered any more as from summer term 2019:

Data Analysis and Environmental Monitoring [WSEM-CC771]

Water Ecology [WSEM-CC371]

Process Engineering in Wastewater Treatment [WSEM-PA321]

Wastewater and Storm Water Treatment [WSEM-PA322]

Transport and Transformation of Contaminants in Hydrological Systems [WSEM-PC725]

Experimental Hydrology [WSEM-PC731]

modules offered newly as from summer term 2019:

Analysis of Spatial Data [WSEM-CC773], replaces module Data Analysis and Environmental Monitoring [WSEM-CC771]

Freshwater Ecology [WSEM-CC371], replaces module Water Ecology [WSEM-CC371]

Mass Transfer and Reaction Kinetics [WSEM-CC925]

Wastewater and Storm Water Treatment Facilities [WSEM-PA322], replaces module Wastewater and Storm Water Treatment [WSEM-PA322]

Subsurface Flow and Contaminant Transport [WSEM-PC725], replaces module Transport and Transformation of Contaminants in Hydrological Systems [WSEM-PC725]

Hydrological Measurements in Environmental Systems [WSEM-PC732], replaces module Experimental Hydrology [WSEM-PC731]

modules not offered any more as from winter term 2019/20:

Integrated Infrastructure Planning [WSEM-CC791]

Aquatic Ecosystems [WSEM-CC792]

Environmental Communication [WSEM-PC761]

modules offered newly as from winter term 2019/20:

Introduction to Environmental Data Analysis and Statistical Learning [WSEM-CC774]

Fundamentals of Numerical Algorithms for Engineers [WSEM-CC571]

Wastewater Treatment Technologies [WSEM-PA321], replaces module Process Engineering in Wastewater Treatment [WSEM-PA321]

changes of the courses assigned to the modules as from summer term 2019:

Industrial Water Management [WSEM-PA323]:

The course Industrial Water Management (6223810), 4 HpW / SWS, is newly offered.

changed examinations and not graded accomplishments as from winter term 2018/19:

Industrial Water Management [WSEM-PA323]:

The not graded accomplishment 'Lab report Industrial Water Management' is additional part of the module as examination prerequisite.

Part II
Modules

M Module: Advanced Computational Fluid Dynamics (WSEM-PB522) [M-BGU-103384]

Responsibility: Markus Uhlmann

Institution: KIT-Fakultät für Bauingenieur-, Geo- und Umweltwissenschaften

Curricular Embedding: Compulsory Elective

Contained in: Profile Studies / Fluid Mechanics & Hydraulic Engineering

Credit Points	Recurrence Frequency	Duration	Language	Version
6	Each summer term	1 term	English	2

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-BGU-106769	Parallel Programming Techniques for Engineering (p. 200)	3	Markus Uhlmann
T-BGU-106768	Numerical Fluid Mechanics II (p. 196)	3	Markus Uhlmann

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
- 'Teilleistung' T-BGU-106768 with oral examination according to § 4 Par. 2 No. 2
- 'Teilleistung' T-BGU-106769 with oral examination according to § 4 Par. 2 No. 2
details about the learning controls see at the respective 'Teilleistung'

Grade of the Module
grade of the module is CP weighted average of grades of the partial exams

Prerequisites
module 'Numerical Fluid Mechanics (AF501)' must be completed

Modeled Conditions
The following conditions must be met:

- The module [M-BGU-103375] *Numerical Fluid Mechanics* must have been passed.

Qualification Goals
Students are able to numerically solve simplified flow problems based upon the Navier-Stokes equations in an independent fashion. This involves the design of a solution method, the analysis of its properties (concerning stability, precision, computational effort), the algorithmic implementation, the validation with respect to appropriate test cases, and the final documentation of the results. Furthermore, participants of this course are enabled to judge techniques for the use of massively parallel computer systems to solve fluid mechanics problems as to their efficiency and applicability. They are capable of applying the appropriate parallel programming techniques to selected model problems.

Content
In the present module, advanced skills in the numerical solution of fluid mechanics problems are imparted, building upon the material of the course Numerical Fluid Mechanics I. Here, various numerical solution methods for the time-dependent Navier-Stokes equations in several spatial dimensions are demonstrated with the aid of practical examples. This includes the following aspects: coupling and decoupling of velocity and pressure fields in incompressible flows, numerical treatment of discontinuities (shock waves, hydraulic jumps), computation of scalar transport, numerical tracking of inertial particles, linear stability analysis.The course Parallel Programing Techniques for Engineering Problems conveys the fundamental programming concepts for massively-parallel computer systems. First, the common parallel computer architectures and the most widely used programming paradigms are introduced. Then techniques for implementing standard algorithms of

numerical fluid mechanics (and other disciplines involving field problems) are presented, analyzed and practiced with the aid of the Message Passing Interface (MPI) standard.

Recommendations
Programing skills in at least one compiler language (C,C++, FORTRAN or equivalent)

Remarks
none

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.

Workload
contact hours (1 HpW = 1 h x 15 weeks):

- Parallel Programming Techniques for Engineering Problems lecture, exercise: 30 h
- Numerical Fluid Mechanics II lecture, exercise: 30 h

independent study:

- preparation and follow-up lectures, exercises Parallel Programming Techniques for Engineering Problems: 30 h
- examination preparation Parallel Programming Techniques for Engineering Problems (partial exam): 30 h
- preparation and follow-up lectures, exercises Numerical Fluid Mechanics II: 30 h
- examination preparation Numerical Fluid Mechanics II (partial exam): 30 h

total: 180 h

M Module: Advanced Fluid Mechanics (WSEM-AF401) [M-BGU-103359]

Responsibility: Olivier Eiff

Institution: KIT-Fakultät für Bauingenieur-, Geo- und Umweltwissenschaften

Curricular Embedding: Compulsory Elective

Contained in: Advanced Fundamentals

Credit Points	Recurrence Frequency	Duration	Language	Version
6	Each summer term	1 term	English	1

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-BGU-106612	Advanced Fluid Mechanics (p. 133)	6	Olivier Eiff

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
- 'Teilleistung' T-BGU-106612 with written examination according to § 4 Par. 2 No. 1
details about the learning control see at the 'Teilleistung'

Grade of the Module
grade of the module is grade of the exam

Prerequisites
none

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

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

Recommendations
first courses in undergraduate fluid-mechanics, advanced engineering mathematics (analysis, differential and integral calculus, ordinary and partial differential equations, linear algebra, Fourier analysis, complex numbers)

Remarks
none

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

Workload
contact hours (1 HpW = 1 h x 15 weeks):
- lecture/exercise: 60 h

independent study:
- preparation and follow-up lecture/exercises: 30 h
- home work on exercises: 30 h
- examination preparation: 60 h

total: 180 h

M Module: Analysis of Spatial Data (WSEM-CC773) [M-BGU-103762]

Responsibility: Erwin Zehe

Institution: KIT-Fakultät für Bauingenieur-, Geo- und Umweltwissenschaften

Curricular Embedding: Compulsory Elective

Contained in: Cross-Cutting Methods & Competencies

Credit Points	Recurrence Frequency	Duration	Language	Version
6	Each summer term	1 term	English	1

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-BGU-106605	Geostatistics (p. 164)	6	Erwin Zehe

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
- 'Teilleistung' T-BGU-106605 with oral examination according to § 4 Par. 2 No. 2
details about the learning control see at the 'Teilleistung'

Grade of the Module
grade of the module is grade of the exam

Prerequisites
none

Modeled Conditions
The following conditions must be met:

- The module [M-BGU-103378] *Data Analysis and Environmental Monitoring* must not have been started.

Qualification Goals
Students can explain and apply methods for analysis and simulation of spatially and temporally distributed environmental data. Based on this, they are capable of setting up experimental designs for environmental monitoring and evaluate the suitability of available data for different tasks.
Students are able to critically assess the results of analysis and simulation tools and to quantify and evaluate the related uncertainties.

Content
- fundamentals of environmental systems theory, environmental monitoring and experimental design (data types, scale triplet, measuring methods)
- experimental variograms, directional variograms, indicator variograms, variogram fitting, anisotropy
- Kriging techniques: Ordinary Kriging, screening properties of Kriging, BLUE, pure nugget effect, cross validation, RMSE
- estimation of spatial patterns in nonstationary data (External Drift Kriging, Simple Updating)
- simulation of spatial patterns: turning Bands Simulation, smoothing problems of interpolation

Recommendations
basic knowledge in statistics
module Hydrological Measurements in Environmental Systems [bauiM2S05-HY5]
knowledge of programming with Matlab; otherwise, it is strongly recommended to attend the course 'Introduction to Matlab' (6224907)

Remarks
This module is offered newly as from summer term 2018.

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).

Workload

contact hours (1 HpW = 1 h x 15 weeks):

- lecture/exercise: 60 h

independent study:

- preparation and follow-up lecture/exercises: 60 h
- examination preparation: 60 h

total: 180 h

M Module: Analysis of Turbulent Flows (WSEM-PB521) [M-BGU-103363]

Responsibility: Markus Uhlmann

Institution: KIT-Fakultät für Bauingenieur-, Geo- und Umweltwissenschaften

Curricular Embedding: Compulsory Elective

Contained in: Profile Studies / Fluid Mechanics & Hydraulic Engineering

Credit Points	Recurrence Frequency	Duration	Language	Version
6	Each summer term	2 terms	English	1

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-BGU-103561	Analysis of Turbulent Flows (p. 134)	6	Markus Uhlmann

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
- 'Teilleistung' T-BGU-103561 with oral examination according to § 4 Par. 2 No. 2
details about the learning control see at the 'Teilleistung'

Grade of the Module
grade of the module is grade of the exam

Prerequisites
none

Qualification Goals
Participants are able to describe the characteristics of turbulent flows, and to quantify their effect upon the transport rates of momentum, heat and mass. They are aware of the problems associated with computationally determining turbulent flow quantities. With this knowledge, they are able to weigh the prosand cons of the different modeling approaches; they are further able to choose an appropriate approach for a given application. Participants have the ability to critically evaluate the expected outcome of a range of turbulence models with respect to their predictive capabilities and the required computational effort.

Content
The present module gives a general introduction to the analysis of turbulent flows. The mathematical description of the physics of turbulence is successively developed, i.e. the properties of the conservation laws, the required mathematical tools and the most useful modeling approaches for fluids engineering problems.
The course Fluid Mechanics of Turbulent Flows presents the phenomenology of turbulent flows, introduces the statistical description of turbulent flow processes, discusses the characteristics of free and wall-bounded shear flows, and presents an analysis of the turbulent energy cascade.
In the course Modeling of Turbulent Flows - RANS and LES, first the statistical approach to turbulence modeling, based upon Reynolds averaging (RANS) is presented, starting with the simplest algebraic model and ranging up to Reynolds stress transport models. Furthermore, an introduction to the concept of large-eddy simulation (LES) is given.

Recommendations
Basic fluid mechanics (experience in working with the Navier-Stokes equations)
Mathematics (analysis – partial differential equations, Fourier series, vectors/tensors, matrices and eigenvalues; statistics)
Knowledge in programming with Matlab is recommended; otherwise it is strongly recommended to participate in the course 'Introduction to Matlab (CC772)'.

Remarks
none

Workload
contact hours (1 HpW = 1 h x 15 weeks):

- Fluid Mechanics of Turbulent Flows lecture/exercise: 30 h
- Modeling of Turbulent Flows - RANS and LES lecture, exercise: 30 h

independent study:

- preparation and follow-up lecture/exercises Fluid Mechanics of Turbulent Flows: 30 h
- preparation and follow-up lectures, exercises Modeling of Turbulent Flows - RANS and LES: 30 h
- examination preparation: 60 h

total: 180 h

M Module: Applied Meteorology: Turbulent Diffusion (WSEM-SM973) [M-PHYS-103387]

Responsibility: Peter Knippertz, Bernhard Vogel, Heike Vogel

Institution: KIT-Fakultät für Physik
Curricular Embedding: Compulsory Elective
Contained in: additional Supplementary Modules

Credit Points	Recurrence Frequency	Duration	Language	Version
6	Each summer term	1 term	English	2

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-PHYS-108610	Turbulent Diffusion (p. 219)	0	Michael Kunz
T-PHYS-109981	Examination on Turbulent Diffusion (p. 149)	6	Bernhard Vogel

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
- 'Teilleistung' T-PHYS-101558 with not graded accomplishment according to § 4 Par. 3 as examination prerequisite
- 'Teilleistung' T-PHYS-106772 with oral examination according to § 4 Par. 2 No. 2
details about the learning controls see at the respective 'Teilleistung'

Grade of the Module
grade of the module is grade of the exam

Prerequisites
none

Qualification Goals
The students are able to explain essential aspects of the diffusion of atmospheric constituents with adequate terminology. They can describe the underlying processes qualitatively and quantitatively, and are able to derive the impact of meteorological conditions on the diffusion of atmospheric constituents.

Content
Dispersion of atmospheric constituents

- relevant trace gases
- diurnal cycles of emissions and concentrations
- temperature and flow evolution in the lower atmosphere
- turbulent diffusion
- turbulence parametrization
- chemical conversion processes
- numerical models

Recommendations
basic knowledge in meteorology, e.g. module 'General Meteorology (SM971)'

Workload
contact hours (1 HpW = 1 h x 15 weeks):

- lecture/exercise: 45 h

independent study:

- preparation and follow-up lecture/exercises Turbulent Diffusion, incl. working on exercises (examination prerequisite): 105 h
- examination preparation: 30 h

total: 180 h

M Module: Applied Microbiology (WSEM-PA982) [M-CIWVT-103436]

Responsibility: Thomas Schwartz, Andreas Tiehm

Institution: KIT-Fakultät für Chemieingenieurwesen und Verfahrenstechnik

Curricular Embedding: Compulsory Elective

Contained in: Profile Studies / Water Technologies & Urban Water Cycle

Credit Points	Recurrence Frequency	Duration	Language	Version
8	Each term	2 terms	English	1

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-CIWVT-106834	Microbiology for Engineers (p. 192)	4	Thomas Schwartz
T-CIWVT-106835	Environmental Biotechnology (p. 144)	4	Andreas Tiehm

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
- 'Teilleistung' T-CIWVT-106834 with oral examination according to § 4 Par. 2 No. 2
- 'Teilleistung' T-CIWVT-106835 with oral examination according to § 4 Par. 2 No. 2
details about the learning controls see at the respective 'Teilleistung'

Grade of the Module
grade of the module is CP weighted average of grades of the partial exams

Prerequisites
none

Qualification Goals
Students can explain the microbiological principles and their technical applications. Students are able to apply technically relevant biochemical and molecular biology issues to ecological, biotechnical and environmental processes. They can analyze
and evaluate factors limiting operations in e.g. biotechnology and water technology and can combine processes for enhanced turnover rates in the sense of ecology and/or economy.

Content
Main issues are the structures and functions of microorganisms, their interactions with global element cycles and other organisms, the microbial impact on energy and corrosion as well as strategies against microbes. Basing on the fundamental metabolism biotechnology operations and specific monitoring strategies are presented.

Recommendations
understanding of microbiological processes in the environment and in technical systems

Workload
contact hours (1 HpW = 1 h x 15 weeks):
- Microbiology for Engineers lecture: 30 h
- Environmental Biotechnology lecture: 30 h

independent study:
- preparation and follow-up lectures Microbiology for Engineers: 45 h
- examination preparation Microbiology for Engineers: 45 h
- preparation and follow-up lectures Environmental Biotechnology: 45 h
- examination preparation Environmental Biotechnology: 45 h

total: 240 h

M Module: Aquatic Ecosystems (WSEM-PC761) [M-BGU-103400]

Responsibility: Charlotte Kämpf

Institution: KIT-Fakultät für Bauingenieur-, Geo- und Umweltwissenschaften

Curricular Embedding: Compulsory Elective

Contained in: Profile Studies / Environmental System Dynamics & Management

Credit Points	Recurrence Frequency	Duration	Language	Version
6	Each winter term	1 term	German	1

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-BGU-106788	Examination Prerequisite Aquatic Ecosystems (p. 150)	0	Charlotte Kämpf
T-BGU-106789	Aquatic Ecosystems (p. 136)	6	Charlotte Kämpf

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
- 'Teilleistung' T-BGU-106788 with not graded accomplishment according to § 4 Par. 3 as examination prerequisite
- 'Teilleistung' T-BGU-106789 with examination of other type according to § 4 Par. 2 No. 3
details about the learning controls see at the respective 'Teilleistung'

Grade of the Module
grade of the module is grade of the exam

Prerequisites
none

Qualification Goals
see German version

Content
see German version

Recommendations
none

Remarks
IMPORTANT:
The module will not be offered anymore as from winter term 2019/20.

Workload
contact hours (1 HpW = 1 h x 15 weeks):
- seminar (lecture)/exercise: 40 h

independent study:
- preparation and follow-up seminar (lectures)/exercises: 20 h
- preparation of literature annotations and short presentation (exam prerequisite): 45 Std.
- preparation of presentation, manuscript and poster (exam): 75 Std.

total: 180 h

M Module: Biofilm Systems (WSEM-PA224) [M-CIWVT-103441]

Responsibility: Harald Horn

Institution: KIT-Fakultät für Chemieingenieurwesen und Verfahrenstechnik

Curricular Embedding: Compulsory Elective

Contained in: Profile Studies / Water Technologies & Urban Water Cycle

Credit Points	Recurrence Frequency	Duration	Language	Version
4	Each summer term	1 term	English	1

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-CIWVT-106841	Biofilm Systems (p. 137)	4	Harald Horn

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
- 'Teilleistung' T-CIWVT-106841 with oral examination according to § 4 Par. 2 No. 2
details about the learning control see at the 'Teilleistung'

Grade of the Module
grade of the module is grade of the exam

Prerequisites
none

Qualification Goals
Students can describe the structure and function of biofilms in natural habitats as well as in technical systems. They can explain the major influencing factors and processes for the formation of biofilms. They are familiar with techniques for visualizing biofilm structures as well as with models for simulating biofilm growth. They are able to select appropriate methods for the analysis of biofilms and to evaluate the habitat conditions.

Content
Microorganisms typically organize in the form of biofilms in technical and natural aquatic systems. However, biofilms are not only accumulated microorganisms at interfaces: They are bound together by a matrix of extracellular polymeric substances (EPS). In this course, the structure and function of biofilms in different natural habitats and technical applications (biofilm reactors, biofilms in natural waters, biofouling in technical systems and biofilms for power generation in microbial fuel cells) are presented and discussed. Biofilm growth and abrasion as well as models for the simulation of these processes are introduced. Furthermore, microscopic techniques for the visualization of biofilm structures are presented.

Recommendations
none

Workload
contact hours (1 HpW = 1 h x 15 weeks):
- lecture: 30 h

independent study:
- preparation and follow-up lectures: 30 h
- examination preparation: 60 h

total: 120 h

M Module: Data Analysis and Environmental Monitoring (WSEM-CC771) [M-BGU-103378]

Responsibility: Erwin Zehe

Institution: KIT-Fakultät für Bauingenieur-, Geo- und Umweltwissenschaften

Curricular Embedding: Compulsory Elective

Contained in: Cross-Cutting Methods & Competencies

Credit Points	Recurrence Frequency	Duration	Language	Version
9	Each term	2 terms	English	1

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-BGU-106761	Data Analysis and Environmental Monitoring (p. 140)	9	Erwin Zehe

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
- 'Teilleistung' T-BGU-106761 with oral examination according to § 4 Par. 2 No. 2
details about the learning control see at the 'Teilleistung'

Grade of the Module
grade of the module is grade of the exam

Prerequisites
none

Qualification Goals
Students can explain and apply methods for analysis and simulation of spatially and temporally distributed environmental data.Based on this, they are capable of setting up experimental designs for environmental monitoring and evaluate the suitability of available data for different tasks.Students are able to critically assess the results of analysis and simulation tools and to quantify and evaluate the related uncertainties.

Content
Geostatistics:
- fundamentals of environmental systems theory, environmental monitoring and experimental design (data types, scale triplet, measuring methods)
- experimental variograms, directional variograms, indicator variograms, variogram fitting, anisotropy
- Kriging techniques: Ordinary Kriging, screening properties of Kriging, BLUE, pure nugget effect, cross validation, RMSE
- estimation of spatial patterns in nonstationary data (External Drift Kriging, Simple Updating)
- simulation of spatial patterns: Turning Bands Simulation, smoothing problems of interpolation

Introduction to Data Analysis, Machine Learning and Information Theory:descriptive statistics
- analysis and prediction of time series
- analysis and prediction of spatial data
- introduction to information theory
- machine learning

Recommendations
statisticsmodule 'Experimental Hydrology (PC731)'knowledge in programming with Matlab; otherwise, it is strongly recommended to attend the course 'Introduction to Matlab (6224907)'

Remarks
MPORTANT:

The module will not be offered anymore as from summer term 2019. Parts of the module will be replaced by the module Analysis of Spatial Data and the module Introduction to Environmental Data Analysis and Statistical Learning.

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).
Daniel Wilks (2011): Statistical Methods in the Atmospheric Sciences, Volume 100, 3rd Edition, ISBN 978-0-1238-5022-5, Academic Press.
Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani (2014): An Introduction to Statistical Learning, ISBN 978-1-4614-7137-0, Springer.
Thomas M. Cover, Joy A. Thomas (2006): Elements of Information Theory, 2nd Edition, ISBN: 978-0-471-24195-9, Wiley.

Workload

contact hours (1 HpW = 1 h x 15 weeks):

- Geostatistics lecture, exercise: 60 h
- Introduction to Data Analysis, Machine Learning and Information Theory lecture, exercise: 30 h

independent study:

- preparation and follow-up lectures, exercises Geostatistics: 75 h
- preparation and follow-up lectures, exercises Introduction to Data Analysis, Machine Learning and Information Theory: 45 h
- examination preparation: 60 h

total: 270 h

M Module: Earthwork and Embankment Dams (WSEM-SM961) [M-BGU-103402]

Responsibility: Theodoros Triantafyllidis

Institution: KIT-Fakultät für Bauingenieur-, Geo- und Umweltwissenschaften

Curricular Embedding: Compulsory Elective

Contained in: additional Supplementary Modules

Credit Points	Recurrence Frequency	Duration	Language	Version
6	Each winter term	2 terms	German	1

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-BGU-106792	Earthwork and Embankment Dams (p. 141)	6	Andreas Bieberstein

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
- 'Teilleistung' T-BGU-106792 with oral examination according to § 4 Par. 2 No. 2
details about the learning control see at the 'Teilleistung'

Grade of the Module
grade of the module is grade of the exam

Prerequisites
none

Qualification Goals
see German version

Content
see German version

Recommendations
none

Remarks
none

Workload
contact hours (1 HpW = 1 h x 15 weeks):

- Basics in Earthworks and Embankment Dams lecture/exercise: 30 Std.
- Embankment Dams (Advanced) lecture/exercise: 30 Std.

independent study:

- preparation and follow-up lecture/exercises Basics in Earthworks and Embankment Dams: 30 h
- preparation and follow-up lecture/exercises Embankment Dams (Advanced): 30 h
- examination preparation: 60 h

total: 180 h

M Module: Environmental Communication (WSEM-CC792) [M-BGU-101108]

Responsibility: Charlotte Kämpf

Institution: KIT-Fakultät für Bauingenieur-, Geo- und Umweltwissenschaften

Curricular Embedding: Compulsory Elective

Contained in: Cross-Cutting Methods & Competencies

Credit Points	Recurrence Frequency	Duration	Language	Version
6	Each winter term	1 term	German	1

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-BGU-106620	Examination Prerequisite Environmental Communication (p. 151)	0	Charlotte Kämpf
T-BGU-101676	Environmental Communication (p. 145)	6	Charlotte Kämpf

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
- 'Teilleistung' T-BGU-106620 with not graded accomplishment according to § 4 Par. 3 as examination prerequisite
- 'Teilleistung' T-BGU-101676 with examination of other type according to § 4 Par. 2 No. 3
details about the learning controls see at the respective 'Teilleistung'

Grade of the Module
grade of the module is grade of the exam

Prerequisites
none

Qualification Goals
(see German version)

Content
(see German version)

Recommendations
none

Remarks
IMPORTANT:
The module will not be offered anymore as from winter term 2019/20.

Literature
(see German version)

Workload
contact hours (1 HpW = 1 h x 15 weeks):
- seminar (lecture): 20 h

independent study:
- preparation and follow-up seminar: 40 h
- preparation of literature annotations and short presentation (exam prerequisite): 45 Std.
- preparation of presentation, manuscript and poster (exam): 75 Std.

total: 180 h

M Module: Environmental Fluid Mechanics (WSEM-PB421) [M-BGU-103383]

Responsibility: Olivier Eiff

Institution: KIT-Fakultät für Bauingenieur-, Geo- und Umweltwissenschaften

Curricular Embedding: Compulsory Elective

Contained in: Profile Studies / Fluid Mechanics & Hydraulic Engineering

Credit Points	Recurrence Frequency	Duration	Language	Version
6	Each winter term	1 term	English	1

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-BGU-106767	Environmental Fluid Mechanics (p. 146)	6	Olivier Eiff

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
- 'Teilleistung' T-BGU-106767 with written examination according to § 4 Par. 2 No. 1
details about the learning control see at the 'Teilleistung'

Grade of the Module
grade of the module is grade of the exam

Prerequisites
none

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

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

Recommendations
modules 'Advanced Fluid Mechanics (AF401)', 'Analysis of Turbulent Flows (PB521)'

Remarks
none

Workload
contact hours (1 HpW = 1 h x 15 weeks):
- lecture/exercise: 60 h

independent study:
- preparation and follow-up lecture/exercises: 60 h
- examination preparation: 60 h

total: 180 h

M Module: Environmental Geotechnics (WSEM-SM962) [M-BGU-100079]

Responsibility: Theodoros Triantafyllidis

Institution: KIT-Fakultät für Bauingenieur-, Geo- und Umweltwissenschaften

Curricular Embedding: Compulsory Elective

Contained in: additional Supplementary Modules

Credit Points	Recurrence Frequency	Duration	Language	Version
6	Each winter term	1 term	German	1

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-BGU-100084	Landfills (p. 185)	3	Andreas Bieberstein
T-BGU-100089	Brownfield Sites - Investigation, Evaluation, Rehabilitation (p. 139)	3	Andreas Bieberstein

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
- 'Teilleistung' T-BGU-100084 with oral examination according to § 4 Par. 2 No. 2
- 'Teilleistung' T-BGU-100089 with oral examination according to § 4 Par. 2 No. 2
details about the learning control see at the 'Teilleistung'

Grade of the Module
grade of the module is CP weighted average of grades of the partial exams

Prerequisites
none

Qualification Goals
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
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, Statical analysis, Serviceability analysis, Construction, Special design solutions, strengthening of landfills. 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.

Recommendations
none

Remarks
none

Literature
DGGT, GDA-Empfehlungen – Geotechnik der Deponien und Altlasten, Ernst und Sohn, Berlin
Drescher (1997), Deponiebau, Ernst und Sohn, Berlin
Reiersloh, D und Reinhard, M. (2010): Altlastenratgeber für die Praxis, Vulkan-V. Essen

Workload
contact hours (1 HpW = 1 h x 15 weeks):

- Landfills lecture/exercise: 30 h
- Brownfield Sites - Investigation, Evaluation, Rehabilitation lecture: 30 h
- Excursion: 10 h

independent study:

- preparation and follow-up lecture/exercises Landfills: 25 h
- examination preparation Landfills (partial exam): 30 h
- preparation and follow-up lectures Brownfield Sites - Investigation, Evaluation, Rehabilitation: 25 h
- examination preparation Brownfield Sites - Investigation, Evaluation, Rehabilitation (partial exam): 30 h

total: 180 h

M Module: Experimental Hydraulics and Measuring Techniques (WSEM-PB641) [M-BGU-103388]

Responsibility: Frank Seidel

Institution: KIT-Fakultät für Bauingenieur-, Geo- und Umweltwissenschaften

Curricular Embedding: Compulsory Elective

Contained in: Profile Studies / Fluid Mechanics & Hydraulic Engineering

Credit Points	Recurrence Frequency	Duration	Language	Version
6	Each winter term	1 term	German	1

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-BGU-106773	Experimental Hydraulics II (p. 153)	3	Frank Seidel
T-BGU-103562	Flow Measuring Technique (p. 158)	3	Christof-Bernhard Gromke

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
- 'Teilleistung' T-BGU-106773 with examination of other type according to § 4 Par. 2 No. 3
- 'Teilleistung' T-BGU-103562 with oral examination according to § 4 Par. 2 No. 2
details about the learning controls see at the respective 'Teilleistung'

Grade of the Module
grade of the module is CP weighted average of grades of the partial exams

Prerequisites
none

Qualification Goals
Students are able to describe the principles of different flow measurement methods and combine this information with the basics of today's flow measurement technology. They have basic knowledge about the structure and can analyze the suitability of measurement methods and set application boundaries.
Students have basic knowledge about experimentation in hydraulics. They know the similarity mechanical requirements and assign them to the hydromechanical basics. Students are able to analyze applications in the field of multiphase hydraulics and select suitable model concepts. They can present their own thoughts and ideas in a structured manner and discuss the themes with specialists.

Content
In this module, the following topics will be discussed in depth:
- basic equations in fluid mechanics
- measurement methods and their fields of application
- experimental models with movable beds
- experiments related to multiphase flow problems (water-air, water-solid)

Recommendations
module 'Experiments in Fluid Mechanics (CC471)'
hydraulic lab practice

Remarks
none

Workload
contact hours (1 HpW = 1 h x 15 weeks):
- Flow Measuring Techniques lecture/exercise: 30 h
- Experimental Hydraulics II lecture/exercise: 30 h

independent study:

- preparation and follow-up lecture/exercises Flow Measuring Techniques: 30 h
- examination preparation Flow Measuring Techniques: 30 h
- preparation and follow-up lecture/exercises Experimental Hydraulics II: 30 h
- preparation of term paper (examination): 30 h

total: 180 h

M Module: Experimental Hydrology (WSEM-PC731) [M-BGU-103371]

Responsibility: Jan Wienhöfer

Institution: KIT-Fakultät für Bauingenieur-, Geo- und Umweltwissenschaften

Curricular Embedding: Compulsory Elective

Contained in: Profile Studies / Environmental System Dynamics & Management

Credit Points	Recurrence Frequency	Duration	Language	Version
9	Each summer term	1 term	English	1

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-BGU-106599	Hydrological Measurements in Environmental Systems (p. 174)	6	Jan Wienhöfer
T-BGU-106606	Isotope Hydrology (p. 183)	3	Julian Klaus

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
- 'Teilleistung' T-BGU-106599 with examination of other type according to § 4 Par. 2 No. 3
- 'Teilleistung' T-BGU-106606 with examination of other type according to § 4 Par. 2 No. 3
details about the learning controls see at the respective 'Teilleistung'

Grade of the Module
grade of the module is CP weighthed average of grades of the partial exams

Prerequisites
none

Qualification Goals
Students can name the processes of the terrestrial water cycle and explain their influence on catchment-scale landscape evolution. Students know and understand measurement principles for catchment properties, catchment states, and water fluxes. They are able to independently plan and conduct measurements on various scales (soil column, plot, hillslope, catchment) in the field and the laboratory. Students can analyze observation data with statistical methods, and are able to quantify and evaluate the related uncertainties. Students are able to work and present their results as a team.

Content
Hydrological Measurements in Environmental Systems:
- fundamentals of environmental systems theory and environmental observations (scales, uncertainties)
- literature study and discussion related to environmental monitoring
- hydrological measurement devices in field and laboratory: Discharge, soil moisture, infiltration, matric potential, ground water
- statistical data analysis and error analysis

Isotope Hydrology:
- fundamentals of isotope hydrology of 2H and 18O in the water cycle
- application examples and literature study on stable water isotopes in (eco-)hydrological process studies
- examples of further isotopes used in hydrological process studies: 3H, 17O, 15N
- analysis and evaluation of isotope data

Both:Lab and field work (several days) where students conduct hydrological measurements and infiltration and tracer experiments. They analyze the obtained data statistically. The results are documented in a report, and presented and critically discussed in a colloquium.

Recommendations
knowledge in hydrology

Remarks
MPORTANT:

The module will not be offered anymore as from summer term 2019. It will be replaced by the module Hydrological Measurements in Environmental Systems.

The courses in this module require a minimum number of 6 and a maximum number of 30 participants. Please register online (in exceptional cases via e-mail to the responsible lecturer). Participants are selected according to their year of study and in the following order: students of Water Science and Engineering, students of Geoecology, others.

Literature
Lecture notes

Workload
contact hours (1 HpW = 1 h x 15 weeks):

- Hydrological Measurements in Environmental Systems lecture, exercise, practical training: 70 h
- Isotope Hydrology lecture, exercise: 30 h

independent study:

- preparation and follow-up lectures, exercises, Hydrological Measurements in Environmental Systems: 20 h
- preparation of the report on Hydrological Measurements in Environmental Systems (partial exam): 80 h
- preparation and follow-up lectures, exercises Isotope Hydrology: 10 h
- preparation of the report on Isotope Hydrology (partial exam): 60 h

total: 270 h

M Module: Experiments in Fluid Mechanics (WSEM-CC471) [M-BGU-103377]

Responsibility: Olivier Eiff

Institution: KIT-Fakultät für Bauingenieur-, Geo- und Umweltwissenschaften

Curricular Embedding: Compulsory Elective

Contained in: Cross-Cutting Methods & Competencies

Credit Points	Recurrence Frequency	Duration	Language	Version
6	Each summer term	1 term	English	1

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-BGU-106760	Experiments in Fluid Mechanics (p. 154)	6	Olivier Eiff

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
- 'Teilleistung' T-BGU-106760 with examination of other type according to § 4 Par. 2 No. 3
details about the learning control see at the 'Teilleistung'

Grade of the Module
grade of the module is grade of the exam

Prerequisites
none

Qualification Goals
Students relate the hydrodynamics theory and physical concepts to the observed physical reality. They apply their knowledge and skills for the comparative analysis of basic flow situations in physical models, using appropriate measurement technologies. They assess and evaluate the results and limitations by comparing their results with theoretical deductions. They extend their results of phenomena-oriented experiments with regard to practical applications in technical hydraulics and environmental flows. Acquired competence: operation of test facilities and instrumentation, data analysis and basic statistical error analysis, team work, written and oral communication.

Content
Lecture:
- typical set-up of hydraulic and aerodynamic models
- dimensional analysis, dimensionless parameters
- measurement instrumentation
- introduction to statistical error analysis
- analogy numerical/physical modeling, model distortion
- technical writing and oral presentation

Physical experiments:
- pipe flow with orifice plate
- open channel flow with gates and hydraulic jumps
- Venturi pipe flow with cavitation- Settling velocities of spheres
- diffusion of a turbulent air jet
- turbulent wake
- dam leakage

Recommendations
module Advanced Fluid Mechanics (WSEM-AF401)

Remarks
none

Literature
Tropea, C. et.al., 2007, Springer Handbook of Experimental Fluid Mechanics, Springer Verlag Berlin

Muste, M., Aberle, J., Admiraal, D., Ettema, R., Garcia, M. H., Lyn, D., Nikora, V., Rennie, C., 2017, Experimental Hydraulics: Methods, Instumentation, Data Processing and Management, Taylor and Francis

Workload

contact hours (1 HpW = 1 h x 15 weeks):

- lecture/lab exercise: 60 h

independent study:

- preparation and follow-up lectures: 30 h
- preparation of laboratory reports (part of the examination): 60 h
- preparation of oral examination (part of the examination): 30 h

total: 180 h

M Module: Flow and Sediment Dynamics in Rivers (WSEM-PB633) [M-BGU-104083]

Responsibility: Franz Nestmann

Institution: KIT-Fakultät für Bauingenieur-, Geo- und Umweltwissenschaften

Curricular Embedding: Compulsory Elective

Contained in: Profile Studies / Fluid Mechanics & Hydraulic Engineering

Credit Points	Recurrence Frequency	Duration	Language	Version
6	Each summer term	1 term	English	1

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-BGU-108466	Seminar Paper 'Flow Behavior of Rivers' (p. 211)	2	Franz Nestmann, Frank Seidel
T-BGU-108467	Flow and Sediment Dynamics in Rivers (p. 157)	4	Franz Nestmann

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
- 'Teilleistung' T-BGU-108466 with not graded accomplishment according to § 4 Par. 3 as examination prerequisite
- 'Teilleistung' T-BGU-108467 with oral examination according to § 4 Par. 2 No. 2
details about the learning controls see at the respective 'Teilleistung'

Grade of the Module
grade of the module is grade of the exam

Prerequisites
none

Qualification Goals
Students are able to name and explain the basic relationships and interactions between topography, flow and morphodynamics in natural streams. They can describe and apply the respective design approaches. Students are able to analyze the engineering design methods and combine this information with the basics of hydromechanics. They actively and independently inform themselves about the latest state in technology and can use adequate methods to solve engineering problems. They can present their findings and discuss the themes with specialists.

Content
In this module, the following topics are discussed in depth:
- geomorphic cycle
- space-time approach in morphology
- anthropogenic influences on streams
- vegetation hydraulics
- approaches to interactions
- bed load and sediment management in streams
- practical examples

Recommendations
basics in fluid mechanics, module 'Hydraulic Engineering (AF601)'

Remarks
This module is offered purely in English as from summer term 2018. It replaces the module M-BGU-103393 Flow and Sediment Dynamics in Rivers (offered in German).

Workload

contact hours (1 HpW = 1 h x 15 weeks):

- Morphodynamics lecture/exercise: 30 h
- Flow Behavior of Rivers lecture/exercise: 30 h

independent study:

- preparation and follow-up lecture/exercises Morphodynamics: 15 h
- preparation and follow-up lecture/exercises Flow Behavior of Rivers: 15 h
- preparation of the seminar paper (exam prerequisite): 45 h
- examination preparation: 45 h

total: 180 h

M Module: Freshwater Ecology (WSEM-CC371) [M-BGU-104922]

Responsibility: Stephan Fuchs

Institution: KIT-Fakultät für Bauingenieur-, Geo- und Umweltwissenschaften

Curricular Embedding: Compulsory Elective

Contained in: Cross-Cutting Methods & Competencies

Credit Points	Recurrence Frequency	Duration	Language	Version
6	Each summer term	1 term	English	1

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-BGU-109956	Applied Ecology and Water Quality (p. 135)	3	Stephan Fuchs, Stephan Hilgert
T-BGU-109957	Field Training Water Quality (p. 155)	3	Stephan Fuchs, Stephan Hilgert

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
- 'Teilleistung' T-BGU-109956 with examination of other type according to § 4 Par. 2 No. 3
- 'Teilleistung' T-BGU-109957 with examination of other type according to § 4 Par. 2 No. 3
details about the learning controls see at the respective 'Teilleistung'

Grade of the Module
grade of the module is CP weighted average of grades of the partial exams

Prerequisites
none

Modeled Conditions
The following conditions must be met:

- The module [M-BGU-103361] *Water Ecology* must not have been started.

Qualification Goals
Students get familiar with the basic principles of water ecology in surface waters. They are able to explain interactions between abiotic control factors (flow, chemistry, structure) and their relevance for the ecological status of standing waters and streams and to evaluate them critically. They become acquainted with field and laboratory techniques to establish water quality.With the help of these methods, they evaluate data-quality of information collected in the field regarding chemical, biological and structural water quality and determine the level of uncertainty intrinsic to the data-collection methods.Using case studies, students are able to convey and evaluate positive results as well as restrictions from water restoration processes.

Content
As part of the module, water ecology principles, their practical significance and implementation of restoring measures are presented. The following topics are covered:

- pollutants loads discharged into water bodies: discharge points, pollutants, sediment problems
- sampling methods
- oxygen content
- methods for the assessment of water quality and water general status
- practical exercises to measure water quality and condition in the field

Students get acquainted with practical examples of water protection and water remediation measures and they interpret and discuss them as part of an individual assignment. For this purpose, they implement their own framework, based on visible requirements and achievable targets.

Recommendations
none

Remarks
The module is offered newly as from summer term 2019 and replaces the module Water Ecology.

The number of participants in the courses is limited to 20 persons. The registration is to be made via ILIAS. The places are allocated with priority to students from *Water Science and Engineering*, then *Civil Engineering* and *Geoecology* and further study programs. The allocation is made by consideration of the semester and the time of entry of the registration. The attendance at the first meeting is mandatory. In case of absence the place will be assigned to a person on the waiting list.

Literature
Wetzel, Limnology, 3rd Edition, Academic Press 2001
Jürgen Schwörbel, Methoden der Hydrobiologie, UTB für Wissenschaft 1999
kursbegleitende Materialien

Workload
contact hours (1 HpW = 1 h x 15 weeks):

- Applied Ecology and Water Quality lecture/seminar: 45 h
- Field Training Water Quality (block): 20 h

independent study:

- preparation of the report on Field Training Water Quality (partial examination): 55 h
- preparation of the seminar paper with presentation (partial examination): 60 h

total: 180 h

M Module: Fundamentals of Numerical Algorithms for Engineers (WSEM-CC571) [M-BGU-104920]

Responsibility: Markus Uhlmann

Institution: KIT-Fakultät für Bauingenieur-, Geo- und Umweltwissenschaften

Curricular Embedding: Compulsory Elective

Contained in: Cross-Cutting Methods & Competencies

Credit Points	Recurrence Frequency	Duration	Language	Version
3	Each winter term	1 term	English	1

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-BGU-109953	Fundamentals of Numerical Algorithms for Engineers (p. 159)	3	Markus Uhlmann

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
- 'Teilleistung' T-BGU-109953 with written examination according to § 4 Par. 2 No. 1
details about the learning control see at the 'Teilleistung'

Grade of the Module
grade of the module is grade of the exam

Prerequisites
none

Qualification Goals
The students understand the basic idea (and importance) of numerical methods for solving various mathemetical problems arising in engineering context. The students are able to choose appropriate numerical algorithms for a given mathematical problem and implement the algorithms in a high-level programming language (e.g. Matlab).

Content
- finite precision arithmetic
- numerical solution of non-linear equation (rootfinding)
- numerical integration
- solving linear algebraic systems
- interpolation / approximation
- fourier transform
- solving ODE

Recommendations
good knowledge of basic calculus, linear algebra, and differential equations and familiarity with some higher-level programming language

Remarks
newly offered as from winter term 2019/20

Workload
contact hours (1 HpW = 1 h x 15 weeks):
- lecture: 30 h

independent study:
- preparation and follow-up lectures: 30 h
- examination preparation: 30 h

total: 90 h

M Module: Fundamentals of Water Quality (WSEM-AF201) [M-CIWVT-103438]

Responsibility: Gudrun Abbt-Braun

Institution: KIT-Fakultät für Chemieingenieurwesen und Verfahrenstechnik

Curricular Embedding: Compulsory Elective

Contained in: Advanced Fundamentals

Credit Points	Recurrence Frequency	Duration	Language	Version
6	Each winter term	1 term	English	1

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-CIWVT-106838	Fundamentals of Water Quality (p. 160)	6	Gudrun Abbt-Braun

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
- 'Teilleistung' T-CIWVT-106838 with written examination according SPO/ER § 4 Par. 2 No. 1
details about learning control see at the 'Teilleistung'

Grade of the Module
grade of the module is grade of the exam

Prerequisites
none

Qualification Goals
Students can explain the relationships behind the occurrence of geogenic and anthropogenic compounds in the hydrological cycle. They are able to select adequate methods for the analysis of water constituents and microorganisms in water samples. They are familiar with the associated calculations, and they can compare and interpret the obtained data. They know how to apply different methods, how to analyze relationships and how to critically assess water quality analyses.

Content
Various types of water, legislations, analytical definitions, analytical quality, sampling methods, quick test methods, field investigations, organoleptic determinations, general investigations, optical characterization (turbidity, color, UV, Lambert-Beer's law, photometry), titrations, acid-base-systems, buffering, main inorganic compounds (anions, cations, occurrence, ion chromatography, titration, complexometry, flame photometry, atomic spectroscopy), heavy metals and metalloids (occurrence and main methods for determination), organic compounds and organic micropollutants (occurrence, thin layer chromatography, high performance liquid chromatography, infrared spectroscopy, gas chromatography), water-specific sum parameters (DOC, AOX, COD, BOD), radioactivity, microbiology.

Recommendations
none

Literature
Harris, D.C., 2010. Quantitative chemical analysis. W. H. Freeman and Company, New York.
Crittenden, J.C. et al., 2005. Water treatment – Principles and design. Wiley & Sons, Hoboken.
Patnaik, P., 2010. Handbook of environmental analysis: Chemical pollutants in air, water, soil, and solid wastes. CRC Press.
Wilderer, P., 2011. Treatise on water science, four-volume set, 1st edition, volume 3: Aquatic chemistry and biology. Elsevier, Oxford.
Leture notes in ILIAS

Workload

contact hours (1 HpW = 1 h x 15 weeks):

- lecture, exercise: 45 h

independent study:

- preparation and follow-up lectures, exercises: 65 h
- examination preparation: 70 h

total: 180 h

M Module: General Meteorology (WSEM-SM971) [M-PHYS-103732]

Responsibility: Christoph Kottmeier, Michael Kunz

Institution: KIT-Fakultät für Physik
Curricular Embedding: Compulsory Elective
Contained in: additional Supplementary Modules

Credit Points	Recurrence Frequency	Duration	Language	Version
6	Each winter term	1 term	German	1

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-PHYS-101091	General Meteorology (p. 161)	6	Christoph Kottmeier, Michael Kunz

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
- 'Teilleistung' T-PHYS-101091 with not graded accomplishment according to § 4 Par. 3
details about the learning control see at the 'Teilleistung'

Grade of the Module
not graded

Prerequisites
none

Qualification Goals
see German version

Content
see German version

Recommendations
none

Workload
contact hours (1 HpW = 1 h x 15 weeks):

- lecture, exercise: 75 h

independent study:

- preparation and follow-up lectures, exercises: 55 h
- preparation of the exercise to present: 20 h
- test preparation: 30 h

total: 180 h

M Module: Geodata Infrastructures and Web-Services (WSEM-CC935) [M-BGU-101044]

Responsibility: Stefan Hinz

Institution: KIT-Fakultät für Bauingenieur-, Geo- und Umweltwissenschaften

Curricular Embedding: Compulsory Elective

Contained in: Cross-Cutting Methods & Competencies

Credit Points	Recurrence Frequency	Duration	Language	Version
4	Once	1 term	German	1

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-BGU-101757	Geodata Infrastructures and Web-Services, Prerequisite (p. 163)	3	Stefan Hinz
T-BGU-101756	Geo Data Infrastructures and Web Services (p. 162)	1	Stefan Hinz

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
- 'Teilleistung' T-BGU-101757 with not graded accomplishment according to § 4 Par. 3 as examination prerequisite
- 'Teilleistung' T-BGU-101756 with oral examination according to § 4 Par. 2 No. 2
details about the learning controls see at the respective 'Teilleistung'

Grade of the Module
grade of the module is grade of the exam

Prerequisites
none

Qualification Goals
see German version

Content
see German version

Recommendations
none

Workload
contact hours (1 HpW = 1 h x 15 weeks):
- lecture, exercise: 20 h

independent study:
- preparation and follow-up lectures, exercises: 20 h
- working on exercises (examination prerequisite): 60 h
- examination preparation: 40 h

total: 120 h

M Module: Groundwater Management (WSEM-PC561) [M-BGU-100340]

Responsibility: Ulf Mohrlok

Institution: KIT-Fakultät für Bauingenieur-, Geo- und Umweltwissenschaften

Curricular Embedding: Compulsory Elective

Contained in: Profile Studies / Environmental System Dynamics & Management

Credit Points	Recurrence Frequency	Duration	Language	Version
6	Each summer term	2 terms	English	1

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-BGU-100624	Groundwater Hydraulics (p. 166)	3	Ulf Mohrlok
T-BGU-100625	Numerical Groundwater Modeling (p. 197)	3	Ulf Mohrlok

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
- 'Teilleistung' T-BGU-100624 with oral examination according to § 4 Par. 2 No. 2
- 'Teilleistung' T-BGU-100625 with examination of other type according to § 4 Par. 2 No. 3
details about the learning controls see at the respective 'Teilleistung'

Grade of the Module
grade of the module is CP weighted average of grades of the partial exams

Prerequisites
none

Qualification Goals
Based on the understanding of hydrogeological settings and fluid-mechanical processes in the subsurface students can characterize different kinds of groundwater systems by means of hydraulics. They can quantify the relevant flow and transport processes with simple analytical and numerical methods for different problems regarding groundwater quantity and quality. Thereby, they are able to conceive and evaluate the relations important for the management of groundwater resources.

Content
- groundwater systems
- fluid-mechanical processes in porous media
- methods of balancing groundwater flow and solute transport processes
- examples of groundwater management
- project work

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

Remarks
none

Literature
Bear, J. (1979). Hydraulics of Groundwater. McGraw Hill.
Chiang, W.H. (2005). 3D - Groundwater Modeling with PMWIN: A Simulation System for Modeling Groundwater Flow and Transport Processes, 2/e, incl. CD-Rom. Berlin, Heidelberg, D.: Springer.
Fetter, C.W. (1999). Contaminant Hydrogeology , 2/e. Upper Saddle River, NJ, U.S.A.: Prentice Hall.
Mohrlok, U. (2009). Bilanzmodelle in der Grundwasserhydraulik: quantitative Beschreibung von Strömung und Transport im Untergrund, Karlsruhe, D.: Universitätsverlag.
Schwartz, F. and H. Zhang (2003). Fundamentals of Ground Water. New York, NY, U.S.A.: John Wiley & Sons.

Workload

contact hours (1 HpW = 1 h x 15 weeks):

- Groundwater Hydraulics lecture/exercise: 30 h
- Numerical Groundwater Modeling presentations/project discussions: 15 h

independent study:

- preparation and follow-up lecture/exercises, working on exercises Groundwater Hydraulics: 40 h
- examination preparation Groundwater Hydraulics (partial exam): 20 h
- project work Numerical Groundwater Modeling, incl. presentation and preparation of the report (partial exam): 80 h

total: 185 h

M Module: Hydraulic Engineering (WSEM-AF601) [M-BGU-103376]

Responsibility: Franz Nestmann

Institution: KIT-Fakultät für Bauingenieur-, Geo- und Umweltwissenschaften

Curricular Embedding: Compulsory Elective

Contained in: Advanced Fundamentals

Credit Points	Recurrence Frequency	Duration	Language	Version
6	Each summer term	1 term	English	1

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-BGU-106759	Hydraulic Engineering (p. 168)	6	Franz Nestmann

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
- 'Teilleistung' T-BGU-106759 with written examination according to § 4 Par. 2 No. 1
details about the learning control see at the 'Teilleistung'

Grade of the Module
grade of the module is grade ot the exam

Prerequisites
none

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

Content
The module provides students with basic theoretical and practical aspects of water-air and water-solid interactions as well as the relevance to engineering. Beginning with the basics in morphodynamics approaches for motion and mass fluxes at the river bed are presented. As another focus buildings in hydraulic engineering are addressed as well as their embedding in the river system.

Recommendations
none

Remarks
none

Workload
contact hours (1 HpW = 1 h x 15 weeks):
- Multiphase Flow in Hydraulic Engineering lecture/exercise: 30 h
- Design of Hydraulic Structures lecture/exercise: 30 h

independent study:
- preparation and follow-up lecture/exercises Multiphase Flow in Hydraulic Engineering: 30 h
- preparation and follow-up lecture/exercises Design of Hydraulic Structures: 30 h
- examination preparation: 60 h

total: 180 h

M Module: Hydraulic Structures (WSEM-PB631) [M-BGU-103389]

Responsibility: Olivier Eiff

Institution: KIT-Fakultät für Bauingenieur-, Geo- und Umweltwissenschaften

Curricular Embedding: Compulsory Elective

Contained in: Profile Studies / Fluid Mechanics & Hydraulic Engineering

Credit Points	Recurrence Frequency	Duration	Language	Version
6	Each term	2 terms	German/English	1

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-BGU-106774	Groundwater Flow around Structures (p. 165)	3	Luca Trevisan
T-BGU-106775	Interaction Flow – Hydraulic Structures (p. 178)	3	Michael Gebhardt

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
- 'Teilleistung' T-BGU-106774 with oral examination according to § 4 Par. 2 No. 2
- 'Teilleistung' T-BGU-106775 with oral examination according to § 4 Par. 2 No. 2
details about the learning controls see at the respective 'Teilleistung'

Grade of the Module
grade of the module is CP weighted average of grades of the partial exams

Prerequisites
none

Qualification Goals
Students are able to analyze and calculate steady and unsteady flow forces on hydraulic structures. They can describe groundwater flow processes and derive flow parameters with common measurement calculations . Based on the acquired knowledge, they can analyze concepts for preventing groundwater-related structural damage in a critical manner.
Students characterize and categorize flow-induced structural vibrations. They can apply their knowledge to application examples.

Content
In this module, the following topics are discussed in depth:
- potential theory
- groundwater flow
- structural adjustment to groundwater flow
- determination of hydrostatic and hydrodynamic flow forces
- overview of sealing mechanisms: flood sluices, weirs, gates
- flow-induced structural vibrations

Recommendations
none

Remarks
none

Literature
Erbisti, P.C.F., 2004, Design of Hydraulic Gates, Balkema Pub. , Tokyo
Naudascher; E, 1991, Hydrodynamic Forces, Balkema Pub., Rotterdam
C. Lang, Skript Interaktion Strömung - Wasserbauwerk

Workload
contact hours (1 HpW = 1 h x 15 weeks):

- Groundwater Flow around Structures lecture/exercise: 30 h
- Wechselwirkung Strömung - Wasserbauwerk lecture/exercise: 30 h

independent study:

- preparation and follow-up lecture/exercises Groundwater Flow around Structures: 30 h
- examination preparation Groundwater Flow around Structures (partial exam): 30 h
- preparation and follow-up lecture/exercises Wechselwirkung Strömung - Wasserbauwerk: 30 h
- examination preparation Wechselwirkung Strömung - Wasserbauwerk (partial exam): 30 h

total: 180 h

M Module: Hydro Power Engineering (WSEM-PB653) [M-BGU-100103]

Responsibility: Peter Oberle

Institution: KIT-Fakultät für Bauingenieur-, Geo- und Umweltwissenschaften

Curricular Embedding: Compulsory Elective

Contained in: Profile Studies / Fluid Mechanics & Hydraulic Engineering

Credit Points	Recurrence Frequency	Duration	Language	Version
6	Each summer term	1 term	German	1

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-BGU-100139	Hydro Power Engineering (p. 169)	6	Peter Oberle

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
- 'Teilleistung' T-BGU-100139 with oral examination according to § 4 Par. 2 No. 2
details about the learning control see at the 'Teilleistung'

Grade of the Module
grade of the module is grade of the exam

Prerequisites
none

Qualification Goals
Students are able to describe the different turbine types and can define selection criteria for their usage. They are able to reproduce the basic approaches in the planning and design of hydropower plants and to make own calculations to select turbines. They can select and apply the necessary tools in a methodical matter.
Students are able to discuss the current political conditions in terms of energy policy with other students and support their personal opinion on these issues with technical arguments.

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.

Recommendations
course Hydraulic Engineering and Water Management (6200511)

Remarks
none

Literature
Folienumdrucke;
Giesecke J., Mosonyi E., 2005, Wasserkraftanlagen, Planung, Bau und Betrieb, Springer Verlag, Berlin

Workload
contact hours (1 HpW = 1 h x 15 weeks):
- lecture, exercise: 60 h

independent study:
- preparation and follow-up lectures, exercises: 60 h
- examination preparation: 60 h

total: 180 h

M Module: Hydrogeology (WSEM-AF801) [M-BGU-103406]

Responsibility: Nico Goldscheider

Institution: KIT-Fakultät für Bauingenieur-, Geo- und Umweltwissenschaften

Curricular Embedding: Compulsory Elective

Contained in: Advanced Fundamentals

Credit Points	Recurrence Frequency	Duration	Language	Version
6	Each winter term	2 terms	English	1

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-BGU-106801	Hydrogeology (p. 170)	6	Nico Goldscheider

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
- 'Teilleistung' T-BGU-106801 with written examination according to § 4 Par. 2 No. 1
details about the learning control see at the 'Teilleistung'

Grade of the Module
grade of the module is grade of the exam

Prerequisites
none

Qualification Goals
Students are familiar with the advanced fundamentals and methods of hydrogeology.
They are able to describe the processes of water transport in the subsurface quantitatively, and they can explain the hydrochemical interactions of water and rocks.
Students are capable of solving practical hydrogeological problems related to the exploration, exploitation and protection of groundwater.

Content
General and Applied Hydrogeology:

- subterraneous discharge: process characteristics, measurement techniques and calculation methods, regional and temporal variations
- water transport in the subsurface, groundwater hydraulics
- hydrochemistry
- groundwater use: exploration of groundwater resources, exploitation of groundwater, and groundwater protection
- regional hydrogeology

Field Methods in Hydrogeology:

- pumping tests and other hydraulic tests
- tracer tests
- hydrochemical sampling and monitoring

Recommendations
none

Literature
Fetter, C.W. (2001) Applied Hydrogeology. Prentice Hall: 598 S.
Hölting, B. & Coldewey, W.G. (2009) Einführung in die Allgemeine und Angewandte Hydrogeologie, Spektrum Akademischer Verlag: 384 S.
Keller, E.A. (2000) Environmental Geology. Prentice Hall: 562 S.
Langguth, H.R. & Voigt, R. (2004) Hydrogeologische Methoden, 2. Aufl., Springer: 1005 S.

Mattheß, G. (1994) Die Beschaffenheit des Grundwassers, 3. Aufl., Borntraeger: 499 S.
Mattheß, G. & Ubell, K. (2003) Allgemeine Hydrogeologie – Grundwasserhaushalt, 2. Aufl., Borntraeger: 575 S.
Younger, P. (2007) Groundwater in the Environment: An Introduction. Blackwell Publishing: 318 S.

Workload

contact hours (1 HpW = 1 h x 15 weeks):

- General and Applied Hydrogeology lecture, exercise: 30 h
- Field Methods in Hydrogeology lecture/exercise: 15 h

independent study:

- preparation and follow-up lectures, exercises General and Applied Hydrogeology: 40 h
- preparation and follow-up lecture/exercises Field Methods in Hydrogeology: 25 h
- examination preparation: 70 h

total: 180 h

M Module: Hydrogeology: Field and Laboratory Methods (WSEM-PC821) [M-BGU-102441]

Responsibility: Nadine Göppert

Institution: KIT-Fakultät für Bauingenieur-, Geo- und Umweltwissenschaften

Curricular Embedding: Compulsory Elective

Contained in: Profile Studies / Environmental System Dynamics & Management

Credit Points	Recurrence Frequency	Duration	Language	Version
6	Each summer term	1 term	German	2

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-BGU-104834	Hydrogeology: Field and Laboratory Methods (p. 171)	6	Nadine Göppert

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
- 'Teilleistung' T-BGU-104834 with examination of other type according to § 4 Par. 2 No. 3
details about the learning control see at the 'Teilleistung'

Grade of the Module
grade of the module is grade of the exam

Prerequisites
none

Qualification Goals
see German version

Content
see German version

Recommendations
module 'Hydrogeology (AF801)'

Workload
contact hours (1 HpW = 1 h x 15 weeks):

- Preparatory Seminar: 15 Std.
- Field and Laboratory Excercises: 25 Std.

independent study:

- preparation and follow-up Preparatory Seminar: 10 h
- presentation Preparatory Seminar (part of examination): 40 h
- preparation of the report on Field and Laboratory Excercises (part of examination): 80 h

total: 170 h

M Module: Hydrogeology: Groundwater Modelling (WSEM-PC831) [M-BGU-102439]

Responsibility: Tanja Liesch

Institution: KIT-Fakultät für Bauingenieur-, Geo- und Umweltwissenschaften

Curricular Embedding: Compulsory Elective

Contained in: Profile Studies / Environmental System Dynamics & Management

Credit Points	Recurrence Frequency	Duration	Language	Version
6	Each winter term	1 term	German	1

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-BGU-104757	Hydrogeology: Groundwater modelling (p. 172)	6	Tanja Liesch

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
- 'Teilleistung' T-BGU-104757 with examination of other type according to § 4 Par. 2 No. 3
details about the learning control see at the 'Teilleistung'

Grade of the Module
grade of the module is grade of the exam

Prerequisites
none

Qualification Goals
see German version

Content
see German version

Recommendations
module 'Hydrogeology (AF801)'

Workload
contact hours (1 HpW = 1 h x 15 weeks):

- lecture, exercise: 50 h

independent study:

- preparation and follow-up lectures, exercises: 50 h
- project work Groundwater Modeling, incl. preparation of the report and presentation (examination): 80 h

total: 180 h

M Module: Hydrogeology: Karst and Isotopes (WSEM-PC841) [M-BGU-102440]

Responsibility: Nico Goldscheider

Institution: KIT-Fakultät für Bauingenieur-, Geo- und Umweltwissenschaften

Curricular Embedding: Compulsory Elective

Contained in: Profile Studies / Environmental System Dynamics & Management

Credit Points	Recurrence Frequency	Duration	Language	Version
6	Each winter term	2 terms	German	1

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-BGU-104758	Hydrogeology: Karst and Isotpes (p. 173)	6	Nico Goldscheider

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
- 'Teilleistung' T-BGU-104758 with written examination according to § 4 Par. 2 No. 1
details about the learning control see at the 'Teilleistung'

Grade of the Module
grade of the module is grade of the exam

Prerequisites
none

Qualification Goals
see German version

Content
see German version

Recommendations
module 'Hydrogeology (AF801)'

Workload
contact hours (1 HpW = 1 h x 15 weeks):

- Karst Hydrogeology lecture/exercise: 30 h
- Field Trip Karst Hydrogeology: 18 h
- Isotope Methods in Hydrogeology lecture/exercise: 12 h

independent study:

- preparation and follow-up lecture/exercises Karst Hydrogeology: 40 h
- preparation and follow-up lecture/exercises Isotope Methods in Hydrogeology: 20 h
- examination preparation: 60 h

total: 180 h

M Module: Hydrological Measurements in Environmental Systems (WSEM-PC732) [M-BGU-103763]

Responsibility: Jan Wienhöfer

Institution: KIT-Fakultät für Bauingenieur-, Geo- und Umweltwissenschaften

Curricular Embedding: Compulsory Elective

Contained in: Profile Studies / Environmental System Dynamics & Management

Credit Points	Recurrence Frequency	Duration	Language	Version
6	Each summer term	1 term	English	1

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-BGU-106599	Hydrological Measurements in Environmental Systems (p. 174)	6	Jan Wienhöfer

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
- 'Teilleistung' T-BGU-106599 with examination of other type according to § 4 Par. 2 No. 3
details about the learning control see at the 'Teilleistung'

Grade of the Module
grade of the module is grade of the exam

Prerequisites
none

Modeled Conditions
The following conditions must be met:

- The module [M-BGU-103371] *Experimental Hydrology* must not have been started.

Qualification Goals
Students know and understand measurement principles for catchment properties, catchment states, and water fluxes. They are able to independently plan and conduct measurements on various scales (soil column, plot, hillslope, catchment) in the field and the laboratory. Students can analyze observation data with statistical methods, and are able to quantify and evaluate the related uncertainties. Students are able to present the related results in teamwork.

Content
- introduction to environmental observations (scales, uncertainties), statistical data analysis and error analysis
- seminar on hydrological measurement devices in field and laboratory: Discharge, soil moisture, infiltration, hydraulic conductivity
- lab and field work (several days) where students conduct hydrological measurements

Recommendations
knowledge in hydrology

Remarks
This module is offered newly as from summer term 2018.

The course requires a minimum number of 6 and a maximum number of 30 participants. Please register online for the course (not exam!), 6224807, via the Campus portal (in exceptional cases via e-mail to the responsible lecturer). Participants are selected according to their year of study and in the following order: students of Water Science and Engineering, students of Civil Engineering, students of Geoecology.

Literature
notes for field exercises

Workload

contact hours (1 HpW = 1 h x 15 weeks):

- laboratory and field exercise: 70 h

independent study:

- preparation and follow-up laboratory and field exercises: 10 h
- preparation of presentations and reports (exam): 100 h

total: 180 h

M Module: Industrial Water Management (WSEM-PA323) [M-BGU-104073]

Responsibility: Tobias Morck

Institution: KIT-Fakultät für Bauingenieur-, Geo- und Umweltwissenschaften

Curricular Embedding: Compulsory Elective

Contained in: Profile Studies / Water Technologies & Urban Water Cycle

Credit Points	Recurrence Frequency	Duration	Language	Version
6	Each summer term	1 term	English	2

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-BGU-108448	Industrial Water Management (p. 175)	5	Tobias Morck
T-BGU-109980	Lab report 'Industrial Water Management' (p. 184)	1	Tobias Morck

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
- 'Teilleistung' T-BGU-109980 with not graded accomkplishment according to § 4 Par. 3 as examination prerequisite
- 'Teilleistung' T-BGU-108448 with oral examination according to § 4 Par. 2 No. 2
details about the learning controls see at the respective 'Teilleistung'

Grade of the Module
grade of the module is grade of the exam

Prerequisites
none

Qualification Goals
Students acquire knowledge about techniques for wastewater treatment in industrial production processes and based on it, they can explain functioning principles of the techniques.Students are able to assess wastewater constituents from industrial effluents and its emissions on the basis of legal regulations. They can analyze arising problems in the industrial wastewater treatment and select appropriate methods for emission reduction and water recycling.

Content
In this module, different types of industrial wastewater (e.g. leather, paper, metal industries) are considered and studied. Customized chemical, physico-chemical and, if necessary, biological treatment processes are presented and discussed.

Recommendations
none

Remarks
none

Workload
contact hours (1 HpW = 1 h x 15 weeks):
- lecture/exercise: 60 h

independent study:
- preparation and follow-up lecture/exercises: 40 h
- report on laboratory work (examination prerequisite): 30 h
- examination preparation: 50 h

total: 180 h

M Module: Instrumental Analysis (WSEM-CC921) [M-CIWVT-103437]

Responsibility: Gerald Brenner-Weiß, Gisela Guthausen

Institution: KIT-Fakultät für Chemieingenieurwesen und Verfahrenstechnik

Curricular Embedding: Compulsory Elective

Contained in: Cross-Cutting Methods & Competencies

Credit Points	Recurrence Frequency	Duration	Language	Version
6	Each summer term	1 term	English	1

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-CIWVT-106837	Instrumental Analysis (p. 176)	4	Gisela Guthausen
T-CIWVT-106836	Organic Trace Analysis of Aqueous Samples (p. 199)	2	Gerald Brenner-Weiß

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
- 'Teilleistung' T-BGU-106836 with not graded accomplishment according to § 4 Par. 3 as examination prerequisite
- 'Teilleistung' T-BGU-106837 with oral examination according to § 4 Par. 2 No. 2
details about the learning controls see at the respective 'Teilleistung'

Grade of the Module
grade of the module is grade of the exam

Prerequisites
none

Qualification Goals
Students are familiar with the important methods of modern instrumental analysis and their range of application. They can explain the basic physical principles of the methods. Students are able to develop solutions for analytical problems, to choose
adequate procedures for sample preparation and measuring techniques. They can evaluate the measurement data and interpret the results.

Content
Instrumental Analysis:
Introduction to selected methods of modern instrumental analysis:
- Optical methods
- Magnetic resonance methods, mass spectrometry
- Imgaging methods as MRT, µCT and optical methods (CLSM
and OCT)
- Basics of data analysis and image processing
Organic Trace Analysis of Aqueous Samples:
Laboratory course on methods for sample concentration, sample
preparation, and analysis of organic trace compounds in aqueous
samples using HPLC coupled with tandem mass spectrometry (LCMSMS)
To participate in the lab course, please make an appointment with Dr.
Brenner-Weiß (IFG).

Recommendations
module 'Fundamentals of Water Quality (AF201)'

Workload
contact hours (1 HpW = 1 h x 15 weeks):

- Instrumental Analysis lecture: 30 h
- Organic Trace Analysis of Aqueous Samples practical training: 30 h

independent study:

- preparation and follow-up lectures Instrumental Analysis: 60 h
- analyses and report on laboratory work (examination prerequisite): 30 h
- examination preparation: 30 h

total: 180 h

M Module: Integrated Infrastructure Planning (WSEM-CC791) [M-BGU-103380]

Responsibility: Charlotte Kämpf

Institution: KIT-Fakultät für Bauingenieur-, Geo- und Umweltwissenschaften

Curricular Embedding: Compulsory Elective

Contained in: Cross-Cutting Methods & Competencies

Credit Points	Recurrence Frequency	Duration	Language	Version
6	Each winter term	1 term	English	1

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-BGU-106763	Booklet Integrated Infrastructure Planning (p. 138)	0	Charlotte Kämpf
T-BGU-106764	Integrated Infrastructure Planning (p. 177)	6	Charlotte Kämpf

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
- 'Teilleistung' T-BGU-106763 with not graded accomplishment according to § 4 Par. 3 as examniatoin prerequisite
- 'Teilleistung' T-BGU-106764 with written examination according to § 4 Par. 2 No. 1
details about the learning controls see at the respective 'Teilleistung'

Grade of the Module
grade of the module is grade of the exam

Prerequisites
none

Qualification Goals
Students are able to rank interdisciplinary texts on development planning according to their relevance, and formulate relevant questions on this topic. Students can research systematically on a scientific problem, and they can use different technical terms.They are able to put the materials in the context of integrated development planning and current water resources problems to work on solutions for adapting to regional conditions.

Content
Socio-economic aspects:
- natural resources as economic goods
- scenario analysis of depletion and capacity of natural resources, assessment of values, additional costs
- coordination of activities on economic development; strategical planning, indicator systems
- cost-benefit analyses, investment criteria

Ecological aspects / environmental impact assessment:
- biodiversity, habitats, resilience, structure and dynamics of ecosystems; nutrient cycling
- bioindicators, ecosystem services
- history of environmental impact assessment (EIA), EIA in the EU, in other countries
- impact assessment in the EW -proje ct management (mitigation, compensation, monitoring, auditing)

Recommendations
none

Remarks
MPORTANT:

The module will not be offered anymore as from winter term 2019/20.

Workload

contact hours (1 HpW = 1 h x 15 weeks):

- lecture, seminar: 40 h

independent study:

- preparation and follow-up lectures, seminar: 20 h
- preparation of a booklet (examination prerequisite): 60 h
- examination preparation: 60 h

total: 180 h

M Module: Introduction to Environmental Data Analysis and Statistical Learning (WSEM-CC774-ENVDAT) [M-BGU-104880]

Responsibility: Uwe Ehret

Institution: KIT-Fakultät für Bauingenieur-, Geo- und Umweltwissenschaften

Curricular Embedding: Compulsory Elective

Contained in: Cross-Cutting Methods & Competencies

Credit Points	Recurrence Frequency	Duration	Language	Version
6	Each winter term	1 term	English	1

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-BGU-109950	Homework 'Introduction to Environmental Data Analysis and Statistical Learning' (p. 167)	2	Uwe Ehret
T-BGU-109949	Introduction to Environmental Data Analysis and Statistical Learning (p. 179)	4	Uwe Ehret

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
- 'Teilleistung' T-BGU-109950 with not graded accomplishment according to § 4 Par. 3 as examination prerequisite
- 'Teilleistung' T-BGU-109949 with written examination according to § 4 Par. 2 No. 1
details about the learning controls see at the respective 'Teilleistung'

Grade of the Module
grade of the module is grade of the exam

Prerequisites
none

Modeled Conditions
The following conditions must be met:

- The module [M-BGU-103378] *Data Analysis and Environmental Monitoring* must not have been started.

Qualification Goals
The students can explain and apply methods for analysis and simulation of environmental data. Based on this they are capable of evaluating the suitability of available data, analysis and simulation methods for different tasks. The students are able to critically assess the results of analysis and simulation tools and to quantify and evaluate the related uncertainties.

Content
- explorative data analysis
- data storage / data bases
- probability theory (short summary)
- statistical tests (short summary)
- Bayesian methods
- information theory
- time series
- statistical learning / machine learning basics
- supervised learning
- unsupervised learning

Recommendations
preliminary knowledge in statistics, e.g. successful completion of Probability and Statistics (CC911), and Matlab programming skills, e.g. successful completion of Introduction to Matlab (CC772)

Remarks
The module is offered newly as from summer term 2019.

Literature
Daniel Wilks (2011): Statistical Methods in the Atmospheric Sciences, Volume 100, 3rd Edition, ISBN 978-0-1238-5022-5, Academic Press.
Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani (2014): An Introduction to Statistical Learning, ISBN 978-1-4614-7137-0, Springer.
Thomas M. Cover, Joy A. Thomas (2006): Elements of Information Theory, 2nd Edition, ISBN: 978-0-471-24195-9, Wiley.

Workload
contact hours (1 HpW = 1 h x 15 weeks):

- lecture/exercise: 60 h

independent study:

- preparation and follow-up lecture/exercises: 20 h
- preparation of Homework 'Introduction to Environmental Data Analysis and Statistical Learning' (exam prerequisite): 60 h
- examination preparation: 40 h

total: 180 h

M Module: Introduction to GIS for Students of Natural, Engineering and Geo Sciences (WSEM-CC933) [M-BGU-101846]

Responsibility: Norbert Rösch, Sven Wursthorn

Institution: KIT-Fakultät für Bauingenieur-, Geo- und Umweltwissenschaften

Curricular Embedding: Compulsory Elective

Contained in: Cross-Cutting Methods & Competencies

Credit Points	Recurrence Frequency	Duration	Language	Version
6	Each winter term	1 term	German	1

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-BGU-103541	Introduction to GIS for Students of Natural, Engineering and Geo Sciences (p. 180)	3	Norbert Rösch, Sven Wursthorn
T-BGU-101681	Introduction to GIS for Students of Natural, Engineering and Geo Sciences (p. 181)	3	Norbert Rösch, Sven Wursthorn

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
- 'Teilleistung' T-BGU-103541 with not graded accomplishment according to § 4 Par. 3 as examination prerequisite
- 'Teilleistung' T-BGU-101681 with written examination according to § 4 Par. 2 No. 1

details about the learning controls see at the respective 'Teilleistung'

Grade of the Module
grade of the module is grade of the exam

Prerequisites
none

Qualification Goals
see German version

Content
see German version

Recommendations
none

Workload
contact hours (1 HpW = 1 h x 15 weeks):

- lecture, exercise: 60 h

independent study:

- preparation and follow-up lectures, exercises: 60 h
- examination preparation, incl. online test (examination prerequisite): 60 h

total: 180 h

M Module: Introduction to Matlab (WSEM-CC772) [M-BGU-103381]

Responsibility: Uwe Ehret

Institution: KIT-Fakultät für Bauingenieur-, Geo- und Umweltwissenschaften

Curricular Embedding: Compulsory Elective

Contained in: Cross-Cutting Methods & Competencies

Credit Points	Recurrence Frequency	Duration	Language	Version
3	Each winter term	1 term	English	1

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-BGU-106765	Introduction to Matlab (p. 182)	3	Uwe Ehret

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
- 'Teilleistung' T-BGU-106765 with not graded accomplishment according to § 4 Par. 3
details about the learning control see at the 'Teilleistung'

Grade of the Module
not graded

Prerequisites
none

Qualification Goals
Students are familiar with common programming rules and the working environment and basic syntax of Matlab. They are capable of independently formulating and coding simple programs for data analysis and visualization as well as simulation of dynamical systems with Matlab. Students have thus gained the competence to independently solve computer-based modeling tasks in advanced courses. Students are able to solve problems and to present the related results in teamwork.

Content
- universal programming basics: Programing strategies, program structures, control structures, operators and variables, functions and objects, matrix calculations
- basics of Matlab: History, installation, graphical user interface, tool boxes, using help
- Matlab programming basics: syntax, debugging, reading and writing of files, data visualization

Take-home programming assignments:
- programs to analyze and visualize observation data
- design and implementation of a simple dynamical model
- preparation of ungraded assignments and presentation in small groups

Recommendations
none

Remarks
The course is limited to 60 participants. Please register via the student portal (Studierendenportal). Only in case that this should not be possible: Please register via e-mail to the responsible lecturer. Participants are selected according to their year of study and in the following order: students of Water Science and Engineering, then students of Civil Engineering with focus 'Water and Environment', then other students.

Workload
contact hours (1 HpW = 1 h x 15 weeks):

- lecture/exercise: 30 h

independent study:

- preparation and follow-up lecture/exercises: 10 h
- homework: 30 h
- take-home exam: 20 h

total: 90 h

M Module: Language Skills 1 (2 CP) (WSEM-CC949) [M-BGU-103466]

Responsibility: Jan Wienhöfer

Institution: Universität gesamt
Curricular Embedding: Compulsory Elective
Contained in: Cross-Cutting Methods & Competencies

Credit Points	Recurrence Frequency	Duration	Version
2	Each term	1 term	1

Language Skills 1
Compulsory Elective; You must choose 2 credits.

Identifier	'Teilleistung'	CP	Responsibility
T-BGU-106884	Wildcard 1 Language Skills 1 (p. 229)	2	
T-BGU-106885	Wildcard 2 Language Skills (p. 230)	2	

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
One or more learning controls, depending in th selected module, can be taken in form of a written test. These can be graded or not graded.
Attendance of classes is compulsory. Further information is provided by Sprachenzentrum (www.spz.kit.edu), Studienkolleg für ausländische Studierende (www.stk.kit.edu).
The learning controls can be taken graded or not graded. The registration is done directly at the 'Sprachenzentrum' (www.spz.kit.edu) or 'Studienkolleg für ausländische Studierende' (www.stk.kit.edu) but not online.

Grade of the Module
not graded

Prerequisites
Only one module can be selected. This module must not be selected together with one of the modules
M-BGU-103468 - Language Skills 2 (3 CP)
M-BGU-103469 - Language Skills 3 (4 CP)
M-BGU-103470 - Language Skills 4 (5 CP)
M-BGU-103471 - Language Skills 5 (6 CP)
The same is valid for the other modules.
Language courses in the native language of the student are not accredited.
English language courses below or at the level required for admission to the master's degree program Water Science & Engineering are not accredited.

Qualification Goals
Students acquire skills in cross-cultural communication.

Content
Students can acquire and improve knowledge of a language of their choice. Information on the courses offered and on the registration procedure are given at
www.spz.kit.edu.
Students who are not native German speakers may attend German courses at Studienkolleg:
www.stk.kit.edu/deutsch_kurse.php.

Recommendations
none

Remarks
Language Skills can be taken in extent of 2 - 6 CPs. For the desired amount of CPs the respective module has to be selected. The Module Handbook provides exemplarily the description for the module 'M-BGU-103466 - Language Skills 1 (2 CP)'.

The module can only be selcted within the subject 'Cross-Cutting Methods and Competencies' or accredited as additional accomplishment.

Workload
corresponding to the selected language course/s

M Module: Management of Water Resources and River Basins (WSEM-PC721) [M-BGU-103364]

Responsibility: Uwe Ehret

Institution: KIT-Fakultät für Bauingenieur-, Geo- und Umweltwissenschaften

Curricular Embedding: Compulsory Elective

Contained in: Profile Studies / Environmental System Dynamics & Management

Credit Points	Recurrence Frequency	Duration	Language	Version
6	Each summer term	1 term	English	1

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-BGU-106597	Management of Water Resources and River Basins (p. 186)	6	Uwe Ehret

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
- 'Teilleistung' T-BGU-106597 with examination of other type according to § 4 Par. 2 No. 3
details about the learning control see at the 'Teilleistung'

Grade of the Module
grade of the module is grade of the exam

Prerequisites
none

Qualification Goals
Students are able to identify the components of tasks related to Water Management. They are able to formulate solutions for these tasks based on the principles of Integrated Water Resources Management (IWRM).
Students are familiar with the principles, methods and limitations of environmental systems modeling and are able to set up and apply water balance models for given tasks of Water Resources Management. They are able to interpret the results and quantify and evaluate the related uncertainties.
Students are able to solve problems and to present the related results in teamwork.

Content
- definition, scope and examples of Integrated River Basin Management
- methods for Multi-Objective Decision Making (Utility Matrix)
- hydrological Modeling: Environmental Systems Theory, Calibration and Validation, Sensitivity and Uncertainty Analysis
- methods of Engineering Hydrology
- computer-based application of hydrological models (HBV,Larsim): manual and automated calibration, Monte-Carlo based uncertainty estimation, identification of design storm hydrographs

Preparation of assignments and presentation in small groups.

Recommendations
knowledge in Hydrology and Engineering Hydrology

Remarks
none

Workload
contact hours (1 HpW = 1 h x 15 weeks):

- lecture/exercise: 60 h

independent study:

- preparation and follow-up lecture/exercises: 20 h
- preparation of course associated assignments (parts of the exam): 60 h
- preparation of final take home exam (part of the exam): 40 h

total: 180 h

M Module: Mass Transfer and Reaction Kinetics (WSEM-CC925) [M-CIWVT-104879]

Responsibility: Nikolaos Zarzalis

Institution: KIT-Fakultät für Chemieingenieurwesen und Verfahrenstechnik

Curricular Embedding: Compulsory Elective

Contained in: Cross-Cutting Methods & Competencies

Credit Points	Recurrence Frequency	Duration	Language	Version
4	Each summer term	1 term	English	1

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-CIWVT-109913	Mass Transfer and Reaction Kinetics (p. 187)	4	Nikolaos Zarzalis

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
- 'Teilleistung' T-CIWVT-109913 with written examination according SPO/ER § 4 Par. 2 No. 1
details about learning control see at the 'Teilleistung'

Grade of the Module
grade of the module is grade of the exam

Prerequisites
none

Qualification Goals
The students understand and master the analogy between momentum, energy and mass transport.
They can calculate the mass flows for different fluid and thermodynamics conditions with the aid of the analogy of heat and mass transfer (Nu- and Sh-number). Furthermore, the students can apply the basic chemical kinetic concepts in order to calculate the rates of species. The students can analyze new problems with the aid of the acquired methods. The lack of knowledge to solve the problems is closed by a literature study.

Content
Mass Transfer
- Ficks's law of diffusion
  - Equimolar diffusion
  - One way diffusion
- Liquid-vapor interfaces
- Analogy between heat and mass transfer – Sherwood and Nusselt number

Reaction Kinetics
- Elementary reaction rates – Bimolecular reaction and collision theory
- Rate of reaction for multistep mechanisms
- Net production rates
- Rate coefficients and equilibrium constants
- Steady-state approximation
- Chemical time scales
- Partial equilibrium

Recommendations
none

Literature

- P. Incropera, D.P. De Witt, Fundamentals of Heat and Mass Transfer, John Wiley & Sons, Second Edition 1981
- S. R. Turns, An Introduction to Combustion, Mc Graw-Hill, Second Edition 2000

Workload
contact hours (1 HpW = 1 h x 15 weeks):

- lecture: 30 h

independent study:

- preparation and follow-up lectures: 60 h
- examination preparation: 30 h

total: 180 h

M Module: Membrane Technologies and Excursions (WSEM-PA222) [M-CIWVT-103413]

Responsibility: Gudrun Abbt-Braun, Harald Horn, Florencia Saravia

Institution: KIT-Fakultät für Chemieingenieurwesen und Verfahrenstechnik

Curricular Embedding: Compulsory Elective

Contained in: Profile Studies / Water Technologies & Urban Water Cycle

Credit Points	Recurrence Frequency	Duration	Language	Version
6	Each summer term	1 term	English	2

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-CIWVT-106820	Excursions: Waste Water Disposal and Drinking Water Supply (p. 152)	0	Gudrun Abbt-Braun
T-CIWVT-106819	Membrane Technologies and Excursions (p. 189)	6	Gudrun Abbt-Braun, Harald Horn, Florencia Saravia

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
- 'Teilleistung' T-CIWVT-106820 with not graded accomplishment according to § 4 Par. 3 as examination prerequisite
- 'Teilleistung' T-CIWVT-106819 with oral examination according to § 4 Par. 2 No. 2
details about the learning controls see at the respective 'Teilleistung'

Grade of the Module
grade of the module is grade of the exam

Prerequisites
none

Qualification Goals
Students have a fundamental knowledge on membrane technology in water and waste water treatment. They learn how the different membrane systems (reverse osmosis, nanofiltration, ultrafiltration, microfiltration, and dialysis) have to be applied to produce a certain water quality. They are able to design such systems.

Content
The solution-diffusion model. Concentration polarization and the consequences for membrane module design. Membrane production and properties. Membrane configuration and design. Membrane systems for desalination and brackish water treatment. Membrane bio reactors for waste water treatment. Biofouling, scaling and prevention of both.
Introduction to excursions and excursions: basic processes in waste water disposal and drinking water supply, including visits to municipal waste water treatment plants and treatment plants for drinking water.

Recommendations
module 'Water Technology (WSEM-PA221)'

Literature
Melin, T., Rautenbach, R., 2007. Membranverfahren - Grundlagen der Modul- und Anlagenauslegung. Springer Verlag Berlin Heidelberg.
Mulder, M.H., 2000. Basic Principles of Membrane Technology. Kluwer Academic, Dordrecht.
Schäfer, A.I., 2005. Nanofiltration: Principles and applications. Elsevier, Oxford.
Staude, E., 1992. Membranen und Membranprozesse. Verlag Chemie, Weinheim.
Lecture Notes in ILIAS

Workload
contact hours (1 HpW = 1 h x 15 weeks):

- Membrane Technologies in Water Treatment lecture: 30 h
- Waste Water Disposal and Drinking Water Supply – Introduction and Excursions lecture, excursions: 25 h

independent study:

- preparation and follow-up lectures Membrane Technologies in Water Treatment: 45 h
- preparation and follow-up lectures, excursions Waste Water Disposal and Drinking Water Supply – Introduction and Excursions: 15 h
- examination preparation: 65 h

total: 180 h

M Module: Meteorological Hazards and Climate Change (WSEM-SM972) [M-PHYS-103386]

Responsibility: Peter Knippertz

Institution: KIT-Fakultät für Physik
Curricular Embedding: Compulsory Elective
Contained in: additional Supplementary Modules

Credit Points	Recurrence Frequency	Duration	Language	Version
6	Each term	2 terms	English	2

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-PHYS-107713	Examination on Seminar IPCC Assessment Report (p. 148)	3	Joaquim José Ginete Werner Pinto, Corinna Hoose
T-PHYS-109140	Meteorological Hazards (p. 190)	0	Michael Kunz
T-PHYS-109979	Examination on Meteorological Hazards (p. 147)	3	Michael Kunz

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
- 'Teilleistung' T-PHYS-109140 with not graded accomplishment according to § 4 Par. 3 as examination prerequisite
- 'Teilleistung' T-PHYS-109979 with oral examination according to § 4 Par. 2 No. 2
- 'Teilleistung' T-PHYS-107713 with examination of other type according to § 4 Par. 2 No. 3

details about the learning controls see at the respective 'Teilleistung'

Grade of the Module
grade of the modul is CP weighted average of grades of the partial exams

Prerequisites
none

Qualification Goals
The students are able to professionally present and critically discuss causes of climate change. They can use climate and weather data or forecasts to estimate the potential for extreme events and their effects by region and season. In addition, they can expertly present and discuss learned or self-developed scientific findings.

Content
Meteorological natural hazards:
Extreme events, extratropical and tropical cyclones, convection, thunderstorms, supercells, tornadoes, convective storm gusts, derechos, hail, climate change and extreme event
Seminar on IPCC Assessment Report:
Causes of climate change: External and internal factors influencing the climate, radiation effect and the importance of greenhouse gases, results of model projections of the global climate
Systematic review based on the current progress report of the Intergovernmental Panel on Climate Change: structuring of the IPCC process, background to the origin of the report, lectures on sub-aspects and discussion

Recommendations
basic knowledge in meteorology, e.g. module 'General Meteorology (SM971)', and about the climate system

Workload
contact hours (1 HpW = 1 h x 15 weeks):

- Seminar on IPCC Assessment Report: 30 h
- Meteorological Hazards lecture: 30 h

independent study:

- preparation and follow-up Seminar on IPCC Assessment Report: 30 h
- preparation of the presentation Seminar on IPCC Assessment Report (partial examination): 30 h
- preparation and follow-up lectures Meteorological Hazards: 30 h
- examination preparation Meteorological Hazards (partial examination): 30 h

total: 180 h

M Module: Modeling of Water and Environmental Systems (WSEM-AF101) [M-BGU-103374]

Responsibility: Erwin Zehe

Institution: KIT-Fakultät für Bauingenieur-, Geo- und Umweltwissenschaften

Curricular Embedding: Compulsory Elective

Contained in: Advanced Fundamentals

Credit Points	Recurrence Frequency	Duration	Language	Version
3	Each winter term	1 term	English	1

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-BGU-106757	Modeling of Water and Environmental Systems (p. 193)	3	Erwin Zehe

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
- 'Teilleistung' T-BGU-106757 with not graded accomplishment according to § 4 Par. 3
details about the learning control see at the 'Teilleistung'

Grade of the Module
not graded

Prerequisites
none

Qualification Goals
Students can explain approaches to model environmental systems in different water-related disciplines. Based on this, they are able to explain common approaches and methods of environmental systemmodeling, and to name and evaluate the respective advantages, disadvantages, ranges of applicability and inherent limitations.
Students can explain universal challenges of modeling and are able to select adequate model concepts for given water-related tasks.

Content
This lecture series comprises individual lectures on environmental systems modeling from a broad range of water-related disciplines (e.g. flood forecasting, contaminant transport, fluid-particle interaction, water quality, or hydraulic design). The commonalities and differences of the modeling approaches are discussed with respect to their conceptual approach, mathematical formulation and numerical scheme. Spatial and temporal scales as well as discretization of the various models are compared and discussed. Based on this broad range of examples, universal challenges of modeling are illustrated: Intrinsic uncertainties, adequate selection of numerical schemes, calibration and validation, adequate model choice.

Recommendations
none

Remarks
none

Workload
contact hours (1 HpW = 1 h x 15 weeks):
- lecture: 30 h

independent study:
- preparation and follow-up lectures: 30 h
- working on take home examination: 30 h

total: 90 h

M Module: Module Master Thesis (WSE-MSC-THESIS) [M-BGU-100080]

Responsibility: Peter Vortisch

Institution: KIT-Fakultät für Bauingenieur-, Geo- und Umweltwissenschaften

Curricular Embedding: Compulsory

Contained in: Master Thesis

Credit Points	Recurrence Frequency	Duration	Language	Version
30	Each term	1 term	German/English	1

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-BGU-100093	Master Thesis (p. 188)	30	Peter Vortisch

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
thesis and final presentation according to § 14 ER/SPO

Grade of the Module
The grade of the module results from the evaluation of the Master Thesis and the final presentation.

Prerequisites
Prerequiste for the admission to the Master Thesis is that the student has passed module examinations in the extent of minimum 42 CP. The examination board decides about exceptions on request of the student (ER/SPO § 14 Par. 1).

Qualification Goals
The student is able to investigate independently a complex problem within a particular research field of his choice in limited time, following scientific methods. He can search autonomously for literature, can find own approaches, can evaluate his results and can classify them according to the state of the art. He is further able to present clearly the essential matter and results in his master thesis and in a comprehensive presentation.

Content
The Master Thesis is an independent written report and comprises the theoretical or experimental work on a complex problem within a particular field of civil engineering with scientific methods. The topic of the master thesis derives from the students choice of a particular field. The student and can make proposals for the topic.

Recommendations
All technical skills and soft skills required for working on the selected topic and the preparation of the thesis should be attained.

Remarks
none

Workload

- working on thesis project: 720 h
- thesis writing: 150 h.
- preparation of presentation: 30 h

total: 900 h

M Module: Numerical Flow Modeling in Hydraulic Engineering (WSEM-PB651) [M-BGU-103390]

Responsibility: Peter Oberle

Institution: KIT-Fakultät für Bauingenieur-, Geo- und Umweltwissenschaften

Curricular Embedding: Compulsory Elective

Contained in: Profile Studies / Fluid Mechanics & Hydraulic Engineering

Credit Points	Recurrence Frequency	Duration	Language	Version
6	Each winter term	1 term	German	1

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-BGU-106776	Numerical Flow Modeling in Hydraulic Engineering (p. 194)	6	Peter Oberle

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
- 'Teilleistung' T-BGU-106776 with oral examination according to § 4 Par. 2 No. 2
details about the learning control see at the 'Teilleistung'

Grade of the Module
grade of the module is grade of the exam

Prerequisites
none

Qualification Goals
see German version

Content
see German version

Recommendations
basic knowledge of hydrology, hydraulic engineering and water management as well as open channel hydraulics

Remarks
none

Literature
lecture notes

Workload
contact hours (1 HpW = 1 h x 15 weeks):
- lecture, exercise: 60 h

independent study:
- preparation and follow-up lectures, exercises: 60 h
- examination preparation: 60 h

total: 180 h

M Module: Numerical Fluid Mechanics (WSEM-AF501) [M-BGU-103375]

Responsibility: Markus Uhlmann

Institution: KIT-Fakultät für Bauingenieur-, Geo- und Umweltwissenschaften

Curricular Embedding: Compulsory Elective

Contained in: Advanced Fundamentals

Credit Points	Recurrence Frequency	Duration	Language	Version
6	Each winter term	1 term	English	1

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-BGU-106758	Numerical Fluid Mechanics (p. 195)	6	Markus Uhlmann

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
- 'Teilleistung' T-BGU-106758 with written examination according to § 4 Par. 2 No. 1
details about the learning control see at the 'Teilleistung'

Grade of the Module
grade of the module is grade of the exam

Prerequisites
none

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

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

Recommendations
- Fluid Mechanics (knowledge of the fundamental processes of advection and diffusion, familiarity with the Navier-Stokes equations)
- Mathematics (analysis - partial differential equations, Fourier analysis, series expansions, complex numbers; linear algebra - matrices, determinants, eigensystems; numerics - discrete number representation, round-off, floating point operations, numerical treatment of partial differential equations)
- Knowledge in programming with Matlab is recommended; otherwise it is strongly recommended to participate in the course 'Introduction to Matlab (CC772)'

Remarks
none

Workload
contact hours (1 HpW = 1 h x 15 weeks):
- lecture, exercise: 60 h

independent study:
- preparation and follow-up lectures, exercises: 60 h
- examination preparation: 60 h

total: 180 h

M Module: Numerical Mathematics for Students of Computer Science and Engineering (WSEM-CC912) [M-MATH-103404]

Responsibility: Christian Wieners

Institution: KIT-Fakultät für Mathematik

Curricular Embedding: Compulsory Elective

Contained in: Cross-Cutting Methods & Competencies

Credit Points	Recurrence Frequency	Duration	Language	Version
6	Each summer term	1 term	German	1

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-MATH-102242	Numerical Mathematics for Students of Computer Science (p. 198)	6	Andreas Rieder, Daniel Weiß, Christian Wieners

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
- 'Teilleistung' T-BGU-102242 with written examination according to § 4 Par. 2 No. 1
details about the learning control see at the 'Teilleistung'

Grade of the Module
grade of the module is grade of the exam

Prerequisites
none

Qualification Goals
see German version

Content
see German version

Recommendations
advanced mathematics: analysis; e.g. Advanced Mathematics I & II [0131000; 0180800]

Workload
contact hours (1 HpW = 1 h x 15 weeks):

- lecture, exercise: 45 h

independent study:

- preparation and follow-up lectures, exercises: 65 h
- examination preparation: 70 h

total: 180 h

M Module: Practical Course in Water Technology (WSEM-PA223) [M-CIWVT-103440]

Responsibility: Harald Horn

Institution: KIT-Fakultät für Chemieingenieurwesen und Verfahrenstechnik

Curricular Embedding: Compulsory Elective

Contained in: Profile Studies / Water Technologies & Urban Water Cycle

Credit Points	Recurrence Frequency	Duration	Language	Version
4	Each summer term	1 term	English	2

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-CIWVT-106840	Practical Course in Water Technology (p. 201)	4	Harald Horn

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
- 'Teilleistung' T-CIWVT-106840 with examination of other type according to § 4 Par. 2 No. 3
details about the learning control see at the 'Teilleistung'

Grade of the Module
grade of the module is the grade of the exam

Prerequisites
The module "Water Technology (WSEM-PA221)" has to be begun, i.e. at least the registration has to be made.

Modeled Conditions
The following conditions must be met:

- The module [M-CIWVT-103407] *Water Technology* must have been started.

Qualification Goals
Students can explain the most important processes in water treatment. They are able to do calculations, and to compare and interpret data. They learn how to use different methods, and to interpret different processes.

Content
6 different experiments out of: equilibrium study of the calcium carbonate system, flocculation, adsorption, oxidation, atomic absorption spectroscopy, ion chromatography, liquid chromatography, sum parameter, and an oral presentation of the student

Recommendations
none

Literature
Harris, D.C., 2010. Quantitative chemical analysis. W. H. Freeman and Company, New York.
Crittenden, J.C. et al., 2005. Water treatment – Principles and design, Wiley & Sons, Hoboken.
Patnaik, P., 2010. Handbook of environmental analysis: Chemical pollutants in air, water, soil, and solid wastes. CRC Press.
Wilderer, P., 2011. Treatise on water science, four-volume set, 1st edition, volume 3: Aquatic chemistry and biology. Elsevier, Oxford.
Lecture Notes in ILIAS

Workload

contact hours (1 HpW = 1 h x 15 weeks):

- lecture/practical training: 35 Std.

independent study:

- preparation of reports on practical training (part of the examination): 55 h
- examination preparation: 35 h

total: 120 h

M Module: Probability and Statistics (WSEM-CC911) [M-MATH-103395]

Responsibility: Bernhard Klar

Institution: KIT-Fakultät für Mathematik
Curricular Embedding: Compulsory Elective
Contained in: Cross-Cutting Methods & Competencies

Credit Points	Recurrence Frequency	Duration	Language	Version
3	Each summer term	1 term	German/English	1

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-MATH-106784	Probability and Statistics (p. 203)	3	Bernhard Klar

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
- 'Teilleistung' T-BGU-106784 with oral examination according to § 4 Par. 2 No. 2
details about the learning control see at the 'Teilleistung'

Grade of the Module
grade of the module is grade of the exam

Prerequisites
none

Qualification Goals
- Students acquire basic knowledge of probability theory, and are able to model simple random phenomena
- they know the basic differences between descriptive and inferential statistics
- Students learn basic statistical methods, and are able to apply this knowledge to new examples

Content
The lecture gives a concise introduction to probability theory and covers some important statistical methods.
Key terms: random experiments, events, probability, conditional probability, independent events, random variables, probability distribution, density, sample mean, sample variance, sample correlation, point estimate, confidence interval, test, error propagation, linear regression.

Recommendations
none

Workload
contact hours (1 HpW = 1 h x 15 weeks):
- lecture: 30 h

independent study:
- preparation and follow-up lectures: 35 h
- examination preparation: 25 h

total: 90 h

M Module: Process Engineering in Wastewater Treatment (WSEM-PA321) [M-BGU-103399]

Responsibility: Tobias Morck

Institution: KIT-Fakultät für Bauingenieur-, Geo- und Umweltwissenschaften

Curricular Embedding: Compulsory Elective

Contained in: Profile Studies / Water Technologies & Urban Water Cycle

Credit Points	Recurrence Frequency	Duration	Language	Version
6	Each winter term	1 term	English	1

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-BGU-106787	Process Engineering in Wastewater Treatment (p. 204)	6	Tobias Morck

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
- 'Teilleistung' T-BGU-106787 with written examination according to § 4 Par. 2 No. 1
details about the learning control see at the 'Teilleistung'

Grade of the Module
grade of the module is grade of the exam

Prerequisites
none

Qualification Goals
Students acquire knowledge about typical techniques in wastewater treatment at local and international level. They are able to perform a technical evaluation and describe dimensioning approaches taking into consideration legal boundary conditions. Students analyze, evaluate and optimize operation of plant technologies. They focus on energy-efficient plant designs considering the most relevant factors affecting the total costs.Students can analyze the situation in emerging and developing countries making a comparison with that in industrialized countries. Based on that, they are able to develop water-related management strategies.

Content
Municipal Wastewater Treatment:Students gain deep knowledge about design and operation of typical process technologies in municipal wastewater treatment in Germany. Following processes are covered:

- different activated sludge processes
- anaerobic technologies and energy-recovery systems
- filtration technologies
- wastewater disinfection and pathogen removal
- chemical and biological phosphorus removal
- micro-pollutants removal
- resource management and energy efficiency

International Sanitary Engineering:Students get acquainted with the design and operation used for wastewater treatment at international level. They analyze, evaluate and take decisions when new and more holistic oriented met hods can be implemented. Following topics are covered:

- activated sludge processes
- trickling filters and rotating biological contactors
- treatment ponds
- retention soil filter / Wetlands
- UASB/EGSB/Anaerobic filter
- decentralized versus centralized systems
- material flow separation

- energy-recovery from wastewater
- drinking water purification
- waste management

Recommendations
module "Urban Water Infrastructure and Management (AF301)"

Remarks
IMPORTANT:

The module will not be offered anymore as from summer term 2019. It will be replaced by the module Wastewater Treatment Technologies.

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group presentation and written report is internal examination prerequisite.

Literature
Imhoff, K. u. K.R. (1999) Taschenbuch der Stadtentwässerung, 29. Aufl., Oldenbourg Verlag, München, WienATV-DVWK (1997) Handbuch der Abwassertechnik: Biologische und weitergehende Abwasserreinigung, Band 5, Verlag Ernst & Sohn, BerlinATV-DVWK(1997) Handbuch der Abwassertechnik: Mechanische Abwasserreinigung, Band 6, Verlag Ernst & Sohn , BerlinSperling, M.; Chernicaro, C.A.L. (2005) Biological wastewater treatment in warm climate regions, IWA publishing, LondonWilderer, P.A., Schroeder, E.D. and Kopp, H. (2004) Global Sustainability - The Impact of Local Cultures. A New Perspective for Science and Engineering, Economics and Politics WILEY-VCH

Workload
contact hours (1 HpW = 1 h x 15 weeks):
- Municipal Wastewater Treatment lecture/exercise: 30 h
- International Sanitary Engineering lecture/exercise: 30 h

independent study:
- preparation and follow-up lecture/exercises Municipal Wastewater Treatment: 30 h
- preparation and follow-up lecture/exercises International Sanitary Engineering: 30 h
- examination preparation: 60 h

total: 180 h

M Module: Project Studies in Water Resources Management (WSEM-PB661) [M-BGU-103394]

Responsibility: Frank Seidel

Institution: KIT-Fakultät für Bauingenieur-, Geo- und Umweltwissenschaften

Curricular Embedding: Compulsory Elective

Contained in: Profile Studies / Fluid Mechanics & Hydraulic Engineering

Credit Points	Recurrence Frequency	Duration	Language	Version
6	Each winter term	1 term	German	1

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-BGU-106783	Project Studies in Water Resources Management (p. 206)	6	Franz Nestmann, Frank Seidel

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
- 'Teilleistung' T-BGU-106783 with examination of other type according to § 4 Par. 2 No. 3
details about the learning control see at the 'Teilleistung'

Grade of the Module
grade of the module is grade of the exam

Prerequisites
none

Qualification Goals
see German version

Content
see German version

Recommendations
module 'Flow and Sediment Dynamics in Rivers (PB633)'

Remarks
none

Workload
contact hours (1 HpW = 1 h x 15 weeks):

- lecture, exercise: 30 h

independent study:

- preparation and follow-up lectures, exercises: 30 h
- preparation of term paper (exam): 120 h

total: 180 h

M Module: Protection and Use of Riverine Systems (WSEM-PC762) [M-BGU-103401]

Responsibility: Charlotte Kämpf

Institution: KIT-Fakultät für Bauingenieur-, Geo- und Umweltwissenschaften

Curricular Embedding: Compulsory Elective

Contained in: Profile Studies / Environmental System Dynamics & Management

Credit Points	Recurrence Frequency	Duration	Language	Version
6	Each summer term	1 term	English	1

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-BGU-106790	Prerequisite Protection and Use of Riverine Systems (p. 202)	1	Charlotte Kämpf
T-BGU-106791	Protection and Use of Riverine Systems (p. 207)	5	Charlotte Kämpf

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
- 'Teilleistung' T-BGU-106790 with not graded accomplishment according to § 4 Par. 3 as examination prerequisite
- 'Teilleistung' T-BGU-106791 with examination of other type according to § 4 Par. 2 No. 3
details about the learning controls see at the respective 'Teilleistung'

Grade of the Module
grade of the module is grade of the exam

Prerequisites
none

Qualification Goals
Students are able to rank interdisciplinary texts on riverine systems according to their relevance, and formulate relevant questions on this topic. Students can research systematically on a scientific problem. They are able to put the materials in the context of integrated management strategies and current water resources problems to work on solutions for adapting to regional conditions.

Content
Integrated Water Management:
- planning of water management projects
- adapted technologies (small hydropower systems)
- water distribution networks
- consideration of the geographical, social and political environmen

International Nature Conservation:
- FFH Directive, Natura 2000, wildlife conservation concepts
- renaturation concepts

Recommendations
none

Remarks
none

Workload
contact hours (1 HpW = 1 h x 15 weeks):
- seminar, excursion: 50 h

independent study:
- preparation and follow-up seminar, excursion: 40 h
- preparation of literature annotation, short presentation and excursion report (examination prerequisite): 30 Std.
- preparation of presentation and manuscript (examination): 60 Std.

total: 180 h

M Module: Remote Sensing and Positioning (WSEM-CC931) [M-BGU-103442]

Responsibility: Maria Hennes, Hansjörg Kutterer, Thomas Vögtle

Institution: KIT-Fakultät für Bauingenieur-, Geo- und Umweltwissenschaften

Curricular Embedding: Compulsory Elective

Contained in: Cross-Cutting Methods & Competencies

Credit Points	Recurrence Frequency	Duration	Language	Version
6	Each winter term	1 term	English	1

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-BGU-106843	Remote Sensing and Positioning (p. 208)	6	Maria Hennes, Hansjörg Kutterer, Thomas Vögtle

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
- 'Teilleistung' T-BGU-106843 with oral examination according to § 4 Par. 2 No. 2
details about the learning control see at the 'Teilleistung'

Grade of the Module
grade of the module is grade of the exam

Prerequisites
none

Qualification Goals
The students understand and apply surveying and remote sensing methods. They use tools for data processing and evaluation of uncertainties as well as for spatial data management and visualization. Students gain insight into processing resp. generating and analysis chains of remote sensing and Geodesy; covering data acquisition techniques, data filtering, statistical assessment, 3D modeling, model assimilation/adaption, and critical evaluation.

Content
Terrestrial & Satellite Positioning:

- contributions of Geodesy to Water Science
- terrestrial surveying of heights: methods and introduction to instruments
- definition of reference systems and realization of reference frames
- GNSS positioning: Segments, signals, code and phase measurements, error sources and error reduction, processing strategies, differential and absolute positioning, real-time/post-processing, RTK and static mode, Precise Point Positioning, services
- height concepts, vertical reference frames
- comparison of terrestrial and satellite-based height determination
- GNSS levelling

Remote Sensing & Geo-Information Systems:

- electromagnetic spectrum; sensors and data of remote sensing, image processing; strategy of development of GIS, definition and example, standardization; reference and coordinate systems, deformation and rectification, digital terrain models
- data processing: histograms, multispectral classification, quality assessment
- examples of Remote Sensing Applications
- sensors and systems: Airborne vs. satellite platforms, metric cameras, scanner, radar

Exercise: Introduction to Remote Sensing Software, Multi-spectral classification, evaluation techniques

Recommendations
fundamentals of geometric optics, oscillations and waves, linear algebra (vectors, coordinate geometry, trigonometry)

Workload
contact hours (1 HpW = 1 h x 15 weeks):

- Terrestrial & Satellite Positioning lecture, exercise: 30 h
- Remote Sensing & Geo-Information Systems lecture, exercise: 30 h

independent study:

- preparation and follow-up lectures, exercises Terrestrial & Satellite Positioning: 30 h
- preparation and follow-up lectures, exercises Remote Sensing & Geo-Information Systems: 30 h
- examination preparation: 60 h

total: 180 h

M Module: Research Module: Microbial Diversity (WSEM-CC922) [M-CHEMBIO-100238]

Responsibility: Johannes Gescher

Institution: KIT-Fakultät für Chemie und Biowissenschaften

Curricular Embedding: Compulsory Elective

Contained in: Cross-Cutting Methods & Competencies

Credit Points	Recurrence Frequency	Duration	Language	Version
8	Each winter term	1 term	German	2

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-CHEMBIO-108674	Microbial Diversity (p. 191)	8	Johannes Gescher

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
The control of success of this module is one markedperformance of different types of examination
Maximum 100 points can be reached. These points consits the following components:

- On examination is a written part,with duration of 120 minutes, about the contents of the lecture and the practical part. With this performance 80 points can be reached.
- Beside this written test, a protocol of the practical part must be written. This protocol must be in accordance with scientific requirements.
  For this protocol 10 points can be reached.
- Furthermore, 10 points can be achieved by giving a talk about the contents of the course within the working group.

Prerequisites
none

M Module: River Basin Modeling (WSEM-PC341) [M-BGU-103373]

Responsibility: Stephan Fuchs

Institution: KIT-Fakultät für Bauingenieur-, Geo- und Umweltwissenschaften

Curricular Embedding: Compulsory Elective

Contained in: Profile Studies / Environmental System Dynamics & Management

Credit Points	Recurrence Frequency	Duration	Language	Version
6	Each summer term	2 terms	English	1

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-BGU-106603	River Basin Modelling (p. 210)	6	Stephan Fuchs

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
- 'Teilleistung' T-BGU-106603 with examination of other type according to § 4 Par. 2 No. 3
details about the learning control see at the 'Teilleistung'

Grade of the Module
grade of the module is grade of the exam

Prerequisites
none

Qualification Goals
Students are able to explain the basic relationships between water-driven material cycles in river basins and their budget in aquatic ecosystems. They are able to analyze the impact of anthropogenic activities on water condition and quality. Students gain knowledge regarding transport pathways of substances and biochemical and physical interactions in water bodies in order to formulate mathematical model approaches. Using simulation models, they are able to quantify substance emissions; to predict the impact from external influences on the water quality relevant processes and; to perform different scenario analysis. Students are capable of evaluating model results in terms of their plausibility and uncertainty.

Content
This module provides students with a broad-based understanding of the fundamentals of materials flows (N, P, pollutants) and their relevant transport pathways in river basins. Different modeling approaches for a quantitative description of the processes will be presented. Students receive a single-user version of the simulation tool MoRE (Modeling of Regionalized Emissions). They have to develop and implement their own model in small groups and interpret simulation results.

Recommendations
modules 'Urban Water Infrastructure and Management (AF301)', 'Water Ecology (CC371)'

Remarks
none

Literature
Schwoerbel, J. (1993): Einführung in die Limnologie, 7. Aufl., Fischer Verlag, Stuttgart
Kummert, R. (1989): Gewässer als Ökosysteme: Grundlagen des Gewässerschutzes, 2. Aufl., Teubner Verlag, Stuttgart
Stumm, W.; Morgan, J.J. (1996): Aquatic Chemistry – Chemical equilibria and rates in natural waters, Wiley Interscience, NY

Workload
contact hours (1 HpW = 1 h x 15 weeks):

- Mass Fluxes in River Basins lecture: 30 h
- Modeling Mass Fluxes in River Basins exercise: 30 h

independent study:

- preparation and follow-up lectures Mass Fluxes in River Basins: 60 h
- project work on River Basin Modeling (examination): 60 h

total: 180 h

M Module: Study Project (WSEM-SP111) [M-BGU-103439]

Responsibility: Luca Trevisan

Institution: KIT-Fakultät für Bauingenieur-, Geo- und Umweltwissenschaften

Curricular Embedding: Compulsory

Contained in: Study Project

Credit Points	Recurrence Frequency	Duration	Language	Version
15	Each term	1 term	German/English	1

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-BGU-106839	Study Project (p. 213)	15	Luca Trevisan

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
- 'Teilleistung' T-BGU-106839 with examination of other type according to § 4 Par. 2 No. 3
details about the learning control see at the 'Teilleistung'

Grade of the Module
grade of the module is grade of the exam

Prerequisites
none

Qualification Goals
Students are able to work on an interdisciplinary, water-related project using scientific methods. They can, with guidance, plan, structure, prepare, conduct, and document a study. They are able to select appropriate methods for the solution of the given problem.
Students are able to work self-organized and structured. They possess skills in the field of project management, teamwork and presentation, both orally and in writing.

Content
Conducting a water-related, interdisciplinary project work. This may be of a theoretical and/or experimental type. The focus is on the development of conclusions using scientific methods, project management and presentation of the results. The project can also be worked on in student teams. In this case, each student works on a particular aspect of an overall problem as part of a joint project.
Students are invited to make suggestions for topics.
It is possible to conduct the project in cooperation with external partners.

Recommendations
The knowledge and technical and interdisciplinary skills needed to work on the selected topic and to prepare the 'Study Project' should have been acquired.

Remarks
none

Workload
processing time appr. 3 months

M Module: Subsurface Flow and Contaminant Transport (WSEM-PC725) [M-BGU-103872]

Responsibility: Erwin Zehe

Institution: KIT-Fakultät für Bauingenieur-, Geo- und Umweltwissenschaften

Curricular Embedding: Compulsory Elective

Contained in: Profile Studies / Environmental System Dynamics & Management

Credit Points	Recurrence Frequency	Duration	Language	Version
6	Each summer term	1 term	English	1

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-BGU-106598	Transport and Transformation of Contaminants in Hydrological Systems (p. 218)	6	Erwin Zehe

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
- 'Teilleistung' T-BGU-106598 with oral examination according to § 4 Par. 2 No. 2
details about the learning control see at the 'Teilleistung'

Grade of the Module
grade of the module is grade of the exam

Prerequisites
none

Modeled Conditions
The following conditions must be met:

- The module [M-BGU-103369] *Transport and Transformation of Contaminants in Hydrological Systems* must not have been started.

Qualification Goals
Students are able to explain processes of transport and decomposition related to nutrients and pollutants in surface runoff and in the unsaturated zone of rural catchments.
Students are able to independently apply analytical and process-based models: estimation of model parameters from field investigations, estimation of water and substance fluxes and balance in the critical zone, statements on the risks related to contaminant mobilization in natural soils.
Students are able to evaluate the limits of applicability of modeling approaches in natural, heterogeneous soils.

Content
Transport processes in the unsaturated zone related to infiltration, surface runoff, and movement of soil water:

- advective-dispersive transport in homogeneous and heterogeneous soils
- particulate transport by erosion
- adsorption
- chemical and microbial processes of reaction and decay in soils
- modeling contaminant transport (e.g. pesticides) in soils using analytical models
- risk assessment for pesticides in soils (transport, residence times, adsorption, decay)
- estimation of model parameters from field exploration
- parameterization of adsorption isotherms
- breakthrough curve

Computer exercise:

- simulation of water and substance transport with process-based models
- independently conducted risk-assessments for pesticides using simple simulation techniques

Recommendations
modules Water and Energy Cycles [bauiM2P8-WATENCYC] and Hydrological Measurements in Environmental Systems [bauiM2S05-HY5]
knowledge of programming with Matlab; otherwise, it is strongly recommended to attend the course 'Introduction to Matlab' (6224907)

Remarks
This module is offered newly as from summer term 2018.

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.

Workload
contact hours (1 HpW = 1 h x 15 weeks):

- lecture/exercise: 60 h

independent study:

- preparation and follow-up lecture/exercises: 60 h
- examination preparation: 60 h

total: 270 h

M Module: Sustainable Management of rivers and Floodplains (WSEM-PC986) [M-BGU-103391]

Responsibility: Florian Wittmann

Institution: KIT-Fakultät für Bauingenieur-, Geo- und Umweltwissenschaften

Curricular Embedding: Compulsory Elective

Contained in: Profile Studies / Environmental System Dynamics & Management

Credit Points	Recurrence Frequency	Duration	Language	Version
6	Each term	2 terms	German	1

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-BGU-106777	River and Floodplain Ecology (p. 209)	3	Florian Wittmann
T-BGU-106778	Ecosystem Management (p. 143)	3	Christian Damm, Florian Wittmann

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
- 'Teilleistung' T-BGU-106777 with written examination according § 4 Par. 2 No. 1
- 'Teilleistung' T-BGU-106778 with examination of other type according § 4 Par. 2 No. 3
details about the learning controls see at the respective 'Teilleistung'

Grade of the Module
grade of the module is CP weighted average of grades of the partial exams

Prerequisites
none

Qualification Goals
see German version

Content
see German version

Recommendations
start at winter term with course 'Ecology of Rivers and Wetlands'

Remarks
None

Workload
contact hours (1 HpW = 1 h x 15 weeks):
- Ecology of Rivers and Wetlands lecture: 30 h
- Ecosystem Management seminar: 30 h

independent study:
- preparation and follow-up lectures Ecology of Rivers and Wetlands: 30 h
- examination preparation Ecology of Rivers and Wetlands: 30 h
- preparation and follow-up lectures Ecosystem Management: 30 h
- preparation of presentation Ecosystem Management (partial examination): 30 h

total: 180 h

M Module: Technical Hydraulics (WSEM-PB431) [M-BGU-103385]

Responsibility: Cornelia Lang

Institution: KIT-Fakultät für Bauingenieur-, Geo- und Umweltwissenschaften

Curricular Embedding: Compulsory Elective

Contained in: Profile Studies / Fluid Mechanics & Hydraulic Engineering

Credit Points	Recurrence Frequency	Duration	Language	Version
6	Each summer term	1 term	German	1

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-BGU-106770	Technical Hydraulics (p. 214)	6	Cornelia Lang

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
- 'Teilleistung' T-BGU-106770 with written examination according to § 4 Par. 2 No. 1
details about the learning control see at the 'Teilleistung'

Grade of the Module
grade of the module is grade of the exam

Prerequisites
none

Qualification Goals
see German version

Content
see German version

Recommendations
course Hydromechanics (6200304),module Advanced Fluid Mechanics (AF401)

Remarks
IMPORTANT:
The module will not be offered in summer term 2019.

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

Workload
contact hours (1 HpW = 1 h x 15 weeks):
- lecture, exercise: 60 h

independent study:
- preparation and follow-up lectures, exercises: 60 h
- examination preparation: 60 h

total: 180 h

M Module: Thermal Use of Groundwater (WSEM-SM879) [M-BGU-103408]

Responsibility: Philipp Blum

Institution: KIT-Fakultät für Bauingenieur-, Geo- und Umweltwissenschaften

Curricular Embedding: Compulsory Elective

Contained in: additional Supplementary Modules

Credit Points	Recurrence Frequency	Duration	Language	Version
3	Each winter term	1 term	English	1

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-BGU-106803	Thermal Use of Groundwater (p. 217)	3	Philipp Blum

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
- 'Teilleistung' T-BGU-106803 with oral examination according to § 4 Par. 2 No. 2
details about the learning control see at the 'Teilleistung'

Grade of the Module
grade of the module is grade of the exam

Prerequisites
none

Qualification Goals
Students get familiar with the topic 'Thermal Use of Groundwater' and will be able to integrate their knowledge in particular in an urban water energy nexus. They get knowledge about the fundamentals of thermal transport in groundwater and their application to shallow geothermal systems such as ground source and groundwater heat pump systems. Hence, analytical and numerical simulations will be performed using Excel and Matlab scripted codes. They will be able to perform their own simulations and will be able to design shallow geothermal systems in context of the water energy nexus.

Content
The content of this module is mainly based on the textbook on 'Thermal Use of Shallow Groundwater' and is therefore structured as follows:
- fundamentals (theory of heat transport in the subsurface)
- analytical solutions for closed and open systems
- numerical solutions for shallow geothermal systems
- long-term operability and sustainability
- field methods such as thermal tracer tests and thermal response tests (TRT)
- case studies and applications

Analytical simulations are performed using Excel and Matlab scripted codes. In addition, calibration and validation exercises are performed using existing field and monitoring data. Finally, the students are actively planning an own geothermal system from the application up to the long-term performance of such a system. Hence, a final planning report should be written.

Recommendations
knowledge of programming with Matlab; otherwise, it is strongly recommended to attend the course 'Introduction to Matlab' (6224907)

Workload
contact hours (1 HpW = 1 h x 15 weeks):

- lecture/exercise: 30 h

independent study:

- preparation and follow-up lecture/exercises: 30 h
- examination preparation: 30 h

total: 90 h

M Module: Transport and Transformation of Contaminants in Hydrological Systems (WSEM-PC725) [M-BGU-103369]

Responsibility: Erwin Zehe

Institution: KIT-Fakultät für Bauingenieur-, Geo- und Umweltwissenschaften

Curricular Embedding: Compulsory Elective

Contained in: Profile Studies / Environmental System Dynamics & Management

Credit Points	Recurrence Frequency	Duration	Language	Version
9	Each summer term	1 term	English	1

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-BGU-106683	Term Paper Contaminant Transport (p. 215)	3	Erwin Zehe
T-BGU-106598	Transport and Transformation of Contaminants in Hydrological Systems (p. 218)	6	Erwin Zehe

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
- 'Teilleistung' T-BGU-106683 with not graded accomplishment according to § 4 Par. 3 as examination prerequisite
- 'Teilleistung' T-BGU-106598 with oral examination according to § 4 Par. 2 No. 2
details about the learning controls see at the respective 'Teilleistung'

Grade of the Module
grade of the module is grade of the exam

Prerequisites
none

Qualification Goals
Students are able to explain processes of transport and decomposition related to nutrients and pollutants in surface runoff and in the unsaturated zone of rural catchments.Students are able to independently apply analytical and process-based models: estimation of model parameters from field investigations, estimation of water and substance fluxes and balance in the critical zone, statements on the risks related to contaminant mobilization in natural soils.Students are able to evaluate the limits of applicability of modeling approaches in natural, heterogeneous soils.

Content
Transport processes in the unsaturated zone related to infiltration, surface runoff, and movement of soil water:
- advective-dispersive transport in homogeneous and heterogeneous soils
- particulate transport by erosion
- adsorption
- chemical and microbial processes of reaction and decay in soils
- modeling contaminant transport (e.g. pesticides) in soils using analytical models
- risk assessment for pesticides in soils (transport, residence times, adsorption, decay)
- estimation of model parameters from field exploration
- parameterization of adsorption isotherms
- breakthrough curves

Lab experiments:
- setup of a undisturbed soil column, and conduction of transport experiments

Computer exercise:
- simulation of water and substance transport with process-based models
- independently conducted risk-assessments for pesticides using simple simulation techniques

Recommendations
modules 'Water and Energy Cycles (AF701)' and 'Experimental Hydrology (PC731)'knowledge of programming with Matlab; otherwise, it is strongly recommended to attend the course 'Introduction to Matlab' (6224907)

Remarks
IMPORTANT:

The module will not be offered anymore as from summer term 2019. It will be replaced by the module Subsurface Flow and Contaminant Transport.

Literature
Jury, W. and Horton, R. (2004): Soil physics. John WileyHillel, D. (1995): Environmental Soil Physics. Academic PressFritsche, W. (1998) Umweltmikrobiologie, Grundlagen und Anwendungen. Gustav Fischer Verlag, 248pp.

Workload
contact hours (1 HpW = 1 h x 15 weeks):

- lecture, exercise: 75 h

independent study:

- preparation and follow-up lectures, exercises: 45 h
- preparation of lab-report (examination prerequisite): 90 h
- examination preparation: 60 h

total: 270 h

M Module: Urban Water Infrastructure and Management (WSEM-AF301) [M-BGU-103358]

Responsibility: Stephan Fuchs

Institution: KIT-Fakultät für Bauingenieur-, Geo- und Umweltwissenschaften

Curricular Embedding: Compulsory Elective

Contained in: Advanced Fundamentals

Credit Points	Recurrence Frequency	Duration	Language	Version
6	Each winter term	1 term	English	2

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-BGU-106600	Urban Water Infrastructure and Management (p. 220)	6	Stephan Fuchs

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
- 'Teilleistung' T-BGU-106600 with written examination according to § 4 Par. 2 No. 1
details about the learning control see at the 'Teilleistung'

Grade of the Module
grade of the module is grade of the exam

Prerequisites
none

Qualification Goals
Students analyze and evaluate basic methods of urban water management. They recognize the interactions between natural and technical systems. They acquire knowledge necessary to identify process engineering solutions and to implement them into functional systems (infrastructure elements). Students are able to describe urban water management issues in the context of watersheds and to take appropriate and environmentally-sound decisions in terms of energy efficiency and costs.

Content
This module provides a deep understanding of basic principles needed for the design, analysis and evaluation of urban water systems. The concept of system analysis is introduced to develop models that consider the most important biological, chemical and physical processes and are used to solve water management problems. Based on a detailed consideration of individual elements (subsystems), an overall picture of the water management system Urban Settlement and its interaction with surface and groundwater bodies can be gained. For this purpose, theoretical tools are developed and modeling approaches are reviewed. Students consider the factors energy and costs in the analysis and assessment of water management systems.

Recommendations
basic knowledge in sanitary engineering

Remarks
keine

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

Workload
contact hours (1 HpW = 1 h x 15 weeks):

- lecture/exercise: 60 h

independent study:

- preparation and follow-up lecture/exercises: 60 h
- examination preparation: 60 h

total: 90 h

M Module: Wastewater and Storm Water Treatment (WSEM-PA322) [M-BGU-103362]

Responsibility: Stephan Fuchs, Tobias Morck

Institution: KIT-Fakultät für Bauingenieur-, Geo- und Umweltwissenschaften

Curricular Embedding: Compulsory Elective

Contained in: Profile Studies / Water Technologies & Urban Water Cycle

Credit Points	Recurrence Frequency	Duration	Language	Version
6	Each summer term	1 term	English	1

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-BGU-106601	Wastewater and Storm Water Treatment (p. 221)	6	Stephan Fuchs, Tobias Morck

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
- 'Teilleistung' T-BGU-106601 with examination of other type according to § 4 Par. 2 No. 3
details about the learning control see at the 'Teilleistung'

Grade of the Module
grade of the module is grade of the exam

Prerequisites
none

Qualification Goals
Students get familiar with technical plants for wastewater and storm water treatment. They can explain operating principles of individual system components as well as assess their suitability for specific applications and apply basic dimensioning approaches.

Content
Guided visits, description and evaluation of different water treatment plants:

- storm water sedimentation tanks
- storm water overflow
- retention soil filters
- sewage treatment plants

Dimensioning approaches for the design of storm water treatment facilities.

Recommendations
module 'Urban Water Infrastructure and Management (AF301)'

Remarks
IMPORTANT:

The module will not be offered anymore as from summer term 2019. It will be replaced by the module Wastewater and Storm Water Treatment Facilities.

The number of participants in the course is limited to 20 persons. The registration is to be made via ILIAS. The places are allocated with priority to students from *Water Science and Engineering*, then *Civil Engineering* and *Geoecology* and further study programs. The allocation is made by consideration of the semester and the time of entry of the registration. The attendance at the first meeting is mandatory. In case of absence the place will be assigned to a person on the waiting list.

Literature
Gujer, W. „Siedlungswasserwirtschaft“, Springer, Berlin 3.Aufl., 2007Grigg, N, S „Water, Wastewater, and Stormwater Infrastructure Management“, Second Edition (Englisch) Francis and Taylor 2012

Workload
contact hours (1 HpW = 1 h x 15 weeks):

- lecture/exercise: 60 h

independent study:

- preparation and follow-up lecture/exercises: 30 h
- presentation and preparation of term paper (examination): 90 h

total: 180 h

M Module: Wastewater and Storm Water Treatment Facilities (WSEM-PA322) [M-BGU-104898]

Responsibility: Stephan Fuchs, Tobias Morck

Institution: KIT-Fakultät für Bauingenieur-, Geo- und Umweltwissenschaften

Curricular Embedding: Compulsory Elective

Contained in: Profile Studies / Water Technologies & Urban Water Cycle

Credit Points	Recurrence Frequency	Duration	Language	Version
6	Each summer term	1 term	English	1

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-BGU-109934	Wastewater and Storm Water Treatment Facilities (p. 222)	6	Stephan Fuchs, Tobias Morck

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
- 'Teilleistung' T-BGU-109934 with examination of other type according to § 4 Par. 2 No. 3
details about the learning control see at the 'Teilleistung'

Grade of the Module
grade of the module is grade of the exam

Prerequisites
none

Modeled Conditions
The following conditions must be met:

- The module [M-BGU-103362] *Wastewater and Storm Water Treatment* must not have been started.

Qualification Goals
Students get familiar with technical plants for wastewater and storm water treatment. They can explain operating principles of individual system components as well as assess their suitability for specific applications and apply basic dimensioning approaches.

Content
Guided visits, description and evaluation of different water treatment plants:

- storm water sedimentation tanks
- storm water overflow
- retention soil filters
- sewage treatment plants

Dimensioning approaches for the design of storm water treatment facilities.

Recommendations
module 'Urban Water Infrastructure and Management (AF301)'

Remarks
The module is offered newly as from summer term 2019 and replaces the module Wastewater and Storm Water Treatment.

The number of participants in the course is limited to 20 persons. The registration is to be made via ILIAS. The places are allocated with priority to students from *Water Science and Engineering*, then *Civil Engineering* and *Geoecology* and further study programs. The allocation is made by consideration of the semester and the time of entry of the registration. The attendance at the first meeting is mandatory. In case of absence the place will be assigned to a person on the waiting list.

Literature
Gujer, W. „Siedlungswasserwirtschaft“, Springer, Berlin 3.Aufl., 2007Grigg, N, S „Water, Wastewater, and Stormwater Infrastructure Management“, Second Edition (Englisch) Francis and Taylor 2012

Workload
contact hours (1 HpW = 1 h x 15 weeks):

- lecture/exercise: 60 h

independent study:

- preparation and follow-up lecture/exercises: 30 h
- presentation and preparation of term paper (examination): 90 h

total: 180 h

M Module: Wastewater Treatment Technologies (WSEM-PA321) [M-BGU-104917]

Responsibility: Tobias Morck

Institution: KIT-Fakultät für Bauingenieur-, Geo- und Umweltwissenschaften

Curricular Embedding: Compulsory Elective

Contained in: Profile Studies / Water Technologies & Urban Water Cycle

Credit Points	Recurrence Frequency	Duration	Language	Version
6	Each winter term	1 term	English	1

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-BGU-109265	Term Paper 'International Sanitary Engineering' (p. 216)	1	Stephan Fuchs, Tobias Morck
T-BGU-109948	Wastewater Treatment Technologies (p. 223)	5	Stephan Fuchs, Tobias Morck

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
- 'Teilleistung' T-BGU-109265 with not graded accomplishment according to § 4 Par. 3 as examination prerequisite
- 'Teilleistung' T-BGU-109948 with written examination according to § 4 Par. 2 No. 1
details about the learning controls see at the respective 'Teilleistung'

Grade of the Module
grade of the module is grade of the exam

Prerequisites
none

Modeled Conditions
The following conditions must be met:

- The module [M-BGU-103399] *Process Engineering in Wastewater Treatment* must not have been started.

Qualification Goals
Students acquire knowledge about typical techniques in wastewater treatment at local and international level. They are able to perform a technical evaluation and describe dimensioning approaches taking into consideration legal boundary conditions. Students analyze, evaluate and optimize operation of plant technologies. They focus on energy-efficient plant designs considering the most relevant factors affecting the total costs.Students can analyze the situation in emerging and developing countries making a comparison with that in industrialized countries. Based on that, they are able to develop water-related management strategies.

Content
Municipal Wastewater Treatment:Students gain deep knowledge about design and operation of typical process technologies in municipal wastewater treatment in Germany. Following processes are covered:

- different activated sludge processes
- anaerobic technologies and energy-recovery systems
- filtration technologies
- wastewater disinfection and pathogen removal
- chemical and biological phosphorus removal
- micro-pollutants removal
- resource management and energy efficiency

International Sanitary Engineering:Students get acquainted with the design and operation used for wastewater treatment at international level. They analyze, evaluate and take decisions when new and more holistic oriented met hods can be implemented. Following topics are covered:

- activated sludge processes

- trickling filters and rotating biological contactors
- treatment ponds
- retention soil filter / Wetlands
- UASB/EGSB/Anaerobic filter
- decentralized versus centralized systems
- material flow separation
- energy-recovery from wastewater
- drinking water purification
- waste management

Recommendations
module "Urban Water Infrastructure and Management (AF301)"

Remarks
The module is offered newly as from summer term 2019 and replaces the module Water Treatment Technologies.

Literature
Imhoff, K. u. K.R. (1999) Taschenbuch der Stadtentwässerung, 29. Aufl., Oldenbourg Verlag, München, WienATV-DVWK (1997) Handbuch der Abwassertechnik: Biologische und weitergehende Abwasserreinigung, Band 5, Verlag Ernst & Sohn, BerlinATV-DVWK(1997) Handbuch der Abwassertechnik: Mechanische Abwasserreinigung, Band 6, Verlag Ernst & Sohn , BerlinSperling, M.; Chernicaro, C.A.L. (2005) Biological wastewater treatment in warm climate regions, IWA publishing, LondonWilderer, P.A., Schroeder, E.D. and Kopp, H. (2004) Global Sustainability - The Impact of Local Cultures. A New Perspective for Science and Engineering, Economics and Politics WILEY-VCH

Workload
contact hours (1 HpW = 1 h x 15 weeks):
- Municipal Wastewater Treatment lecture/exercise: 30 h
- International Sanitary Engineering lecture/exercise: 30 h

independent study:
- preparation and follow-up lecture/exercises Municipal Wastewater Treatment: 30 h
- preparation of Term paper 'International Sanitary Engineering' (exam prerequisite): 45 h
- examination preparation: 45 h

total: 180 h

M Module: Water and Energy Cycles (WSEM-AF701) [M-BGU-103360]

Responsibility: Erwin Zehe

Institution: KIT-Fakultät für Bauingenieur-, Geo- und Umweltwissenschaften

Curricular Embedding: Compulsory Elective

Contained in: Advanced Fundamentals

Credit Points	Recurrence Frequency	Duration	Language	Version
6	Each winter term	1 term	English	1

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-BGU-106596	Water and Energy Cycles (p. 224)	6	Erwin Zehe

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
- 'Teilleistung' T-BGU-106596 with oral examination according to § 4 Par. 2 No. 2
details about the learning control see at the 'Teilleistung'

Grade of the Module
grade of the module is grade of the exam

Prerequisites
none

Qualification Goals
Students are able to explain the most relevant processes of the terrestrial water and energy cycles including their feedbacks and limitations. They know the concepts to quantitatively describe and predict these processes in the context of science and water management and are able to independently apply related computer-based tools for analysis and prediction for standard situations.Students are able to evaluate the required data and to quantify and evaluate the uncertainties related to the simulations and predictions.

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

- the soil as the central control element of the water and energy cycle and the interplay of soil water and ground heat balance
- evaporation, energy balance and processes in the atmospheric boundary layer
- runoff and evaporation regimes in different hydro-climates;
- water balance and floods at the catchment scale and statistics for water management
- the interplay between runoff processes and soil water balance, and the soil as filter system
- concepts of hydrological similarity and comparative hydrology
- process-based and conceptual models to predict floods, the water balance and evaporation

Recommendations
knowledge of programming with Matlab; otherwise, it is strongly recommended to attend the course 'Introduction to Matlab (6224907)';knowledge of hydrology and engineering hydrology

Remarks
none

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

Workload
contact hours (1 HpW = 1 h x 15 weeks):

- lecture/exercise: 60 h

independent study:

- preparation and follow-up lecture/exercises, incl. optional homework: 60 h
- examination preparation: 60 h

total: 180 h

M Module: Water Distribution Systems (WSEM-PA621) [M-BGU-104100]

Responsibility: Franz Nestmann

Institution: KIT-Fakultät für Bauingenieur-, Geo- und Umweltwissenschaften

Curricular Embedding: Compulsory Elective

Contained in: Profile Studies / Water Technologies & Urban Water Cycle

Credit Points	Recurrence Frequency	Duration	Language	Version
6	Each winter term	1 term	English	1

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-BGU-108485	Project Report Water Distribution Systems (p. 205)	2	Franz Nestmann
T-BGU-108486	Water Distribution Systems (p. 225)	4	Franz Nestmann

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
- 'Teilleistung' T-BGU-108485 with not graded accomplishment according to § 4 Par. 3 as examination prerequisite
- 'Teilleistung' T-BGU-108486 with oral examination according to § 4 Par. 2 No. 2
details about the learning controls see at the respective 'Teilleistung'

Grade of the Module
grade of the module is grade of the exam

Prerequisites
none

Qualification Goals
Students will have profound knowledge of the components and operational requirements of water supply systems. They are enabled to plan, design and optimize water distribution systems. They are capable to critically analyze concepts and designs based on their knowledge. Participants are able to set up and apply numerical models of water distribution systems for planning and analysis. Students have competences in work organization, presentation and discussion of results.

Content
The module covers the following topics:
- fundamentals of water distribution
- fundamentals of water distribution system modeling
- introduction to the software Epanet (water distribution system model) and ArcGIS (geographic information system)
- water demand
- water losses
- calibrating a water distribution system model
- designing pipe networks, storage tanks and pump stations
- application of the technical standards (DVGW)

The participants apply the theoretical knowledge to analyze and design an exemplary water distribution network.

Recommendations
hydromechanics (specifically pipe hydraulics)

Remarks
This module is offered purely in English as from summer term 2018. It replaces the module M-BGU-103443 Water Distribution Systems (offered in German).

Literature
Mutschmann und Stimmelmayr (2007). Taschenbuch der Wasserversorgung, 14. Auflg., Vieweg.Walski, T. M., Chase, D. V., Savic, D. A., Grayman, W., Beckwith, S. und Koelle, E. (2003). Advanced Water Distribution Modeling Management, Haestad Methods Inc., Waterbury.Schrifttum zur Vorlesung (auf Deutsch und Englisch)

Workload

contact hours (1 HpW = 1 h x 15 weeks):

- lecture/exercise: 60 h

independent study:

- preparation and follow-up lecture/exercises: 30 h
- project work water distribution (exam prerequisite): 60 h
- examination preparation: 30 h

total: 180 h

M Module: Water Ecology (WSEM-CC371) [M-BGU-103361]

Responsibility: Stephan Fuchs

Institution: KIT-Fakultät für Bauingenieur-, Geo- und Umweltwissenschaften

Curricular Embedding: Compulsory Elective

Contained in: Cross-Cutting Methods & Competencies

Credit Points	Recurrence Frequency	Duration	Language	Version
6	Each summer term	1 term	English	1

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-BGU-106602	Water Ecology (p. 226)	6	Stephan Fuchs, Stephan Hilgert
T-BGU-106668	Field Training Water Quality (p. 156)	0	Stephan Fuchs, Stephan Hilgert

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
- 'Teilleistung' T-BGU-106602 with examination of other type according to § 4 Par. 2 No. 3
- 'Teilleistung' T-BGU-106668 with not graded accomplishment according to § 4 Par. 3
details about the learning controls see at the respective 'Teilleistung'

Grade of the Module
grade of the module is grade of the exam

Prerequisites
none

Qualification Goals
Students get familiar with the basic principles of water ecology in surface waters. They are able to explain interactions between abiotic control factors (flow, chemistry, structure) and their relevance for the ecological status of standing waters and streams and to evaluate them critically. They become acquainted with field and laboratory techniques to establish water quality.With the help of these methods, they evaluate data-quality of information collected in the field regarding chemical, biological and structural water quality and determine the level of uncertainty intrinsic to the data-collection methods.Using case studies, students are able to convey and evaluate positive results as well as restrictions from water restoration processes.

Content
As part of the module, water ecology principles, their practical significance and implementation of restoring measures are presented. The following topics are covered:
- pollutants loads discharged into water bodies: discharge points, pollutants, sediment problems
- sampling methods
- oxygen content
- methods for the assessment of water quality and water general status
- practical exercises to measure water quality and condition in the field

Students get acquainted with practical examples of water protection and water remediation measures and they interpret and discuss them as part of an individual assignment. For this purpose, they implement their own framework, based on visible requirements and achievable targets.

Recommendations
none

Remarks
IMPORTANT:

The module will not be offered anymore as from summer term 2019. It will be replaced by the module Freshwater Ecology.

The number of participants in the courses is limited to 20 persons. The registration is to be made via ILIAS. The places are allocated with priority to students from *Water Science and Engineering*, then *Civil Engineering* and *Geoecology* and further study programs. The allocation is made by consideration of the semester and the time of entry of the registration. The attendance at the first meeting is mandatory. In case of absence the place will be assigned to a person on the waiting list.

Literature
Wetzel, Limnology, 3rd Edition, Academic Press 2001Jürgen Schwörbel, Methoden der Hydrobiologie, UTB für Wissenschaft 1999kursbegleitende Materialien

Workload
contact hours (1 HpW = 1 h x 15 weeks):

- Applied Ecology and Water Quality lecture/seminar: 45 h
- Field Training Water Quality (block): 20 h

independent study:

- preparation of the report on Field Training Water Quality (not graded accomplishment): 55 h
- preparation of the seminar paper with presentation (exam): 60 h

total: 180 h

M Module: Water Technology (WSEM-PA221) [M-CIWVT-103407]

Responsibility: Harald Horn

Institution: KIT-Fakultät für Chemieingenieurwesen und Verfahrenstechnik

Curricular Embedding: Compulsory Elective

Contained in: Profile Studies / Water Technologies & Urban Water Cycle

Credit Points	Recurrence Frequency	Duration	Language	Version
6	Each winter term	1 term	English	1

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-CIWVT-106802	Water Technology (p. 227)	6	Harald Horn

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
- 'Teilleistung' T-CIWVT-106802 with oral examination according to § 4 Par. 2 No. 2
details about learning control see at the 'Teilleistung'

Grade of the Module
grade of the module is grade of the exam

Prerequisites
none

Qualification Goals
Students learn fundamental knowledge in water chemistry and how to apply it to processes in aquatic systems in general and in reactors for water treatment. Water treatment will be taught for drinking water and partly waste water. The students are able to apply physical, chemical and biochemical treatment for the respective removal of particulate and dissolved components in water. They are able to use the fundamental design parameters for the different types of unit operations.

Content
Water cycle, different types of raw water (ground and surface water). Water as solvent, carbonate balance, differentiation between microbiological and chemical population. Unit operations: sieving, sedimentation, filtration, flocculation, flotation, ion exchange, aeration, oxidation, disinfection, adsorption). For all unit operations design parameters will be provided. Simple 1D models will be discussed for description of kinetics and retention time in reactors for water treatment.

Recommendations
none

Literature
Crittenden, J.C. et al., 2005. Water treatment – Principles and design. Wiley & Sons, Hoboken.
Jekel, M., Gimbel, R., Ließfeld, R., 2004. DVGW-Handbuch: Wasseraufbereitung – Grundlagen und Verfahren. Oldenbourg, München.
Lecture notes will be provided in ILIAS

Workload
contact hours (1 HpW = 1 h x 15 weeks):
- lecture, exercise: 45 h

independent study:
- preparation and follow-up lectures, exercises: 60 h
- examination preparation: 75 h

total: 180 h

M Module: Waterway Engineering (WSEM-PB655) [M-BGU-103392]

Responsibility: Andreas Kron

Institution: KIT-Fakultät für Bauingenieur-, Geo- und Umweltwissenschaften

Curricular Embedding: Compulsory Elective

Contained in: Profile Studies / Fluid Mechanics & Hydraulic Engineering

Credit Points	Recurrence Frequency	Duration	Language	Version
6	Each summer term	1 term	German	1

Compulsory

Identifier	'Teilleistung'	CP	Responsibility
T-BGU-106779	Seminar Paper 'Waterway Engineering' (p. 212)	1	Andreas Kron
T-BGU-106780	Waterway Engineering (p. 228)	5	Andreas Kron

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
- 'Teilleistung' T-BGU-106779 with not graded accomplishment according to § 4 Par. 3 as examination prerequisite
- 'Teilleistung' T-BGU-106780 with oral examination according to § 4 Par. 2 No. 2
details about the learning controls see at the respective 'Teilleistung'

Grade of the Module
grade of the module is grade of the exam

Prerequisites
none

Qualification Goals
Students are knowledgeable about the various types of navigable waterways and their hydraulic structures. They are able to describe and apply the hydraulic basics for the design of these hydraulic structures and the interaction between ship and waterway. Students can assign the tasks and responsibilities of waterway engineering to the administrative structure of the waterways and shipping.

Content
- inland waterways
- types of navigation locks and ship lifts
- hydraulics and design of navigation locks and ship lifts
- reinforcement of embankments, banks and beds
- interaction ship-waterway

Recommendations
course Hydraulic Engineering and Water Management (6200511)

Remarks
none

Workload
contact hours (1 HpW = 1 h x 15 weeks):
- lecture/exercise: 60 h

independent study:
- preparation and follow-up lectures/exercises: 30 h
- preparation of the seminar paper (exam prerequisite): 30 h
- examination preparation: 60 h

total: 180 h

Part III
'Teilleistungen'

T 'Teilleistung': Advanced Fluid Mechanics [T-BGU-106612]

Responsibility: Olivier Eiff
Contained in: [M-BGU-103359] Advanced Fluid Mechanics

Credit Points	Language	Recurrence Frequency	Type of Learning Control	Version
6	English	Each term	written examination	1

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
SS 2019	6221701	Advanced Fluid Mechanics	Vorlesung / Übung (VÜ)	4	Olivier Eiff

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
written exam, 90 min.

Prerequisites
none

Recommendations
none

Remarks
none

T 'Teilleistung': Analysis of Turbulent Flows [T-BGU-103561]

Responsibility: Markus Uhlmann
Contained in: [M-BGU-103363] Analysis of Turbulent Flows

Credit Points	Language	Recurrence Frequency	Type of Learning Control	Version
6	English	Each term	oral examination	1

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
WS 18/19	6221911	Modelling of Turbulent Flows - RANS and LES	Vorlesung (V)	2	Markus Uhlmann
SS 2019	6221806	Fluid Mechanics of Turbulent Flows	Vorlesung (V)	2	Markus Uhlmann

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
oral exam, appr. 45 min.

Prerequisites
none

Recommendations
none

Remarks
none

T 'Teilleistung': Applied Ecology and Water Quality [T-BGU-109956]

Responsibility: Stephan Fuchs, Stephan Hilgert
Contained in: [M-BGU-104922] Freshwater Ecology

Credit Points	Language	Recurrence Frequency	Type of Learning Control	Version
3	English	Each summer term	examination of other type	1

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
SS 2019	6223813	Applied Ecology and Water Quality	Seminar (S)	3	Stephan Fuchs, Stephan Hilgert

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
term paper, appr. 8-15 pages, and
presentation, appr. 15 min.

Prerequisites
none

Recommendations
none

Remarks
The number of participants in the course is limited to 20 persons. The registration is to be made via ILIAS. The places are allocated with priority to students from *Water Science and Engineering*, then *Civil Engineering* and *Geoecology* and further study programs. The allocation is made by consideration of the semester and the time of entry of the registration. The attendance at the first meeting is mandatory. In case of absence the place will be assigned to a person on the waiting list.

T 'Teilleistung': Aquatic Ecosystems [T-BGU-106789]

Responsibility: Charlotte Kämpf
Contained in: [M-BGU-103400] Aquatic Ecosystems

Credit Points	Recurrence Frequency	Type of Learning Control	Version
6	Each winter term	examination of other type	1

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
WS 18/19	6224903		Seminar (S)	4	Charlotte Kämpf

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
about a topic selected by oneself:
presentation, appr. 15-20 min.,
maunscript, appr. 4000 words, and
poster DIN A1

Prerequisites
The accomplishment 'Examination Prerequisite Aquatic Ecosystems' (T-BGU-106788) has to be passed.

Modeled Conditions
The following conditions must be met:

- The course [T-BGU-106788] *Examination Prerequisite Aquatic Ecosystems* must have been passed.

Recommendations
none

Remarks
none

T 'Teilleistung': Biofilm Systems [T-CIWVT-106841]

Responsibility: Harald Horn
Contained in: [M-CIWVT-103441] Biofilm Systems

Credit Points	Language	Recurrence Frequency	Type of Learning Control	Version
4	English	Each summer term	oral examination	1

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
SS 2019	22617	Biofilm Systems	Vorlesung (V)	2	Johannes Gescher, Andrea Hille-Reichel, Harald Horn, Michael Wagner

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
oral exam, appr. 20 min.

Prerequisites
none

Recommendations
none

Remarks
none

T 'Teilleistung': Booklet Integrated Infrastructure Planning [T-BGU-106763]

Responsibility: Charlotte Kämpf
Contained in: [M-BGU-103380] Integrated Infrastructure Planning

Credit Points	Recurrence Frequency	Type of Learning Control	Version
0	Each winter term	not graded accomplishment	1

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
WS 18/19	6224910		Vorlesung / Übung (VÜ)		Charlotte Kämpf, Rainer Walz

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
booklet; DIN A5, appr. 15 pages

Prerequisites
none

Recommendations
none

Remarks
none

T 'Teilleistung': Brownfield Sites - Investigation, Evaluation, Rehabilitation [T-BGU-100089]

Responsibility: Andreas Bieberstein
Contained in: [M-BGU-100079] Environmental Geotechnics

Credit Points	Language	Recurrence Frequency	Type of Learning Control	Version
3	German	Each winter term	oral examination	1

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
WS 18/19	6251915	Brownfield Sites - Investigation, Evaluation, Rehabilitation	Vorlesung (V)	2	Andreas Bieberstein, Elisabeth Eiche, Ulf Mohrlok, Hilke Würdemann

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
oral exam, appr. 20 min.

Prerequisites
none

Recommendations
none

Remarks
none

V Course Excerpt: Brownfield Sites - Investigation, Evaluation, Rehabilitation (WS 18/19)

Aim
The students are able to interlink interdisciplinary the chemical, mineralogical, biological, hydraulic and geotechnical aspects dealing with brownfields. They can choose reasonably between the relevant remediation technologies and assess their limits of applications and risks.

Content
- 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
- sustainability aspects for brownfield rehabilitation
- case-studies, excursion

Literature
Reiersloh, D und Reinhard, M. (2010): Altlastenratgeber für die Praxis, Vulkan-V. Essen

T 'Teilleistung': Data Analysis and Environmental Monitoring [T-BGU-106761]

Responsibility: Erwin Zehe
Contained in: [M-BGU-103378] Data Analysis and Environmental Monitoring

Credit Points	Language	Recurrence Frequency	Type of Learning Control	Version
9	English	Each term	oral examination	1

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
WS 18/19	6224908	Introduction to Data Analysis, Machine Learning and Information Theory	Vorlesung / Übung (VÜ)	2	Uwe Ehret
SS 2019	6224805	Geostatistics	Vorlesung / Übung (VÜ)	4	Uwe Ehret, Erwin Zehe

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
oral exam, appr. 30 min.

Prerequisites
none

Recommendations
none

Remarks
none

V Course Excerpt: Introduction to Data Analysis, Machine Learning and Information Theory (WS 18/19)

Aim
The students can explain and apply methods for analysis and simulation of spatially and temporally distributed environmental data.

Based on this they are capable of evaluating the suitability of available data and analysis methods for different tasks.

The students are able to critically assess the results of analysis and simulation tools and to quantify and evaluate the related uncertainties.

T 'Teilleistung': Earthwork and Embankment Dams [T-BGU-106792]

Responsibility: Andreas Bieberstein
Contained in: [M-BGU-103402] Earthwork and Embankment Dams

Credit Points	Language	Recurrence Frequency	Type of Learning Control	Version
6	German	Each winter term	oral examination	1

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
WS 18/19	6251703	Basics in Earthworks and Embankment Dams	Vorlesung / Übung (VÜ)	2	Andreas Bieberstein
SS 2019	6251816	Embankment Dams (Advanced)	Vorlesung / Übung (VÜ)	2	Andreas Bieberstein

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
oral exam, appr. 40 min.

Prerequisites
none

Recommendations
none

Remarks
none

V Course Excerpt: Basics in Earthworks and Embankment Dams (WS 18/19)

Aim
The students are able to select and apply appropriate methods for exploration, modelling, dimensioning, realization and control for earthworks and dam construction. They can identify all geotechnically relevant problems occuring with dams and can apply design and dimensioning rules in outline self-reliantly.

Content
- 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

Literature
Striegler (1998), Dammbau in Theorie und Praxis, Verlag für Bauwesen Berlin
Kutzner (1996), Erd- und Steinschüttdämme für Stauanlagen, Enke Verlag Stuttgart

V Course Excerpt: Embankment Dams (Advanced) (SS 2019)

Aim
The students are able to develop their own solution approaches for earth dam design problems, to evaluate the relevant construction techniques and to conduct the requested geotechnical proofs.

Content

- hydrologic and hydraulic design of dams
- regulations for dams and embankments
- design of freeboard
- slope stability concepts
- proof of sliding stability
- uplift stability
- stress distribution in the dam base
- spread stability
- settlements
- hydraulic stability
- seepage and flow nets
- determination of the phreatic line
- erosion criteria, methods to prove inner erosion stability
- filters and drains
- subsoil sealing
- deformation of embankments
- safety against flaws
- earthquake design
- monitoring of dams
- buried auxiliary structures
- artificial sealings
- dams and embankments designed for overtopping

Literature

Cedergren, H.R. (1989), Seepage, Drainage, and Flow Nets, 3. Aufl. Wiley
Herdt, W. & Arndts, E. (1985), Theorie und Praxis der Grundwasserabsenkung, 2. Aufl. Ernst & S.

T 'Teilleistung': Ecosystem Management [T-BGU-106778]

Responsibility: Christian Damm, Florian Wittmann
Contained in: [M-BGU-103391] Sustainable Management of rivers and Floodplains

Credit Points	Recurrence Frequency	Type of Learning Control	Version
3	Each summer term	examination of other type	1

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
SS 2019	6111234		Seminar (S)	2	Christian Damm

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
presentation, appr. 20-30 min.

Prerequisites
none

Recommendations
none

Remarks
none

T 'Teilleistung': Environmental Biotechnology [T-CIWVT-106835]

Responsibility: Andreas Tiehm
Contained in: [M-CIWVT-103436] Applied Microbiology

Credit Points	Recurrence Frequency	Type of Learning Control	Version
4	Each winter term	oral examination	1

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
WS 18/19	22614	Environmental Biotechnology	Vorlesung (V)	2	Andreas Tiehm

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
oral exam, ca. 30 min.

Prerequisites
none

Recommendations
none

Remarks
none

T 'Teilleistung': Environmental Communication [T-BGU-101676]

Responsibility: Charlotte Kämpf
Contained in: [M-BGU-101108] Environmental Communication

Credit Points	Language	Recurrence Frequency	Type of Learning Control	Version
6	German	Each term	examination of other type	2

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
WS 18/19	6224905		Seminar (S)	2	Charlotte Kämpf
SS 2019	6224905	Environmental Communication	Seminar (S)	2	Charlotte Kämpf

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
presentation, appr. 15 min.,
manuscript, appr. 6000 words, and
Poster DIN-A3

Prerequisites
The accomplishment 'Examination Prerequisite Environmental Communication' (T-BGU-106620) has to be passend.

Modeled Conditions
The following conditions must be met:

- The course [T-BGU-106620] *Examination Prerequisite Environmental Communication* must have been passed.

Recommendations
none

Remarks
none

T 'Teilleistung': Environmental Fluid Mechanics [T-BGU-106767]

Responsibility: Olivier Eiff
Contained in: [M-BGU-103383] Environmental Fluid Mechanics

Credit Points	Language	Recurrence Frequency	Type of Learning Control	Version
6	English	Each winter term	written examination	1

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
WS 18/19	6221909	Environmental Fluid Mechanics	Vorlesung / Übung (VÜ)	4	Olivier Eiff

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
written exam, 90 min.

Prerequisites
none

Recommendations
none

Remarks
none

T 'Teilleistung': Examination on Meteorological Hazards [T-PHYS-109979]

Responsibility: Michael Kunz
Contained in: [M-PHYS-103386] Meteorological Hazards and Climate Change

Credit Points	Recurrence Frequency	Type of Learning Control	Version
3	Each summer term	oral examination	1

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
oral exam, 30 min.

Prerequisites
The accomplishment 'Meteorological Hazards' (T-PHYS-101557) has to be passed.
[attendance as examination prerequisite ?]

Recommendations
none

Remarks
none

Replaces
T-PHYS-105954

T 'Teilleistung': Examination on Seminar IPCC Assessment Report [T-PHYS-107713]

Responsibility: Joaquim José Ginete Werner Pinto, Corinna Hoose
Contained in: [M-PHYS-103386] Meteorological Hazards and Climate Change

Credit Points	Language	Recurrence Frequency	Type of Learning Control	Version
3	English	Each winter term	examination of other type	2

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
WS 18/19	4052194	Seminar on IPCC Assessment Report	Hauptseminar (HS)	2	Joaquim José Ginete Werner Pinto, Patrick Ludwig

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
presentation of a chapter of the current IPCC report, appr. 20-25 min., with subsequent discussion and submission of a written summary, appr. 1 page

Prerequisites
none

Recommendations
none

Remarks
none

T 'Teilleistung': Examination on Turbulent Diffusion [T-PHYS-109981]

Responsibility: Bernhard Vogel
Contained in: [M-PHYS-103387] Applied Meteorology: Turbulent Diffusion

Credit Points	Language	Recurrence Frequency	Type of Learning Control	Version
6	English	Each summer term	oral examination	1

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
SS 2019	4052081	Turbulent Diffusion	Vorlesung (V)	2	Bernhard Vogel, Heike Vogel
SS 2019	4052082	Exercises to Turbulent Diffusion	Übung (Ü)	1	Lukas Muser, Bernhard Vogel, Heike Vogel

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
oral exam, appr. 30 min.

Prerequisites
The accomplishment 'Turbulent Diffusion' (T-PHYS-101558) has to be passed.

Recommendations
none

Remarks
none

T 'Teilleistung': Examination Prerequisite Aquatic Ecosystems [T-BGU-106788]

Responsibility: Charlotte Kämpf
Contained in: [M-BGU-103400] Aquatic Ecosystems

Credit Points	Recurrence Frequency	Type of Learning Control	Version
0	Each winter term	not graded accomplishment	1

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
WS 18/19	6224903		Seminar (S)	4	Charlotte Kämpf

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
literature annotation, appr. 150 words, and
short presentation, appr. 10 min.

Prerequisites
none

Recommendations
none

Remarks
none

T 'Teilleistung': Examination Prerequisite Environmental Communication [T-BGU-106620]

Responsibility: Charlotte Kämpf
Contained in: [M-BGU-101108] Environmental Communication

Credit Points	Language	Recurrence Frequency	Type of Learning Control	Version
0	German	Each summer term	not graded accomplishment	1

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
WS 18/19	6224905		Seminar (S)	2	Charlotte Kämpf
SS 2019	6224905	Environmental Communication	Seminar (S)	2	Charlotte Kämpf

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
2 literature annotations, appr. 150 words each, and
short presentation, appr. 10 min.

Prerequisites
none

Recommendations
none

Remarks
none

T 'Teilleistung': Excursions: Waste Water Disposal and Drinking Water Supply [T-CIWVT-106820]

Responsibility: Gudrun Abbt-Braun
Contained in: [M-CIWVT-103413] Membrane Technologies and Excursions

Credit Points	Recurrence Frequency	Type of Learning Control	Version
0	Each summer term	not graded accomplishment	1

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
SS 2019	22609	Waste Water Disposal and Drinking Water Supply - Introduction and Excursions	Block (B)	1	Gudrun Abbt-Braun, Harald Horn

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
attendance at excursions

Prerequisites
none

Recommendations
none

Remarks
none

T 'Teilleistung': Experimental Hydraulics II [T-BGU-106773]

Responsibility: Frank Seidel
Contained in: [M-BGU-103388] Experimental Hydraulics and Measuring Techniques

Credit Points	Language	Recurrence Frequency	Type of Learning Control	Version
3	German	Each winter term	examination of other type	1

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
WS 18/19	6222907	Experimental Hydraulics II	Vorlesung / Übung (VÜ)	2	Franz Nestmann, Frank Seidel

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
term paper, appr. 10 pages

Prerequisites
none

Recommendations
none

Remarks
none

T 'Teilleistung': Experiments in Fluid Mechanics [T-BGU-106760]

Responsibility: Olivier Eiff
Contained in: [M-BGU-103377] Experiments in Fluid Mechanics

Credit Points	Language	Recurrence Frequency	Type of Learning Control	Version
6	English	Each summer term	examination of other type	2

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
SS 2019	6221802	Experiments in Fluid Mechanics	Vorlesung / Übung (VÜ)	4	Olivier Eiff, Mitarbeiter/innen

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
laboratory reports with analyses of the experiments in small teams, each appr. 10 pages including figures and tables, and oral exam, appr. 30 min.

Prerequisites
none

Recommendations
none

Remarks
none

T 'Teilleistung': Field Training Water Quality [T-BGU-109957]

Responsibility: Stephan Fuchs, Stephan Hilgert
Contained in: [M-BGU-104922] Freshwater Ecology

Credit Points	Language	Recurrence Frequency	Type of Learning Control	Version
3	English	Each summer term	examination of other type	1

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
SS 2019	6223814	Field Training Water Quality	Übung (Ü)	1	Stephan Fuchs, Stephan Hilgert

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
report on field training, appr. 8-15 pages

Prerequisites
The 'Teilleistung' Appplied Ecology and Water Quality (T-BGU-109956, seminar paper with presentation) has to be begun, i.e. at least the registration has to be made.

Modeled Conditions
The following conditions must be met:

- The course [T-BGU-109956] *Applied Ecology and Water Quality* must have been started.

Recommendations
none

Remarks
The number of participants in the course is limited to 20 persons. The registration is to be made via ILIAS. The places are allocated with priority to students from *Water Science and Engineering*, then *Civil Engineering* and *Geoecology* and further study programs. The allocation is made by consideration of the semester and the time of entry of the registration. The attendance at the first meeting is mandatory. In case of absence the place will be assigned to a person on the waiting list.

T 'Teilleistung': Field Training Water Quality [T-BGU-106668]

Responsibility: Stephan Fuchs, Stephan Hilgert
Contained in: [M-BGU-103361] Water Ecology

Credit Points	Language	Recurrence Frequency	Type of Learning Control	Version
0	English	Each summer term	not graded accomplishment	1

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
SS 2019	6223814	Field Training Water Quality	Übung (Ü)	1	Stephan Fuchs, Stephan Hilgert

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
report on field training, appr. 8-15 pages

Prerequisites
The 'Teilleistung' Water Ecology (T-BGU-106602, seminar paper with presentation) has to be begun, i.e. at least the registration has to be made.

Modeled Conditions
The following conditions must be met:

- The course [T-BGU-106602] *Water Ecology* must have been started.

Recommendations
none

Remarks
The number of participants in the course is limited to 20 persons. The registration is to be made via ILIAS. The places are allocated with priority to students from *Water Science and Engineering*, then *Civil Engineering* and *Geoecology* and further study programs. The allocation is made by consideration of the semester and the time of entry of the registration. The attendance at the first meeting is mandatory. In case of absence the place will be assigned to a person on the waiting list.

T 'Teilleistung': Flow and Sediment Dynamics in Rivers [T-BGU-108467]

Responsibility: Franz Nestmann
Contained in: [M-BGU-104083] Flow and Sediment Dynamics in Rivers

Credit Points	Language	Recurrence Frequency	Type of Learning Control	Version
4	English	Each term	oral examination	2

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
SS 2019	6222805	Morphodynamics	Vorlesung / Übung (VÜ)	2	Franz Nestmann
SS 2019	6222807	Flow Behavior of Rivers	Vorlesung / Übung (VÜ)	2	Victor Dupuis, Olivier Eiff, Frank Seidel

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
oral exam, appr. 30 min.

Prerequisites
The accomplishment 'Seminar Paper Flow Behavior of Rivers' (T-BGU-108466) has to be passed.

Modeled Conditions
The following conditions must be met:

- The course [T-BGU-108466] *Seminar Paper 'Flow Behavior of Rivers'* must have been passed.

Recommendations
none

Remarks
none

T 'Teilleistung': Flow Measuring Technique [T-BGU-103562]

Responsibility: Christof-Bernhard Gromke
Contained in: [M-BGU-103388] Experimental Hydraulics and Measuring Techniques

Credit Points	Language	Recurrence Frequency	Type of Learning Control	Version
3	German	Each term	oral examination	1

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
WS 18/19	6221907		Vorlesung / Übung (VÜ)	2	Bodo Ruck

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
oral exam, appr. 30 min.

Prerequisites
none

Recommendations
none

Remarks
none

T 'Teilleistung': Fundamentals of Numerical Algorithms for Engineers [T-BGU-109953]

Responsibility: Markus Uhlmann
Contained in: [M-BGU-104920] Fundamentals of Numerical Algorithms for Engineers

Credit Points	Language	Recurrence Frequency	Type of Learning Control	Version
3	English	Each term	written examination	1

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
written exam, 60 min.

Prerequisites
none

Recommendations
none

Remarks
none

T 'Teilleistung': Fundamentals of Water Quality [T-CIWVT-106838]

Responsibility: Gudrun Abbt-Braun
Contained in: [M-CIWVT-103438] Fundamentals of Water Quality

Credit Points	Recurrence Frequency	Type of Learning Control	Version
6	Each winter term	written examination	1

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
WS 18/19	22625	Fundamentals of Water Quality	Lecture (L)	2	Gudrun Abbt-Braun
WS 18/19	22626	Fundamentals of Water Quality - Exercises	Exercise (E)	1	Gudrun Abbt-Braun, Mitarbeiter/innen

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
written exam, 90 min.

Prerequisites
none

Recommendations
none

Remarks
none

T 'Teilleistung': General Meteorology [T-PHYS-101091]

Responsibility: Christoph Kottmeier, Michael Kunz
Contained in: [M-PHYS-103732] General Meteorology

Credit Points	Language	Recurrence Frequency	Type of Learning Control	Version
6	German	Each winter term	not graded accomplishment	1

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
WS 18/19	4051011		Vorlesung (V)	3	Christoph Kottmeier
WS 18/19	4051012		Übung (Ü)	2	Katharina Maurer, NN

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
presenting one exercise and
test (not graded)

Prerequisites
none

Recommendations
none

Remarks
none

T 'Teilleistung': Geo Data Infrastructures and Web Services [T-BGU-101756]

Responsibility: Stefan Hinz
Contained in: [M-BGU-101044] Geodata Infrastructures and Web-Services

Credit Points	Language	Recurrence Frequency	Type of Learning Control	Version
1	German	Each summer term	oral examination	1

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
SS 2019	6026204		Vorlesung (V)	1	Sven Wursthorn

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
oral exam, appr. 20 min.

Prerequisites
The accomplishment 'Geodata Infrastructures and Web-Services, Prerequisite' (T-BGU-101757) has to be passed

Modeled Conditions
The following conditions must be met:

- The course [T-BGU-101757] *Geodata Infrastructures and Web-Services, Prerequisite* must have been passed.

Recommendations
none

Remarks
none

T 'Teilleistung': Geodata Infrastructures and Web-Services, Prerequisite [T-BGU-101757]

Responsibility: Stefan Hinz
Contained in: [M-BGU-101044] Geodata Infrastructures and Web-Services

Credit Points	Language	Recurrence Frequency	Type of Learning Control	Version
3	German	Each summer term	not graded accomplishment	1

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
SS 2019	6026204		Vorlesung (V)	1	Sven Wursthorn

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
working on exercises

Prerequisites
none

Recommendations
none

Remarks
none

T 'Teilleistung': Geostatistics [T-BGU-106605]

Responsibility: Erwin Zehe
Contained in: [M-BGU-103762] Analysis of Spatial Data

Credit Points	Language	Recurrence Frequency	Type of Learning Control	Version
6	English	Each term	oral examination	1

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
SS 2019	6224805	Geostatistics	Vorlesung / Übung (VÜ)	4	Uwe Ehret, Erwin Zehe

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
oral exam, appr. 30 min.

Prerequisites
none

Recommendations
none

Remarks
none

T 'Teilleistung': Groundwater Flow around Structures [T-BGU-106774]

Responsibility: Luca Trevisan
Contained in: [M-BGU-103389] Hydraulic Structures

Credit Points	Language	Recurrence Frequency	Type of Learning Control	Version
3	English	Each term	oral examination	1

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
SS 2019	6221815	Groundwater Flow around Structures	Vorlesung / Übung (VÜ)	2	Luca Trevisan

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
oral exam, appr. 30 min.

Prerequisites
none

Recommendations
none

Remarks
none

V Course Excerpt: Groundwater Flow around Structures (SS 2019)

Content
The course will cover topics related to groundwater hydrology and geotechnical engineering:

- Properties of porous medium
- Groundwater movement
- Potential theory and flow nets
- Subsurface characterization
- Soil strength and stress balance
- Water-induced instabilities

Some applications related to the topics taught during the course include:

- Water level abatement for dry excavations
- Relationship between groundwater extraction and ground subsidence
- Interaction between groundwater and linear structures (tunnels, drains)
- Interaction between groundwater and hydraulic structures (dams)

T 'Teilleistung': Groundwater Hydraulics [T-BGU-100624]

Responsibility: Ulf Mohrlok
Contained in: [M-BGU-100340] Groundwater Management

Credit Points	Language	Recurrence Frequency	Type of Learning Control	Version
3	English	Each term	oral examination	1

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
SS 2019	6221801	Groundwater Hydraulics	Vorlesung (V)	2	Ulf Mohrlok

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
oral exam, appr. 20 min.

Prerequisites
none

Recommendations
none

Remarks
none

V Course Excerpt: Groundwater Hydraulics (SS 2019)

Aim
The participants can describe the hydrogeologic situations in groundwater systems. They are able to calculate groundwater level and fluxes for simple flow processes depending on the boundary conditions using analytical methods. They can also describe the transport processes of solutes and calculte concentrations and mass fluxes respectively. They are able to apply these balance approaches in management scenarios for quantity and quality of groundwater resources.

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

Literature
Bear, J. (1979). Hydraulics of Groundwater. McGraw Hill.
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.
Mohrlok, U. (2009). Bilanzmodelle in der Grundwasserhydraulik: quantitative Beschreibung von Strömung und Transport im Untergrund. Karlsruhe, Universitätsverlag. (in German)
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.

T 'Teilleistung': Homework 'Introduction to Environmental Data Analysis and Statistical Learning' [T-BGU-109950]

Responsibility: Uwe Ehret
Contained in: [M-BGU-104880] Introduction to Environmental Data Analysis and Statistical Learning

Credit Points	Language	Recurrence Frequency	Type of Learning Control	Version
2	English	Each winter term	not graded accomplishment	1

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
course associated assignments, short reports appr. 1 page each

Prerequisites
none

Recommendations
none

Remarks
none

T 'Teilleistung': Hydraulic Engineering [T-BGU-106759]

Responsibility: Franz Nestmann
Contained in: [M-BGU-103376] Hydraulic Engineering

Credit Points	Language	Recurrence Frequency	Type of Learning Control	Version
6	English	Each term	written examination	1

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
SS 2019	6222701	Multiphase Flow in Hydraulic Engineering	Vorlesung / Übung (VÜ)	2	Franz Nestmann
SS 2019	6222703	Design of Hydraulic Structures	Vorlesung / Übung (VÜ)	2	Franz Nestmann

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
written exam, 75 min.

Prerequisites
none

Recommendations
none

Remarks
none

T 'Teilleistung': Hydro Power Engineering [T-BGU-100139]

Responsibility: Peter Oberle
Contained in: [M-BGU-100103] Hydro Power Engineering

Credit Points	Language	Recurrence Frequency	Type of Learning Control	Version
6	German	Each term	oral examination	1

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
SS 2019	6222801	Hydro Power Engineering	Vorlesung / Übung (VÜ)	4	Peter Oberle

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
oral exam, appr. 20 min.

Prerequisites
none

Recommendations
none

Remarks
none

V Course Excerpt: Hydro Power Engineering (SS 2019)

Aim
Students are able to describe the different turbine types and can define selection criteria for their usage. They are able to reproduce the basic approach in the planning and design of hydropower plants and to make own calculations to select turbines. They can select and apply the necessary tolls in a methodical matter.
Students are able to discuss the current political conditions in terms of energy policy with other students and support their personal opinion on these issues with technical arguments.

Content
- political frame conditions (EEG)
- Environmental requirements
- Turbine technology and electrical aspects
- Constructive characteristics of hydro power plats
- Development and design of hydro power plants
- Lecture accompanying excursions and projekt examples

Workload
Attendance time: 60h
Preparation/follow-up: 60h
Examination + exam preparation: 60h

Literature
Mosonyi E., 2009, Water Power Development,

T 'Teilleistung': Hydrogeology [T-BGU-106801]

Responsibility: Nico Goldscheider
Contained in: [M-BGU-103406] Hydrogeology

Credit Points	Recurrence Frequency	Type of Learning Control	Version
6	Each term	written examination	1

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
SS 2019	6310415		Vorlesung / Übung (VÜ)	1	Nadine Göppert, Tanja Liesch

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
written exam, 90 min.

Prerequisites
none

Recommendations
none

Remarks
none

T 'Teilleistung': Hydrogeology: Field and Laboratory Methods [T-BGU-104834]

Responsibility: Nadine Göppert
Contained in: [M-BGU-102441] Hydrogeology: Field and Laboratory Methods

Credit Points	Recurrence Frequency	Type of Learning Control	Version
6	Each summer term	examination of other type	1

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
SS 2019	6310412		Übung (Ü)	2	Nadine Göppert, Tanja Liesch
SS 2019	6310414		Seminar (S)	1	Nadine Göppert, Tanja Liesch

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
presentation within the "Preparatory Seminar" and
term paper on the results of the "Field and Laboratory Exercises"

Prerequisites
none

Recommendations
none

Remarks
none

T 'Teilleistung': Hydrogeology: Groundwater modelling [T-BGU-104757]

Responsibility: Tanja Liesch
Contained in: [M-BGU-102439] Hydrogeology: Groundwater Modelling

Credit Points	Recurrence Frequency	Type of Learning Control	Version
6	Each winter term	examination of other type	1

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
WS 18/19	6339113		Vorlesung (V)	2	Tanja Liesch, Wolfgang Schäfer
WS 18/19	6339114		Übung (Ü)	2	Tanja Liesch, Wolfgang Schäfer

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
report and
presentation

Prerequisites
none

Recommendations
none

Remarks
none

T 'Teilleistung': Hydrogeology: Karst and Isotpes [T-BGU-104758]

Responsibility: Nico Goldscheider
Contained in: [M-BGU-102440] Hydrogeology: Karst and Isotopes

Credit Points	Recurrence Frequency	Type of Learning Control	Version
6	Each term	written examination	1

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
WS 18/19	6339076		Vorlesung / Übung (VÜ)	2	Nico Goldscheider
SS 2019	6339078		Übung (Ü)	1	Nico Goldscheider

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
written exam, 90 min.

Prerequisites
none

Recommendations
none

Remarks
none

T 'Teilleistung': Hydrological Measurements in Environmental Systems [T-BGU-106599]

Responsibility: Jan Wienhöfer
Contained in: [M-BGU-103371] Experimental Hydrology
[M-BGU-103763] Hydrological Measurements in Environmental Systems

Credit Points	Language	Recurrence Frequency	Type of Learning Control	Version
6	English	Each summer term	examination of other type	1

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
SS 2019	6224807	Hydrological Measurements in Environmental Systems	Praktische Übung (PÜ)	4	Uwe Ehret, Jan Wienhöfer

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
The examination consists of four parts:

1. active participation in the seminar (presentation ~ 20 mins)
2. active participation in field and lab work
3. documentation of the field experiments (report ~ 10 pages)
4. analysis of field data (presentation ~ 20 mins and report ~10 pages)

Each part is graded with points, and the overall grade is determined by the number of points obtained.
Passing the exam requires at least 1 point in each of the four parts, and in total the minimum number of points.

Prerequisites
none

Recommendations
none

Remarks
none

T 'Teilleistung': Industrial Water Management [T-BGU-108448]

Responsibility: Tobias Morck
Contained in: [M-BGU-104073] Industrial Water Management

Credit Points	Language	Recurrence Frequency	Type of Learning Control	Version
5	English	Each term	oral examination	2

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
WS 18/19	6223903		Vorlesung / Übung (VÜ)	2	Tobias Morck
SS 2019	6223810	Industrial Water Management	Vorlesung / Übung (VÜ)	4	Tobias Morck

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
oral exam, appr. 30 min.

Prerequisites
Lab report 'Industrial Water Management' has to bve passed.

Modeled Conditions
The following conditions must be met:

- The course [T-BGU-109980] *Lab report 'Industrial Water Management'* must have been passed.

Recommendations
none

Remarks
none

T 'Teilleistung': Instrumental Analysis [T-CIWVT-106837]

Responsibility: Gisela Guthausen
Contained in: [M-CIWVT-103437] Instrumental Analysis

Credit Points	Language	Recurrence Frequency	Type of Learning Control	Version
4	English	Each summer term	oral examination	2

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
SS 2019	22942	Instrumental Analyses	Vorlesung (V)	2	Gisela Guthausen

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
oral exam, 30 min.

Prerequisites
The accomplishment 'Organic Trace Analysis of Aqueous Samples' (T-CIWVT-106836) has to be passed.

Modeled Conditions
The following conditions must be met:

- The course [T-CIWVT-106836] *Organic Trace Analysis of Aqueous Samples* must have been passed.

Recommendations
none

Remarks
none

T 'Teilleistung': Integrated Infrastructure Planning [T-BGU-106764]

Responsibility: Charlotte Kämpf
Contained in: [M-BGU-103380] Integrated Infrastructure Planning

Credit Points	Recurrence Frequency	Type of Learning Control	Version
6	Each winter term	written examination	1

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
WS 18/19	6224910		Vorlesung / Übung (VÜ)		Charlotte Kämpf, Rainer Walz

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
written exam, 60 min.

Prerequisites
The accomplishment 'Booklet Integrated Infrastructure Planning' (T-BGU-106763) has to be passed.

Modeled Conditions
The following conditions must be met:

- The course [T-BGU-106763] *Booklet Integrated Infrastructure Planning* must have been passed.

Recommendations
none

Remarks
none

T 'Teilleistung': Interaction Flow – Hydraulic Structures [T-BGU-106775]

Responsibility: Michael Gebhardt
Contained in: [M-BGU-103389] Hydraulic Structures

Credit Points	Language	Recurrence Frequency	Type of Learning Control	Version
3	German	Each term	oral examination	1

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
WS 18/19	6221903		Vorlesung / Übung (VÜ)	2	Michael Gebhardt

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
oral exam, appr. 30 min.

Prerequisites
none

Recommendations
none

Remarks
none

T 'Teilleistung': Introduction to Environmental Data Analysis and Statistical Learning [T-BGU-109949]

Responsibility: Uwe Ehret
Contained in: [M-BGU-104880] Introduction to Environmental Data Analysis and Statistical Learning

Credit Points	Language	Recurrence Frequency	Type of Learning Control	Version
4	English	Each term	written examination	1

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
written exam, 60 min.

Prerequisites
The accomplishment Homework 'Introduction to Environmental Data Analysis and Statistical Learning' (T-BGU-109265) has to be passend.

Modeled Conditions
The following conditions must be met:

- The course [T-BGU-109950] *Homework 'Introduction to Environmental Data Analysis and Statistical Learning'* must have been passed.

Recommendations
none

Remarks
none

T 'Teilleistung': Introduction to GIS for Students of Natural, Engineering and Geo Sciences [T-BGU-103541]

Responsibility: Norbert Rösch, Sven Wursthorn
Contained in: [M-BGU-101846] Introduction to GIS for Students of Natural, Engineering and Geo Sciences

Credit Points	Recurrence Frequency	Type of Learning Control	Version
3	Each winter term	not graded accomplishment	1

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
WS 18/19	6071101		Vorlesung / Übung (VÜ)	4	Norbert Rösch, Sven Wursthorn

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
online test

Prerequisites
none

Recommendations
none

Remarks
none

T 'Teilleistung': Introduction to GIS for Students of Natural, Engineering and Geo Sciences [T-BGU-101681]

Responsibility: Norbert Rösch, Sven Wursthorn
Contained in: [M-BGU-101846] Introduction to GIS for Students of Natural, Engineering and Geo Sciences

Credit Points	Recurrence Frequency	Type of Learning Control	Version
3	Each winter term	written examination	1

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
WS 18/19	6071101		Vorlesung / Übung (VÜ)	4	Norbert Rösch, Sven Wursthorn

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
written exam, 90 min.

Prerequisites
online test 'Introduction to GIS for Students of Natural, Engineering and Geo Sciences' (T-BGU-103541) has to be passed

Modeled Conditions
The following conditions must be met:

- The course [T-BGU-103541] *Introduction to GIS for Students of Natural, Engineering and Geo Sciences* must have been passed.

Recommendations
none

Remarks
none

T 'Teilleistung': Introduction to Matlab [T-BGU-106765]

Responsibility: Uwe Ehret
Contained in: [M-BGU-103381] Introduction to Matlab

Credit Points	Language	Recurrence Frequency	Type of Learning Control	Version
3	English	Each winter term	not graded accomplishment	1

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
WS 18/19	6224907	Introduction to Matlab	Vorlesung / Übung (VÜ)	2	Uwe Ehret, Jan Wienhöfer

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
implementation of a Matlab code with report, appr. 1 page

Prerequisites
none

Recommendations
none

Remarks
none

V Course Excerpt: Introduction to Matlab (WS 18/19)

Aim
Students are familiar with common programming rules and the working environment and basic syntax of Matlab. They are capable of independently formulating and coding simple programs for data analysis and visualization as well as simulation of dynamical systems with Matlab.
Students have thus gained the competence to independently solve computer-based modeling tasks in advanced courses. Students are able to solve problems and to present the related results in teamwork.

Content
- Universal programming basics: Programing strategies, program structures, control structures, operators and variables, functions and objects, matrix calculations
- Basics of Matlab: History, installation, graphical user interface, tool boxes, using help
- Matlab programming basics: syntax, debugging, reading and writing of files, data visualization

Workload
Attendance time: 30 h
Preparation/follow-up: 10 h
Homework: 30 h
Take-home exam: 20 h

T 'Teilleistung': Isotope Hydrology [T-BGU-106606]

Responsibility: Julian Klaus
Contained in: [M-BGU-103371] Experimental Hydrology

Credit Points	Recurrence Frequency	Type of Learning Control	Version
3	Each summer term	examination of other type	1

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
report, appr. 10-15 pages, and
presentation, appr. 15 min.

Prerequisites
none

Recommendations
none

Remarks
none

T 'Teilleistung': Lab report 'Industrial Water Management' [T-BGU-109980]

Responsibility: Tobias Morck
Contained in: [M-BGU-104073] Industrial Water Management

Credit Points	Language	Recurrence Frequency	Type of Learning Control	Version
1	English	Each summer term	not graded accomplishment	1

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
SS 2019	6223810	Industrial Water Management	Vorlesung / Übung (VÜ)	4	Tobias Morck

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
report on laboratory work, appr. 10 pages, as examination prerequisite

Prerequisites
none

Recommendations
none

Remarks
none

T 'Teilleistung': Landfills [T-BGU-100084]

Responsibility: Andreas Bieberstein
Contained in: [M-BGU-100079] Environmental Geotechnics

Credit Points	Language	Recurrence Frequency	Type of Learning Control	Version
3	German	Each winter term	oral examination	1

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
WS 18/19	6251913	Landfills	Vorlesung / Übung (VÜ)	2	Andreas Bieberstein

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
oral exam, appr. 20 min.

Prerequisites
none

Recommendations
none

Remarks
none

V Course Excerpt: Landfills (WS 18/19)

Aim
The students know the legal guidelines regarding the disposal of wastes and the permitted threshold value for brownfields. They overview the geotechnical concerns in the construction of landfill sites depending on the particular landfill classification, landfill elements, their relevant requirements and necessary certifications.

Content
- 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

Literature
DGGT, GDA-Empfehlungen – Geotechnik der Deponien und Altlasten, Ernst und Sohn, Berlin
Drescher (1997), Deponiebau, Ernst und Sohn, Berlin

T 'Teilleistung': Management of Water Resources and River Basins [T-BGU-106597]

Responsibility: Uwe Ehret
Contained in: [M-BGU-103364] Management of Water Resources and River Basins

Credit Points	Language	Recurrence Frequency	Type of Learning Control	Version
6	English	Each summer term	examination of other type	1

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
SS 2019	6224801	Management of Water Resources and River Basins	Vorlesung / Übung (VÜ)	4	Uwe Ehret

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
course associated assignments, short reports appr. 2 pages each, and
final take home exam, report appr. 10 pages and colloquium

Prerequisites
none

Recommendations
none

Remarks
none

T 'Teilleistung': Mass Transfer and Reaction Kinetics [T-CIWVT-109913]

Responsibility: Nikolaos Zarzalis
Contained in: [M-CIWVT-104879] Mass Transfer and Reaction Kinetics

Credit Points	Language	Recurrence Frequency	Type of Learning Control	Version
4	English	Each summer term	written examination	1

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
SS 2019	22534		Vorlesung (V)	2	Nikolaos Zarzalis

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
written exam, 150 min.

Prerequisites
none

Recommendations
none

Remarks
none

T 'Teilleistung': Master Thesis [T-BGU-100093]

Responsibility: Peter Vortisch
Contained in: [M-BGU-100080] Module Master Thesis

Credit Points	Recurrence Frequency	Type of Learning Control	Version
30	Each term	Abschlussarbeit	1

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
duration appr. 6 months
presentation within one month after submission of the thesis

Prerequisites
defined for the module Master Thesis

Recommendations
see module

Remarks
none

T 'Teilleistung': Membrane Technologies and Excursions [T-CIWVT-106819]

Responsibility: Gudrun Abbt-Braun, Harald Horn, Florencia Saravia
Contained in: [M-CIWVT-103413] Membrane Technologies and Excursions

Credit Points	Language	Recurrence Frequency	Type of Learning Control	Version
6	English	Each summer term	oral examination	1

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
SS 2019	22605		Vorlesung (V)	2	Harald Horn, Florencia Saravia

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
oral exam, appr. 30 min.

Prerequisites
The attendance at the excursions is examination prerequisite.

Modeled Conditions
The following conditions must be met:

- The course [T-CIWVT-106820] *Excursions: Waste Water Disposal and Drinking Water Supply* must have been passed.

Recommendations
none

Remarks
none

T 'Teilleistung': Meteorological Hazards [T-PHYS-109140]

Responsibility: Michael Kunz
Contained in: [M-PHYS-103386] Meteorological Hazards and Climate Change

Credit Points	Recurrence Frequency	Version
0	Each summer term	2

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
None

Prerequisites
None

Recommendations
Knowledge from the module Introduction to Meteorology is required.

Remarks
None

Replaces
T-PHYS-101557 Meteorologische Naturgefahren

T 'Teilleistung': Microbial Diversity [T-CHEMBIO-108674]

Responsibility: Johannes Gescher
Contained in: [M-CHEMBIO-100238] Research Module: Microbial Diversity

Credit Points	Recurrence Frequency	Version
8	Each winter term	1

Prerequisites
none

T 'Teilleistung': Microbiology for Engineers [T-CIWVT-106834]

Responsibility: Thomas Schwartz
Contained in: [M-CIWVT-103436] Applied Microbiology

Credit Points	Language	Recurrence Frequency	Type of Learning Control	Version
4	English	Each summer term	oral examination	1

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
SS 2019	22633	Microbiology for Engineers	Vorlesung (V)	2	Thomas Schwartz

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
oral exam, appr. 30 min.

Prerequisites
none

Recommendations
none

Remarks
none

T 'Teilleistung': Modeling of Water and Environmental Systems [T-BGU-106757]

Responsibility: Erwin Zehe
Contained in: [M-BGU-103374] Modeling of Water and Environmental Systems

Credit Points	Language	Recurrence Frequency	Type of Learning Control	Version
3	English	Each winter term	not graded accomplishment	1

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
WS 18/19	6220701	Modeling of Water and Environmental Systems	Vorlesung (V)	2	Mitarbeiter/innen, Erwin Zehe

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
task-led take home exam (written test on knowledge and comprehension questions about the contents of the lecture series), appr. 10 pages

Prerequisites
none

Recommendations
none

Remarks
none

T 'Teilleistung': Numerical Flow Modeling in Hydraulic Engineering [T-BGU-106776]

Responsibility: Peter Oberle
Contained in: [M-BGU-103390] Numerical Flow Modeling in Hydraulic Engineering

Credit Points	Language	Recurrence Frequency	Type of Learning Control	Version
6	German	Each term	oral examination	1

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
WS 18/19	6222903		Vorlesung / Übung (VÜ)	4	Peter Oberle

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
oral exam, appr. 20 min.

Prerequisites
none

Recommendations
none

Remarks
none

V Course Excerpt: (WS 18/19)

Aim
The students learn to use geographic information systems (GIS) as a tool of pre- and postprocessing to simulate river flows. They are able to reflect the fundamentals of the methods used and their methodology. The students have the ability to assess the areas of application of different hydrodynamic-numerical methods. They have the skills to analyze case studies regarding the applicability of the various methods and derive solutions.

Content
The course explains physical and numerical basics as well as operating conditions and application examples of different hydrodynamic-numerical (HN-) methods. Furthermore, geographic information systems (GIS) as a tool of pre- and postprocessing and their linking with HN-methods will be introduced. Other aspects covered are the coupling of elements of automation technology with HN-methods and the use of morphodynamic processes.

Workload
Attendance time lecture: 30 h
Attendance time exercise: 30 h
Preparation/ follow-up: 60 h
Examination + exam preparation: 60 h

T 'Teilleistung': Numerical Fluid Mechanics [T-BGU-106758]

Responsibility: Markus Uhlmann
Contained in: [M-BGU-103375] Numerical Fluid Mechanics

Credit Points	Language	Recurrence Frequency	Type of Learning Control	Version
6	English	Each term	written examination	1

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
WS 18/19	6221702	Numerical Fluid Mechanics I	Vorlesung / Übung (VÜ)	4	Markus Uhlmann

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
written exam, 90 min.

Prerequisites
none

Recommendations
none

Remarks
none

T 'Teilleistung': Numerical Fluid Mechanics II [T-BGU-106768]

Responsibility: Markus Uhlmann
Contained in: [M-BGU-103384] Advanced Computational Fluid Dynamics

Credit Points	Language	Recurrence Frequency	Type of Learning Control	Version
3	English	Each term	oral examination	1

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
SS 2019	6221809	Numerical Fluid Mechanics II	Vorlesung / Übung (VÜ)	2	Markus Uhlmann

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
oral exam, appr. 30 min.

Prerequisites
module 'Numerical Fluid Mechanics (AF501)' must be completed

Modeled Conditions
The following conditions must be met:

- The module [M-BGU-103375] *Numerical Fluid Mechanics* must have been passed.

Recommendations
none

Remarks
none

T 'Teilleistung': Numerical Groundwater Modeling [T-BGU-100625]

Responsibility: Ulf Mohrlok
Contained in: [M-BGU-100340] Groundwater Management

Credit Points	Language	Recurrence Frequency	Type of Learning Control	Version
3	English	Each winter term	examination of other type	1

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
WS 18/19	6221901	Numerical Groundwater Modelling	Projekt (PRO)	2	Ulf Mohrlok

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
project report, appr. 15 pages

Prerequisites
none

Recommendations
none

Remarks
none

T 'Teilleistung': Numerical Mathematics for Students of Computer Science [T-MATH-102242]

Responsibility: Andreas Rieder, Daniel Weiß, Christian Wieners
Contained in: [M-MATH-103404] Numerical Mathematics for Students of Computer Science and Engineering

Credit Points	Recurrence Frequency	Type of Learning Control	Version
6	Each term	written examination	2

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
SS 2019	0187400		Vorlesung (V)	2	Daniel Weiß
SS 2019	0187500		Übung (Ü)	1	Daniel Weiß

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
written exam, 120 min.

Prerequisites
none

Recommendations
none

Remarks
none

T 'Teilleistung': Organic Trace Analysis of Aqueous Samples [T-CIWVT-106836]

Responsibility: Gerald Brenner-Weiß
Contained in: [M-CIWVT-103437] Instrumental Analysis

Credit Points	Recurrence Frequency	Type of Learning Control	Version
2	Each summer term	not graded accomplishment	1

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
SS 2019	22629	Organic Trace Analysis of Aqueous Samples	Praktikum (P)	2	Gerald Brenner-Weiß

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
written report on the analyses of laboratory data, maximum 5 pages

Prerequisites
none

Recommendations
none

Remarks
none

T 'Teilleistung': Parallel Programming Techniques for Engineering [T-BGU-106769]

Responsibility: Markus Uhlmann
Contained in: [M-BGU-103384] Advanced Computational Fluid Dynamics

Credit Points	Language	Recurrence Frequency	Type of Learning Control	Version
3	English	Each term	written examination	2

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
SS 2019	6221807	Parallel programming techniques for engineering problems	Vorlesung / Übung (VÜ)	2	Markus Uhlmann

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
oral exam, appr. 30 min.

Prerequisites
module 'Numerical Fluid Mechanics (AF501)' must be completed

Modeled Conditions
The following conditions must be met:

- The module [M-BGU-103375] *Numerical Fluid Mechanics* must have been passed.

Recommendations
none

Remarks
none

T 'Teilleistung': Practical Course in Water Technology [T-CIWVT-106840]

Responsibility: Harald Horn
Contained in: [M-CIWVT-103440] Practical Course in Water Technology

Credit Points	Language	Recurrence Frequency	Type of Learning Control	Version
4	English	Each summer term	examination of other type	1

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
SS 2019	22664	Practical Course in Water Technology	Praktikum (P)	2	Gudrun Abbt-Braun, Andrea Hille-Reichel, Harald Horn, und Mitarbeiter

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
The exam of other kind consists of the following parts, which contribute to the grade with the specified weighths:
protocols of the experiments, 40 %
oral presentation, 10 %
oral exam, 15 min., 50 %.
Protocols and presentation have to be passed before taking the oral exam.

Prerequisites
none

Modeled Conditions
The following conditions must be met:

- The module [M-CIWVT-103407] *Water Technology* must have been started.

Recommendations
none

Remarks
none

T 'Teilleistung': Prerequisite Protection and Use of Riverine Systems [T-BGU-106790]

Responsibility: Charlotte Kämpf
Contained in: [M-BGU-103401] Protection and Use of Riverine Systems

Credit Points	Language	Recurrence Frequency	Type of Learning Control	Version
1	English	Each summer term	not graded accomplishment	2

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
SS 2019	6220801	Protection and Use of Riverine Systems	Vorlesung (V)	2	Charlotte Kämpf, Andreas Kron, Franz Nestmann

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
literature annotation, appr. 150 words,
short presentation, appr. 10 min., and
excursion report, appr. 2 pages

Prerequisites
none

Recommendations
none

Remarks
none

T 'Teilleistung': Probability and Statistics [T-MATH-106784]

Responsibility: Bernhard Klar
Contained in: [M-MATH-103395] Probability and Statistics

Credit Points	Recurrence Frequency	Type of Learning Control	Version
3	Each summer term	oral examination	1

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
SS 2019	0188100		Vorlesung (V)	2	Bernhard Klar

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
oral exam, 20 min.

Prerequisites
none

Recommendations
none

Remarks
none

T 'Teilleistung': Process Engineering in Wastewater Treatment [T-BGU-106787]

Responsibility: Tobias Morck
Contained in: [M-BGU-103399] Process Engineering in Wastewater Treatment

Credit Points	Language	Recurrence Frequency	Type of Learning Control	Version
6	English	Each winter term	written examination	1

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
WS 18/19	6223901	Municipal Wastewater Treatment	Vorlesung / Übung (VÜ)	2	Tobias Morck
WS 18/19	6223902	International Sanitary Engineering	Vorlesung / Übung (VÜ)	2	Stephan Fuchs, Tobias Morck

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
written exam, 60 min.

Prerequisites
internal examination prerequisite: group presentation, appr. 20 min., and written report, appr. 10 pages

Recommendations
none

Remarks
none

T 'Teilleistung': Project Report Water Distribution Systems [T-BGU-108485]

Responsibility: Franz Nestmann
Contained in: [M-BGU-104100] Water Distribution Systems

Credit Points	Language	Recurrence Frequency	Type of Learning Control	Version
2	English	Each winter term	not graded accomplishment	2

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
WS 18/19	6222905	Water Distribution Systems	Vorlesung / Übung (VÜ)	4	Andreas Kron, Peter Oberle

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
project report, appr. 15 pages, and
presentation, appr. 15 min.

Prerequisites
none

Recommendations
none

Remarks
none

T 'Teilleistung': Project Studies in Water Resources Management [T-BGU-106783]

Responsibility: Franz Nestmann, Frank Seidel
Contained in: [M-BGU-103394] Project Studies in Water Resources Management

Credit Points	Language	Recurrence Frequency	Type of Learning Control	Version
6	German	Each winter term	examination of other type	1

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
WS 18/19	6222901		Vorlesung / Übung (VÜ)	4	Franz Nestmann, Frank Seidel

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
project work: term paper, appr. 15 pages, with presentation

Prerequisites
none

Recommendations
none

Remarks
none

T 'Teilleistung': Protection and Use of Riverine Systems [T-BGU-106791]

Responsibility: Charlotte Kämpf
Contained in: [M-BGU-103401] Protection and Use of Riverine Systems

Credit Points	Language	Recurrence Frequency	Type of Learning Control	Version
5	English	Each summer term	examination of other type	2

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
SS 2019	6220801	Protection and Use of Riverine Systems	Vorlesung (V)	2	Charlotte Kämpf, Andreas Kron, Franz Nestmann

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
about a topic selected by oneself out of the field water management or international nature conservation:
presentation, appr. 15-20 min., and
maunscript, appr. 2500 words

Prerequisites
The accomplishment 'Prerequisite Protection and Use of Riverine Systems' (T-BGU-106790) has to be passed.

Modeled Conditions
The following conditions must be met:

- The course [T-BGU-106790] *Prerequisite Protection and Use of Riverine Systems* must have been passed.

Recommendations
none

Remarks
none

T 'Teilleistung': Remote Sensing and Positioning [T-BGU-106843]

Responsibility: Maria Hennes, Hansjörg Kutterer, Thomas Vögtle
Contained in: [M-BGU-103442] Remote Sensing and Positioning

Credit Points	Recurrence Frequency	Type of Learning Control	Version
6	Each winter term	oral examination	1

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
oral exam, appr. 30 min.

Prerequisites
none

Recommendations
none

Remarks
none

T 'Teilleistung': River and Floodplain Ecology [T-BGU-106777]

Responsibility: Florian Wittmann
Contained in: [M-BGU-103391] Sustainable Management of rivers and Floodplains

Credit Points	Recurrence Frequency	Type of Learning Control	Version
3	Each winter term	written examination	1

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
WS 18/19	6111231		Vorlesung (V)	2	Florian Wittmann

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
written exam, 90 min.

Prerequisites
none

Recommendations
none

Remarks
none

T 'Teilleistung': River Basin Modelling [T-BGU-106603]

Responsibility: Stephan Fuchs
Contained in: [M-BGU-103373] River Basin Modeling

Credit Points	Language	Recurrence Frequency	Type of Learning Control	Version
6	English	Each term	examination of other type	1

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
WS 18/19	6223904	Modelling Mass Fluxes in River Basins	Vorlesung / Übung (VÜ)	2	Stephan Fuchs
SS 2019	6223812	Mass Fluxes in River Basins	Vorlesung (V)	2	Stephan Fuchs

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
project report, appr. 10 pages, and
presentation, appr. 15 min.

Prerequisites
none

Recommendations
none

Remarks
none

T 'Teilleistung': Seminar Paper 'Flow Behavior of Rivers' [T-BGU-108466]

Responsibility: Franz Nestmann, Frank Seidel
Contained in: [M-BGU-104083] Flow and Sediment Dynamics in Rivers

Credit Points	Language	Recurrence Frequency	Type of Learning Control	Version
2	English	Each summer term	not graded accomplishment	2

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
SS 2019	6222807	Flow Behavior of Rivers	Vorlesung / Übung (VÜ)	2	Victor Dupuis, Olivier Eiff, Frank Seidel

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
seminar paper in the course Flow Behavior of Rivers, appr. 15 pages

Prerequisites
none

Recommendations
none

Remarks
none

T 'Teilleistung': Seminar Paper 'Waterway Engineering' [T-BGU-106779]

Responsibility: Andreas Kron
Contained in: [M-BGU-103392] Waterway Engineering

Credit Points	Language	Recurrence Frequency	Type of Learning Control	Version
1	German	Each summer term	not graded accomplishment	2

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
SS 2019	6222803	Waterway Engineering	Vorlesung / Übung (VÜ)	4	Andreas Kron

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
seminar paper, appr. 15 pages

Prerequisites
none

Recommendations
none

Remarks
none

T 'Teilleistung': Study Project [T-BGU-106839]

Responsibility: Luca Trevisan
Contained in: [M-BGU-103439] Study Project

Credit Points	Recurrence Frequency	Type of Learning Control	Version
15	Each term	examination of other type	1

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
report, appr. 30 pages, and
presentation, appr. 20 min.

Prerequisites
none

Recommendations
The knowledge and technical and interdisciplinary skills needed to work on the selected topic and to prepare the 'Study Project' should have been acquired.

Remarks
none

T 'Teilleistung': Technical Hydraulics [T-BGU-106770]

Responsibility: Cornelia Lang
Contained in: [M-BGU-103385] Technical Hydraulics

Credit Points	Recurrence Frequency	Type of Learning Control	Version
6	Each term	written examination	1

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
written exam, 100 min.

Prerequisites
none

Recommendations
none

Remarks
none

T 'Teilleistung': Term Paper Contaminant Transport [T-BGU-106683]

Responsibility: Erwin Zehe
Contained in: [M-BGU-103369] Transport and Transformation of Contaminants in Hydrological Systems

Credit Points	Language	Recurrence Frequency	Type of Learning Control	Version
3	English	Each summer term	not graded accomplishment	1

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
SS 2019	6224803	Transport and Transformation of Contaminants in Hydrological Systems	Vorlesung / Übung (VÜ)	5	Jan Wienhöfer, Erwin Zehe

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
report about laboratory experiments and their analsysis, appr. 10 pages

Prerequisites
none

Recommendations
none

Remarks
none

T 'Teilleistung': Term Paper 'International Sanitary Engineering' [T-BGU-109265]

Responsibility: Stephan Fuchs, Tobias Morck
Contained in: [M-BGU-104917] Wastewater Treatment Technologies

Credit Points	Language	Recurrence Frequency	Type of Learning Control	Version
1	English	Each winter term	not graded accomplishment	2

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
WS 18/19	6223902	International Sanitary Engineering	Vorlesung / Übung (VÜ)	2	Stephan Fuchs, Tobias Morck

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
presentation, appr. 15 min., term paper, appr. 10 pages

Prerequisites
none

Recommendations
none

Remarks
none

T 'Teilleistung': Thermal Use of Groundwater [T-BGU-106803]

Responsibility: Philipp Blum
Contained in: [M-BGU-103408] Thermal Use of Groundwater

Credit Points	Recurrence Frequency	Type of Learning Control	Version
3	Each winter term	oral examination	1

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
WS 18/19	6339115		Vorlesung / Übung (VÜ)	2	Philipp Blum

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
oral exam, appr. 30 min.

Prerequisites
none

Recommendations
knowledge of programming with Matlab; otherwise, it is strongly recommended to attend the course 'Introduction to Matlab' (6224907)

Remarks
none

T 'Teilleistung': Transport and Transformation of Contaminants in Hydrological Systems [T-BGU-106598]

Responsibility: Erwin Zehe
Contained in: [M-BGU-103872] Subsurface Flow and Contaminant Transport
[M-BGU-103369] Transport and Transformation of Contaminants in Hydrological Systems

Credit Points	Language	Recurrence Frequency	Type of Learning Control	Version
6	English	Each term	oral examination	2

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
SS 2019	6224803	Transport and Transformation of Contaminants in Hydrological Systems	Vorlesung / Übung (VÜ)	5	Jan Wienhöfer, Erwin Zehe

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
oral exam, appr. 30 min.

Prerequisites
none

Recommendations
none

Remarks
none

T 'Teilleistung': Turbulent Diffusion [T-PHYS-108610]

Responsibility: Michael Kunz
Contained in: [M-PHYS-103387] Applied Meteorology: Turbulent Diffusion

Credit Points	Language	Recurrence Frequency	Type of Learning Control	Version
0	English	Each summer term	not graded accomplishment	2

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
SS 2019	4052081	Turbulent Diffusion	Vorlesung (V)	2	Bernhard Vogel, Heike Vogel
SS 2019	4052082	Exercises to Turbulent Diffusion	Übung (Ü)	1	Lukas Muser, Bernhard Vogel, Heike Vogel

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
exercises

Prerequisites
none

Recommendations
none

Remarks
none

Replaces
T-PHYS-101558

T 'Teilleistung': Urban Water Infrastructure and Management [T-BGU-106600]

Responsibility: Stephan Fuchs
Contained in: [M-BGU-103358] Urban Water Infrastructure and Management

Credit Points	Language	Recurrence Frequency	Type of Learning Control	Version
6	English	Each term	written examination	2

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
WS 18/19	6223701	Urban Water Infrastructure and Management	Vorlesung / Übung (VÜ)	4	Stephan Fuchs

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
written exam, 60 min.

Prerequisites
none

Recommendations
none

Remarks
none

T 'Teilleistung': Wastewater and Storm Water Treatment [T-BGU-106601]

Responsibility: Stephan Fuchs, Tobias Morck
Contained in: [M-BGU-103362] Wastewater and Storm Water Treatment

Credit Points	Recurrence Frequency	Type of Learning Control	Version
6	Each summer term	examination of other type	1

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
term paper, appr. 10 pages, and
presentation, appr. 15 min.

Prerequisites
none

Recommendations
none

Remarks
The number of participants in the course is limited to 20 persons. The registration is to be made via ILIAS. The places are allocated with priority to students from *Water Science and Engineering*, then *Civil Engineering* and *Geoecology* and further study programs. The allocation is made by consideration of the semester and the time of entry of the registration. The attendance at the first meeting is mandatory. In case of absence the place will be assigned to a person on the waiting list.

T 'Teilleistung': Wastewater and Storm Water Treatment Facilities [T-BGU-109934]

Responsibility: Stephan Fuchs, Tobias Morck
Contained in: [M-BGU-104898] Wastewater and Storm Water Treatment Facilities

Credit Points	Language	Recurrence Frequency	Type of Learning Control	Version
6	English	Each summer term	examination of other type	1

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
SS 2019	6223801	Wastewater and Storm Water Treatment Facilities	Vorlesung / Übung (VÜ)	4	Stephan Fuchs, Tobias Morck

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
term paper, appr. 10 pages, and
presentation, appr. 15 min.

Prerequisites
none

Recommendations
none

Remarks
The number of participants in the course is limited to 20 persons. The registration is to be made via ILIAS. The places are allocated with priority to students from *Water Science and Engineering*, then *Civil Engineering* and *Geoecology* and further study programs. The allocation is made by consideration of the semester and the time of entry of the registration. The attendance at the first meeting is mandatory. In case of absence the place will be assigned to a person on the waiting list.

T 'Teilleistung': Wastewater Treatment Technologies [T-BGU-109948]

Responsibility: Stephan Fuchs, Tobias Morck
Contained in: [M-BGU-104917] Wastewater Treatment Technologies

Credit Points	Language	Recurrence Frequency	Type of Learning Control	Version
5	English	Each winter term	written examination	1

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
written exam, 60 min.

Prerequisites
The accomplishment Term paper 'International Sanitary Engineering' (T-BGU-109265) has to be passend.

Modeled Conditions
The following conditions must be met:

- The course [T-BGU-109265] *Term Paper 'International Sanitary Engineering'* must have been passed.

Recommendations
none

Remarks
none

T 'Teilleistung': Water and Energy Cycles [T-BGU-106596]

Responsibility: Erwin Zehe
Contained in: [M-BGU-103360] Water and Energy Cycles

Credit Points	Language	Recurrence Frequency	Type of Learning Control	Version
6	English	Each term	oral examination	1

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
WS 18/19	6224702	Water and Energy Cycles in Hydrological Systems: Processes, Predictions and Management	Vorlesung / Übung (VÜ)	4	Erwin Zehe

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
oral exam, appr. 30 min.

Prerequisites
none

Recommendations
none

Remarks
none

T 'Teilleistung': Water Distribution Systems [T-BGU-108486]

Responsibility: Franz Nestmann
Contained in: [M-BGU-104100] Water Distribution Systems

Credit Points	Language	Recurrence Frequency	Type of Learning Control	Version
4	English	Each winter term	oral examination	2

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
WS 18/19	6222905	Water Distribution Systems	Vorlesung / Übung (VÜ)	4	Andreas Kron, Peter Oberle

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
oral exam, appr. 30 min.

Prerequisites
The accomplishment 'Project Report Water Distribution Systems' (T-BGU-108485) has to be passed.

Modeled Conditions
The following conditions must be met:

- The course [T-BGU-108485] *Project Report Water Distribution Systems* must have been passed.

Recommendations
none

Remarks
none

T 'Teilleistung': Water Ecology [T-BGU-106602]

Responsibility: Stephan Fuchs, Stephan Hilgert
Contained in: [M-BGU-103361] Water Ecology

Credit Points	Language	Recurrence Frequency	Type of Learning Control	Version
6	English	Each summer term	examination of other type	1

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
SS 2019	6223813	Applied Ecology and Water Quality	Seminar (S)	3	Stephan Fuchs, Stephan Hilgert

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
term paper, appr. 8-15 pages, and
presentation, appr. 15 min.

Prerequisites
none

Recommendations
none

Remarks
The number of participants in the course is limited to 20 persons. The registration is to be made via ILIAS. The places are allocated with priority to students from *Water Science and Engineering*, then *Civil Engineering* and *Geoecology* and further study programs. The allocation is made by consideration of the semester and the time of entry of the registration. The attendance at the first meeting is mandatory. In case of absence the place will be assigned to a person on the waiting list.

T 'Teilleistung': Water Technology [T-CIWVT-106802]

Responsibility: Harald Horn
Contained in: [M-CIWVT-103407] Water Technology

Credit Points	Recurrence Frequency	Type of Learning Control	Version
6	Each winter term	oral examination	1

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
WS 18/19	22621		Vorlesung (V)	2	Harald Horn
WS 18/19	22622		Übung (Ü)	1	Harald Horn, und Mitarbeiter

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
oral exam, appr. 30 min.

Prerequisites
none

Recommendations
none

Remarks
none

T 'Teilleistung': Waterway Engineering [T-BGU-106780]

Responsibility: Andreas Kron
Contained in: [M-BGU-103392] Waterway Engineering

Credit Points	Language	Recurrence Frequency	Type of Learning Control	Version
5	German	Each summer term	oral examination	2

Courses

Term	Course-No.	Courses	Type	HpW / SWS	Lecturers
SS 2019	6222803	Waterway Engineering	Vorlesung / Übung (VÜ)	4	Andreas Kron

Learning Control(s), according ER/SPO Water Science and Engineering (M.Sc.) 2016
oral exam, appr. 20 min.

Prerequisites
The accomplishment 'Seminar Paper Waterway Engineering' (T-BGU-106779) has to be passed.

Modeled Conditions
The following conditions must be met:

- The course [T-BGU-106779] *Seminar Paper 'Waterway Engineering'* must have been passed.

Recommendations
none

Remarks
none

T 'Teilleistung': Wildcard 1 Language Skills 1 [T-BGU-106884]

Responsibility:
Contained in: [M-BGU-103466] Language Skills 1 (2 CP)

Credit Points	Recurrence Frequency	Type of Learning Control	Version
2	Each term	examination of other type	1

T 'Teilleistung': Wildcard 2 Language Skills [T-BGU-106885]

Responsibility:
Contained in: [M-BGU-103466] Language Skills 1 (2 CP)

Credit Points	Recurrence Frequency	Type of Learning Control	Version
2	Each term	not graded accomplishment	1

Part IV
Appendix, Example Curricula

Example Curricula

This section contains example curricula for each of the four profiles. Please note that these are only one out of many other possible combinations. The students can ask the mentors for advice on the selection of modules.

Abbreviations

Subjects

AF	Advanced Fundamentals
CC	Cross-Cutting Methods & Competencies
P	Profile Studies
PA	Profile A
PB	Profile B
PC	Profile C
PD	Profile D
P/SM	Profile Studies/Supplementary Modules
SP	Study Project
MT	Master's Thesis

General Information

CP	credit points
HPW	class hours per week
LC	learning control
G	German
E	English
G/E	teaching language: German/documents: English

Type of Courses

L	lecture
T	tutorial
S	seminar
P	practical training
E	excursion

Learning Controls

wE	written examination
oE	oral examination
EoT	examination of other type
ngA	not graded accomplishment

Example Curriculum PA - Water Technologies & Urban Water Cycle

1st Semester (winter semester)

Hours per week: 18; credit points: 30; exams: 4 (not graded accomplishments)

Subject	Module	Title	CP	HPW	Type	LC	G/E
AF	AF101	Modeling of Water and Environmental Systems	3	2	L	ngA	E
	AF201	Fundamentals of Water Quality	6	3	L/T	wE	E
	AF301	Urban Water Infrastructure and Management	6	4	L/T	wE	E
	AF701	Water and Energy Cycles	6	4	L/T	oE	E
CC	CC772	Introduction to Matlab	3	2	L/T	ngA	E
P	PA221	Water Technology	6	3	L/T	oE	E

2nd Semester (summer semester)

Hours per week: 17; credit points: 29; exams: 6

Subject	Module	Title	CP	HPW	Type	LC	G/E
AF	AF401	Advanced Fluid Mechanics	6	4	L/T	wE	E
CC	CC911	Probability and Statistics	3	2	L	oE	E
	CC921	Instrumental Analysis	6	4	L/P	oE + ngA	E
P	PA222	Membrane Technologies and Excursions	6	3	L/E	oE + ngA	E
	PA223	Practical Course in Water Technology	4	2	L/P	EoT	E
	PA982	Applied Microbiology	4	2	L	oE	E

3rd Semester (winter semester)

Hours per week: 10 + Study Project (3 months); credit points: 31; exams: 4

Subject	Module	Title	CP	HPW	Type	LC	G/E
P	PA982	Applied Microbiology	4	2	L	oE	E
	PA321	Wastewater Treatment Technologies	6	4	L/T	wE + ngA	E
	PA621	Water Distribution Systems	6	4	L/T	oE + ngA	E
SP	SP	Study Project	15	-	-	EoT	E

4th Semester (summer semester)

Master's thesis (6 months); credit points: 30; exams: 1

Example Curriculum PB - Fluid Mechanics & Hydraulic Engineering

1st Semester (summer semester)

Hours per week: 18; credit points: 27; exams: 4 (ungraded LC are not counted)

Subject	Module	Title	CP	HPW	Type	LC	G/E
AF	AF401	Advanced Fluid Mechanics	6	4	L/T	wE	E
	AF601	Hydraulic Engineering	6	4	L/T	wE	E
CC	CC471	Experiments in Fluid Mechanics	6	4	L/T	EoT	E
P	PB521	Analysis of Turbulent Flows	3	2	L	-	E
	PB633	Flow and Sediment Dynamics in Rivers	6	4	L/T	oE	E

2nd Semester (winter semester)

Hours per week: 20; credit points: 30; exams: 5

Subject	Module	Title	CP	HPW	Type	LC	G/E
AF	AF101	Modeling of Water and Environmental Systems	3	2	L	ngA	E
	AF701	Water and Energy Cycles	6	4	L/T	oE	E
	AF501	Numerical Fluid Mechanics	6	4	L/T	wE	E
P	PB521	Analysis of Turbulent Flows	3	2	L	oE	E
	PB421	Environmental Fluid Mechanics	6	4	L/T	wE	E
	PB651	Numerische Strömungsmodellierung im Wasserbau	6	4	L/T	oE	G

3rd Semester (summer semester)

Hours per week: 12 + Study Project (3 months); credit points: 33; exams: 4

Subject	Module	Title	CP	HPW	Type	LC	G/E
P/SM	PB431	Technische Hydraulik	6	4	L/T	wE	G
	PC721	Management of Water Resources and River Basins	6	4	L/T	EoT	E
CC	CC371	Freshwater Ecology	6	4	L/S/T	EoT + ngA	E
SP	SP111	Study Project	15	-	-	EoT	E

4th Semester (winter semester)

Master's thesis (6 months); credit points: 30; exams: 1

Example Curriculum PC - Environmental System Dynamics & Management

1st Semester (winter semester)

Hours per week: 21; credit points: 33; exams: 5 (ungraded LC are not counted)

Subject	Module	Title	CP	HPW	Type	LC	G/E
AF	AF101	Modeling of Water and Environmental Systems	3	2	L	ngA	E
	AF201	Fundamentals of Water Quality	6	3	L/T	wE	E
	AF701	Water and Energy Cycles	6	4	L/T	oE	E
	AF301	Urban Water Infrastructure and Management	6	4	L/T	wE	E
CC	CC774	Introduction to Environmental Data Analysis and Statistical Learning	6	4	L/T	wE + ngA	E
	CC772	Introduction to Matlab	3	2	L/T	ngA	E
P	PC561	Groundwater Management	3	2	T	EoT	E

2nd Semester (summer semester)

Hours per week: 20; credit points: 30; exams: 5

Subject	Module	Title	CP	HPW	Type	LC	G/E
AF	AF801	Hydrogeology	6	3	L/T	wE	E
CC	CC773	Analysis of Spatial Data	6	4	L/T	oE	E
P	PC561	Groundwater Management	3	2	L/T	oE	E
	PC725	Subsurface Flow and Contaminant Transport	6	4	L/T	oE	E
	PC341	River Basin Modeling	3	2	L	-	E
	PC721	Management of Water Resources and River Basins	6	4	L/T	EoT	E

3rd Semester (winter semester)

Hours per week: 8 + Study Project (3 months); credit points: 27; exams: 4

Subject	Module	Title	CP	HPW	Type	LC	G/E
P	PC341	River Basin Modeling	3	2	T	EoT	E
P/SM	CC931	Remote Sensing and Positioning	6	4	L/T	oE	E
	SM879	Thermal Use of Groundwater	3	2	L/T	oE	E
SP	SP111	Study Project	15	-	-	EoT	E

4th Semester (summer semester)

Master's thesis (6 months); credit points: 30; exams: 1

Example Curriculum PD - Water Resources Engineering

1st Semester (winter semester)

Hours per week: 18; credit points: 30; exams: 4 (ungraded LC are not counted)

Subject	Module	Title	CP	HPW	Type	LC	G/E
AF	AF101	Modeling of Water and Environmental Systems	3	2	L	ngA	E
	AF201	Fundamentals of Water Quality	6	3	L/T	wE	E
	AF701	Water and Energy Cycles	6	4	L/T	oE	E
CC	CC772	Introduction to Matlab	3	2	L/T	ngA	E
P	PA221	Water Technology	6	3	L/T	oE	E
	PA321	Wastewater Treatment Technologies	6	4	L/T	wE	E

2nd Semester (summer semester)

Hours per week: 21; credit points: 33; exams: 6

Subject	Module	Title	CP	HPW	Type	LC	G/E
AF	AF301	Urban Water Infrastructure and Management	6	4	L/T	wE	E
	AF801	Hydrogeology	6	3	L/T	wE	E
P	PA322	Wastewater and Storm Water Treatment Facilities	6	4	L/T	EoT	E
	PB633	Flow and Sediment Dynamics in Rivers	6	4	L/T	oE + ngA	E
	PC721	Management of Water Resources and River Basins	6	4	L/T	EoT	E
CC	CC911	Probability and Statistics	3	2	L	oE	E

3rd Semester (winter semester)

Hours per week: 8 + Study Project (3 months); credit points: 27; exams: 3

Subject	Module	Title	CP	HPW	Type	LC	G/E
P	PA621	Water Distribution Systems	6	4	L/T	oE + ngA	E
CC	CC931	Remote Sensing and Positioning	6	4	L/T	oE	E
SP	SP111	Study Project	15	-	-	EoT	E

4th Semester (summer semester)

Master's thesis (6 months); credit points: 30; exams: 1

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