Study plan

Name of study plan: Water and Environmental Engineering

Faculty/Institute/Others:

Department:

Branch of study guaranteed by the department: Welcome page

Garantor of the study branch:

Program of study: Water and Environmental Engineering

Type of study: Follow-up master full-time

Required credits: 120
Elective courses credits: 0
Sum of credits in the plan: 120
Note on the plan: valid from 2020/21

Name of the block: Compulsory courses Minimal number of credits of the block: 44

The role of the block: Z

Code of the group: NW20200001

Name of the group: Water and Environmental Engineering, 1st semester Requirement credits in the group: In this group you have to gain 18 credits

Requirement courses in the group: In this group you have to complete 3 courses

Credits in the group: 18 Note on the group:

Code	Name of the course / Name of the group of courses (in case of groups of courses the list of codes of their members) Tutors, authors and guarantors (gar.)	Completion	Credits	Scope	Semester	Role
141HACE	Hydraulics - Advanced Course Václav Matoušek Václav Matoušek (Gar.)	Z,ZK	6	3P+2C	Z	Z
141HYLE	Hydrology Tomáš Vogel, Jaromír Dušek, Jana Votrubová, Michal Dohnal Michal Dohnal Tomáš Vogel (Gar.)	Z,ZK	6	2P+3C	Z	Z
144WAQE	Water Quality Ivana Kabelková Ivana Kabelková (Gar.)	Z,ZK	6	2P+3C	Z	Z

Characteristics of the courses of this group of Study Plan: Code=NW20200001 Name=Water and Environmental Engineering, 1st semester

141HACE	Hydraulics - Advanced Course	Z,ZK	6					
Flow of real liquid (math	Flow of real liquid (mathematical modelling, Navier-Stokes equations, turbulence). Dimensional analysis and dynamic similarity. Unsteady flow (waves and transients). Flow structure							
and velocity distribution. Flow around solid bodies (boundary layer, wake). Solid particles in quiescent and flowing liquid. Non-Newtonian flow. Flow in pump-pipeline systems. Wastewater								
hydraulics. Hydraulics of	f water structures.							

141HYLE Hydrology

And Advanced hydrology course. Quantitative description of hydrological processes. Methods of measurement and data evaluation. Deterministic and stochastic modelling in

Moderately advanced hydrology course. Quantitative description of hydrological processes. Methods of measurement and data evaluation. Deterministic and stochastic modelling in hydrology.

144WAQE Water Quality Z,ZK 6

The course focuses on understanding of natural processes and human impacts determining water quality of surface waters and gives background to water quality modelling in natural and technical systems. Lectures cover processes and environmental factors effecting composition of surface waters, water pollution and its categories, properties, impacts and sources, ecological functions, processes, human impacts and protective measures in running and standing surface waters, water quality measurement and monitoring and legislative approach to water quality protection. Exercises provide a systematic approach to mass balances, transport and transformation processes, ideal reactors, real reactors and natural systems hydraulics and residence time distribution, advection-dispersion-transformation.

Code of the group: NW20200002

Name of the group: Water and Environmental Engineering, 2nd semester Requirement credits in the group: In this group you have to gain 12 credits

Requirement courses in the group: In this group you have to complete 2 courses

Credits in the group: 12 Note on the group:

Code	Name of the course / Name of the group of courses (in case of groups of courses the list of codes of their members) Tutors, authors and guarantors (gar.)	Completion	Credits	Scope	Semester	Role
142RDME	Reservoirs Design and Management	Z,ZK	6	3P+2C	L	Z
143GWHM	Ground Water Hydraulics and Modelling	Z,ZK	6	2P+3C	L	Z

Characteristics of the courses of this group of Study Plan: Code=NW20200002 Name=Water and Environmental Engineering, 2nd semester

142RDME Reservoirs Design and Management

7 7K

6 ns The course

By undertaking this course, students will be able to understand the fundamental principles with respect to design and control of reservoirs and water resources systems. The course includes methods and analysis for hydrological data preparation, stochastic time series generation and basic simulation and optimization techniques. Students will be able to design the storage capacity of reservoirs to serve water supply and environmental services downstream and to design appropriate flood control capacity to protect downstream area against floods. Environmental, geophysical and water quality aspects of reservoirs will be also discussed.

143GWHM Ground Water Hydraulics and Modelling

track based Project

Václav Matoušek

Z,ZK

4C

7

6

Classification of aquifers. Fundamental principles of water flow in saturated porous media. Darcy's equation. The Dupuit approximation. Unconfined flow in aquifer, well hydraulics. Unsteady flow in aquifers. Numerical modelling of steady and unsteady groundwater flow, boundary conditions. Methods of hydraulic conductivity determination.

Code of the group: NW20200003

Name of the group: Water and Environmental Engineering, 3rd semester Requirement credits in the group: In this group you have to gain 12 credits

Requirement courses in the group: In this group you have to complete 2 courses

Credits in the group: 12 Note on the group:

141PJTB

7

Characteristics of the courses of this group of Study Plan: Code=NW20200003 Name=Water and Environmental Engineering, 3rd semester

142RIAE Risk Analysis
Unified and comprehensive framework covering the various aspects of risk and reliability in both hydraulic structures and water quantity and quality problems. The topics cover uncertainty analysis of acquired data, stochastic simulations, decision theory under uncertainty and case studies. Methods for risk analysis of extremes in hydrology, groundwater clean-up, rivers. Geotechnical risks in dam engineering, safety assessment of various hydraulic structures, reliability analysis of dam equipment, risk and cost benefit analysis of projects related to water management. Risk analysis of urban water systems vulnerability to extreme events and climate change effects. Sources of uncertainty and their propagation through urban water models.

141PJTB track based Project

Z 6

The individual project worked out a by student to solve a particular engineering problem in a topic associated with student's selected track.

Code of the group: NW20200004

Name of the group: Water and Environmental Engineering, 4th semester

Requirement credits in the group: In this group you have to gain at least 2 credits (at most 30)

Requirement courses in the group: In this group you have to complete at least 1 course (at most 2)

Credits in the group: 2 Note on the group:

Code	Name of the course / Name of the group of courses (in case of groups of courses the list of codes of their members) Tutors, authors and guarantors (gar.)	Completion	Credits	Scope	Semester	Role
141WEIL	Series of Water and Environment Invited Lectures Michal Dohnal	Z	2	2P	L	z

Characteristics of the courses of this group of Study Plan: Code=NW20200004 Name=Water and Environmental Engineering, 4th semester

141WEIL	Series of Water and Environment Invited Lectures	Z	2
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Name of the block: Compulsory courses in the specialization

Minimal number of credits of the block: 30

The role of the block: PS

Code of the group: NW202001_01

Name of the group: Water and Environmental Engineering, specialization Hydraulic Engineering

Requirement credits in the group: In this group you have to gain 30 credits

Requirement courses in the group: In this group you have to complete 5 courses

Credits in the group: 30 Note on the group:

	/ I					
Code	Name of the course / Name of the group of courses (in case of groups of courses the list of codes of their members) Tutors, authors and guarantors (gar.)	Completion	Credits	Scope	Semester	Role
141FPSM	Fluvial Processes and Stream Morphology Václav Matoušek, Petr Sklenář Václav Matoušek Václav Matoušek (Gar.)	Z,ZK	6	3P+2C	Z	PS
141REFP	River Engineering and Flood Protection Petr Sklenář	Z,ZK	6	3P+2C	L	PS
142IWWS	Inland Waterways and Weir Structures Miroslav Brouček	Z,ZK	6	3P+2C	L	PS
142DEE	Dam Engineering - Design and Operation Miroslav Brouček, Ladislav Satrapa Miroslav Brouček Ladislav Satrapa (Gar.)	Z,ZK	6	3P+2C	Z	PS
142HNME	Hydropower and Numerical Modelling Petr Nowak, Eva Bilková, Jiří Souček, Eva Bilková, Petr Nowak (Gar.)	Z,ZK	6	3P+2C	Z	PS

Characteristics of the courses of this group of Study Plan: Code=NW202001_01 Name=Water and Environmental Engineering, specialization Hydraulic Engineering

specialization Hyd	raulic Engineering		
141FPSM	Fluvial Processes and Stream Morphology	Z,ZK	6
Properties of rivers and	fluvial processes. River variability and complexity, geomorphic assessment of rivers; controls of river morphology and behavi	iour. Stream sedir	nent and modes
of its transport. Channe	resistance. Equilibrium transport of bed load, suspended load and total load. Transport of sediment out of equilibrium. Mathe	ematical modelling	of flow with
transport of sediment or	er mobile bed. Physical modelling of rivers/streams with mobile bed. Mountain stream morphology. Stability of stream thread	l. Geomorphic and	alysis of river
channel changes. Mode	lling approaches to the ecology of fluvial system and river chemistry. River pollution and mixing zones.		
141REFP	River Engineering and Flood Protection	Z,ZK	6
The course addresses t	he design and dimensioning of river engineering works to create and ensure the sufficient capacity of a channel as well as to	ensure the ecolo	gical functions
of the watercourse. Desi	gn of channels and modifications of formerly heavily engineered channels involves concepts and techniques of open-channel hyc	draulics and fluvial	geomorphology.
Special attention is paid	to the engineering of river channels in heavily urbanized areas and in predominantly rural landscapes.		
142IWWS	Inland Waterways and Weir Structures	Z,ZK	6
By undertaking this cou	rse, students will be able to comprehend the governing ideas of project design of river navigation and regulating weirs and h	dropower weir st	ructures as well
as navigation locks and	canals. The course graduates should be able to implement project study to select optimal type and location for weir and app	urtenant structure	s, specify
dimensions and materia	ls of the crucial parts of the structures, analyse seepage through foundations and perform hydraulic design of weir and energ	gy dissipation stru	ctures. With
regard to the navigation	, student will comprehend the issues of modern inland waterway transport and should be able to design basic dimensions of	the locks and car	ıals.
142DEE	Dam Engineering - Design and Operation	Z,ZK	6
The first part of the cour	se focuses on general understanding and conceptual design of dams. Students will learn advantages and disadvantages of di	fferent dam types,	how to evaluate
potential dam profiles ar	nd how to implement basic design studies for different purposes. Second part of the course focuses on detail design of emban	kment and gravity	dams, including
necessary appurtenant	structures such as spillways and bottom outlets and their hydromechanical equipment. Dam safety and operation are the ma	in topic of the thir	d part of the
course. Students will be	able to comprehend the modern surveillance systems designed for dam and understand the situations behind the results from	om the monitoring	devices.
142HNME	Hydropower and Numerical Modelling	Z,ZK	6

Students will obtain basic view about individual types of hydroelectric power stations and they will be informed about methods of hydropower utilization. Mathematical modelling will be

Name of the block: Compulsory elective courses

presented with respect to optimized design of hydraulic structures, especially intakes and water turbines.

Minimal number of credits of the block: 18

The role of the block: PV

Code of the group: NW202001 02

Name of the group: Water and Environmental Engineering, facultative subjects Requirement credits in the group: In this group you have to gain at least 18 credits

Requirement courses in the group: In this group you have to complete at least 3 courses

Credits in the group: 18

Note on the group:

Code	Name of the course / Name of the group of courses (in case of groups of courses the list of codes of their members) Tutors, authors and guarantors (gar.)	Completion	Credits	Scope	Semester	Role
101MPSE	Probability and Statistics Daniela Jarušková, Jozef Bobok Daniela Jarušková (Gar.)	Z,ZK	6	3P+2C	Z	PV
143WRME	Water Resources Management and Watershed Modelling Josef Krása, Václav David, David Zumr David Zumr Josef Krása (Gar.)	Z,ZK	6	2P+3C	Z	PV
143EMAM	Environmental Monitoring and Data Assimilation Methods Martin Šanda	Z,ZK	6	2P+3C	L	PV

143VZHE	Vadose Zone Hydrology David Zumr	Z,ZK	6	2P+3C	L	PV
144URDR	Urban Drainage Ivana Kabelková	Z,ZK	6	2P+3C	L	PV
143SCRT	Subsurface Contamination & Remediation Technologies Michal Sněhota, Martin Šanda Martin Šanda Michal Sněhota (Gar.)	Z,ZK	6	2P+3C	Z	PV
143SLWM	Sustainable Landscape and Water Management Josef Krása, David Zumr, Miroslav Bauer, Tomáš Dostál Miroslav Bauer Tomáš Dostál (Gar.)	Z,ZK	6	2P+3C	Z	PV
144DWE	Drinking Water Engineering Bohumil Šťastný, Filip Horký Filip Horký Bohumil Šťastný (Gar.)	Z,ZK	6	2P+3C	Z	PV
144WWWT	Water and Waste Water Treatment Jaroslav Pollert, Kateřina Slavíčková Vadim Strogonov Jaroslav Pollert (Gar.)	Z,ZK	6	3P+2C	Z	PV

Characteristics of the courses of this group of Study Plan: Code=NW202001_02 Name=Water and Environmental Engineering, facultative subjects

101MPSE	Probability and Statistics	Z,ZK	6				
Inferential statistics. Theory of probability. Random variables and their characteristics. Parameter estimation. Theory of hypotheses testing. Linear regression.							
143WRME	Water Resources Management and Watershed Modelling	Z,ZK	6				
The subject is applied of	The subject is applied on practical introduction to modelling water balances, sediment and nutrient transport, including real case studies and applications.						
143EMAM	Environmental Monitoring and Data Assimilation Methods	Z,ZK	6				

1. Introduction to environmental monitoring and data assimilation 2. Data acquisition techniques (on-site, remote sensing; real-time, on-line, off-line) 3. Monitoring of meteorological characteristics (precipitation, temperature, wind, air humidity) 4. Methods of isotope hydrology (including analysis of stable isotopes) 5. Monitoring of flow characteristics (urban infrastructure, urban streams) 6. Monitoring of water quality characteristics (incl. sediment) 7. Monitoring of ecological characteristics (biological communities, stream eco-morphology) 8. Monitoring of soil hydrological quantities (water content, water potential) 9. Assessment of soil hydraulic properties (retention curve, hydraulic conductivity) 10. Non-invasive imaging of soil (x-ray tomography, neutron imaging, magnetic resonance imaging) 11. Uncertainty analysis and propagation of monitoring (uncertainty sources, uncertainty analysis methods, propagation methods) 12. Time series analysis 13. Case studies

143VZHF Vadose Zone Hydrology

1. Theory of flow in porous media. Derivation of flow equations, boundary conditions. 2. The hydraulic characteristics of the porous medium. The theory of capillary models. 3. Determination of hydraulic characteristics, optimization of parameters of retention curves, prediction of hydraulic conductivity. 4. Numerical methods to solve flow equations. 5. Elementary processes of water flow in subsurface. 6. Solute transport. Miscible flow, conservative flow, advection, dispersion, dispersion characteristics. 7. Reactive transport. Description of fundamental chemical reactions, equilibrium and kinetic models. Universal transport equations, boundary conditions. 8. Determination of dispersion characteristics. Multiphase flow (non-aqueous phase liquids). 9. Heterogeneity of soil medium. 10. Flow and transport of substances in soils exhibiting preferential flow. 11. Simulation models and their applications. 12. Modeling of soil water regime in engineering and environmental problems. Ethical standards and interpretation of simulation results. 13. Case studies

Z.ZK

Urban Drainage

The course focusses on complex understanding of urban drainage and its consequences. The students will master urban hydrology processes of surface runoff formation and transport, transport and transformation processes in sewer system, impacts of urban drainage on surface waters, description of urban drainage performance by monitoring and modelling, innovative technologies and purpose oriented mitigation measures planning and innovation.

143SCRT Subsurface Contamination & Remediation Technologies

Z,ZK This course focuses on various aspects of geoenvironmental engineering that deals with subsurface contamination and measures that lead to groundwater and soil cleanup. Seminars will include lectures, measurements in laboratory, calculations, and modelling.

Sustainable Landscape and Water Management

Z,ZK Landscape is crucial for human living. All the processes and human activities are linked to landscape, which performs the frame for them. Landscape has to be managed the way it is good place for living, but it is also place, where basic processes and cycles are going on. These processes (energy and mass cycles, ... are running partly independently on human wish, but people surely can influence them. The direction of influence is crucial for further development of society, for supply by basic sources, for climate and weather formation and other crucial features. Landscape and water management are very closely linked together, but also with essential needs of human society. Therefore they have to be carefully studied, well understood and properly managed.

Drinking Water Engineering

The course focusses in the first part on drinking water distribution system including intake objects, treatment plant and storage and consumers infrastructures. In another part connect lectures on water treatment in swimming pools and spas. The students will master technologies and processes used in drinking water and its transportation to the population of towns and villages, including the application of water treatment technology in specialized environments such as swimming pools, spas, zoo, and canoe water slalom.

144WWWT Water and Waste Water Treatment

The course presents fundamental concepts of biological, chemical and physical processes in water and wastewater treatment engineering both theoretically in lectures and practically in excercises.

Name of the block: Povinně volitelné předměty, doporučení S1

Minimal number of credits of the block: 28

The role of the block: S1

Code of the group: NW20200004_1

Name of the group: Water and Environmental Engineering, master thesis

Requirement credits in the group: In this group you have to gain at least 28 credits

Requirement courses in the group: In this group you have to complete at least 1 course

Credits in the group: 28 Note on the group:

Code	Name of the course / Name of the group of courses (in case of groups of courses the list of codes of their members) Tutors, authors and guarantors (gar.)	Completion	Credits	Scope	Semester	Role
141DIPM	Master Thesis Václav Matoušek	Z	28	12C	L,Z	S1
142DIPM	Master Thesis Ladislav Satrapa	Z	28	12C	L,Z	S1
143DIPM	Master Thesis David Zumr	Z	28	12C	L,Z	S1
144DIPM	Master Thesis	Z	28	12C	L,Z	S1

Characteristics of the courses of this group of Study Plan: Code=NW20200004_1 Name=Water and Environmental Engineering, master thesis

141DIPM	Master Thesis	Z	28		
Master thesis is a fina	al work carried out by a Master student. The thesis must be defended in front of a committee as a part of the final state exam.				
142DIPM	Master Thesis	Z	28		
The work is an individ	dual activity of the student in the preparation of the topic of the final thesis for the period of study on the assigned professional t	opic.	'		
143DIPM	Master Thesis	Z	28		
Master thesis typically	r focusses on modelling of hydraulic/hydrological processes in particular applications, case studies in water and environmental er	Igineering or shor	t design projects.		
Student selects a topi	c of his/her thesis according to the program specialization and he/she is supervised by a supervisor (see the list of supervisors) w	ith whom he is req	gularly consulting		
a progress of his/her work. Furthermore, an additional consulting expert can be assigned to the thesis project to assist the student.					
144DIPM	Master Thesis	Z	28		

List of courses of this pass:

Code	Name of the course	Completion	Credits	
101MPSE	Probability and Statistics	Z,ZK	6	
Inferential statistics. Theory of probability. Random variables and their characteristics. Parameter estimation. Theory of hypotheses testing. Linear regression.				
141DIPM	Master Thesis	Z	28	
Master thesis is a final work carried out by a Master student. The thesis must be defended in front of a committee as a part of the final state exam.				
141FPSM	Fluvial Processes and Stream Morphology	Z,ZK	6	
Properties of rivers and fluvial processes. River variability and complexity, geomorphic assessment of rivers; controls of river morphology and behaviour. Stream sediment and modes				
of its transport. Channel resistance. Equilibrium transport of bed load, suspended load and total load. Transport of sediment out of equilibrium. Mathematical modelling of flow with				
transport of sediment over mobile bed. Physical modelling of rivers/streams with mobile bed. Mountain stream morphology. Stability of stream thread. Geomorphic analysis of river				
channel changes. Modelling approaches to the ecology of fluvial system and river chemistry. River pollution and mixing zones.				
141HACE	Hydraulics - Advanced Course	Z,ZK	6	
	mathematical modelling, Navier-Stokes equations, turbulence). Dimensional analysis and dynamic similarity. Unsteady flow (waves a	,		
and velocity distribution. Flow around solid bodies (boundary layer, wake). Solid particles in quiescent and flowing liquid. Non-Newtonian flow. Flow in pump-pipeline systems. Wastewater				
	hydraulics. Hydraulics of water structures.	ı		
141HYLE	Hydrology	Z,ZK	6	
Moderately advanced hydrology course. Quantitative description of hydrological processes. Methods of measurement and data evaluation. Deterministic and stochastic modelling in hydrology.				
141PJTB	track based Project	Z	6	
'	The individual project worked out a by student to solve a particular engineering problem in a topic associated with student's select	ed track.		
141REFP	River Engineering and Flood Protection	Z,ZK	6	
The course addres	ses the design and dimensioning of river engineering works to create and ensure the sufficient capacity of a channel as well as to en	nsure the ecologic	al functions	
of the watercourse. Design of channels and modifications of formerly heavily engineered channels involves concepts and techniques of open-channel hydraulics and fluvial geomorphology.				
	Special attention is paid to the engineering of river channels in heavily urbanized areas and in predominantly rural landscap	es.		
141WEIL	Series of Water and Environment Invited Lectures	Z	2	
142DEE	Dam Engineering - Design and Operation	Z,ZK	6	
The first part of the	course focuses on general understanding and conceptual design of dams. Students will learn advantages and disadvantages of differences	ent dam types, how	to evaluate	
potential dam profiles and how to implement basic design studies for different purposes. Second part of the course focuses on detail design of embankment and gravity dams, including				
necessary appurtenant structures such as spillways and bottom outlets and their hydromechanical equipment. Dam safety and operation are the main topic of the third part of the				
course. Students will be able to comprehend the modern surveillance systems designed for dam and understand the situations behind the results from the monitoring devices.				
142DIPM	Master Thesis	Z	28	
	work is an individual activity of the student in the preparation of the topic of the final thesis for the period of study on the assigned pro-			
142HNME	Hydropower and Numerical Modelling	Z,ZK	6	
Students will obtain basic view about individual types of hydroelectric power stations and they will be informed about methods of hydropower utilization. Mathematical modelling will be				
presented with respect to optimized design of hydraulic structures, especially intakes and water turbines.				
142IWWS	Inland Waterways and Weir Structures	Z,ZK	6	
By undertaking this course, students will be able to comprehend the governing ideas of project design of river navigation and regulating weirs and hydropower weir structures as well				
as navigation locks and canals. The course graduates should be able to implement project study to select optimal type and location for weir and appurtenant structures, specify				
dimensions and materials of the crucial parts of the structures, analyse seepage through foundations and perform hydraulic design of weir and energy dissipation structures. With				
regard to the navigation, student will comprehend the issues of modern inland waterway transport and should be able to design basic dimensions of the locks and canals.				

142RDME Reservoirs Design and Management	Z,ZK	6
By undertaking this course, students will be able to understand the fundamental principles with respect to design and control of reservoirs	1 '	-
includes methods and analysis for hydrological data preparation, stochastic time series generation and basic simulation and optimization te	echniques. Students will be able	to design
the storage capacity of reservoirs to serve water supply and environmental services downstream and to design appropriate flood control ca		rea against
floods. Environmental, geophysical and water quality aspects of reservoirs will be also discussed.		
142RIAE Risk Analysis	Z,ZK	6
Unified and comprehensive framework covering the various aspects of risk and reliability in both hydraulic structures and water quantity and quantity and case studies. Methods for risk analysis of extremes		- 1
Geotechnical risks in dam engineering, safety assessment of various hydraulic structures, reliability analysis of dam equipment, risk and c	, 0,, 0	
water management. Risk analysis of urban water systems vulnerability to extreme events and climate change effects. Sources of uncertainty		
models.		
143DIPM Master Thesis	Z	28
Master thesis typically focusses on modelling of hydraulic/hydrological processes in particular applications, case studies in water and environment of the studies in	nental engineering or short desi	gn projects.
Student selects a topic of his/her thesis according to the program specialization and he/she is supervised by a supervisor (see the list of supervisor).	visors) with whom he is regularly	/ consulting
a progress of his/her work. Furthermore, an additional consulting expert can be assigned to the thesis project to a		
143EMAM Environmental Monitoring and Data Assimilation Methods	Z,ZK	6
1. Introduction to environmental monitoring and data assimilation 2. Data acquisition techniques (on-site, remote sensing; real-time, on-line	·	- 1
characteristics (precipitation, temperature, wind, air humidity) 4. Methods of isotope hydrology (including analysis of stable isotopes) 5. No infrastructure, urban streams) 6. Monitoring of water quality characteristics (incl. sediment) 7. Monitoring of ecological characteristics (biological characteristics)	•	,
8. Monitoring of soil hydrological quantities (water content, water potential) 9. Assessment of soil hydrological quantities (retention curve, hydra		
of soil (x-ray tomography, neutron imaging, magnetic resonance imaging) 11. Uncertainty analysis and propagation of monitoring (uncertainty	= :	
propagation methods) 12. Time series analysis 13. Case studies		,
143GWHM Ground Water Hydraulics and Modelling	Z,ZK	6
Classification of aquifers. Fundamental principles of water flow in saturated porous media. Darcy's equation. The Dupuit approximation. Un	nconfined flow in aquifer, well h	ydraulics.
Unsteady flow in aquifers. Numerical modelling of steady and unsteady groundwater flow, boundary conditions. Methods of hydra	aulic conductivity determination	
143SCRT Subsurface Contamination & Remediation Technologies	Z,ZK	6
This course focuses on various aspects of geoenvironmental engineering that deals with subsurface contamination and measures that lead	to groundwater and soil cleanup	o. Seminars
will include lectures, measurements in laboratory, calculations, and modelling.		
143SLWM Sustainable Landscape and Water Management	Z,ZK	6
Landscape is crucial for human living. All the processes and human activities are linked to landscape, which performs the frame for them. L	•	
good place for living, but it is also place, where basic processes and cycles are going on. These processes (energy and mass cycles, ar wish, but people surely can influence them. The direction of influence is crucial for further development of society, for supply by basic source		
other crucial features. Landscape and water management are very closely linked together, but also with essential needs of human society. T		
well understood and properly managed.	•	
143VZHE Vadose Zone Hydrology	Z,ZK	6
1. Theory of flow in porous media. Derivation of flow equations, boundary conditions. 2. The hydraulic characteristics of the porous med	ium. The theory of capillary mo	dels. 3.
$Determination\ of\ hydraulic\ characteristics,\ optimization\ of\ parameters\ of\ retention\ curves,\ prediction\ of\ hydraulic\ conductivity.\ 4.\ Numerical\ metrical\ metri$	hods to solve flow equations. 5.	Elementary
processes of water flow in subsurface. 6. Solute transport. Miscible flow, conservative flow, advection, dispersion, dispersion characteristic	· ·	•
fundamental chemical reactions, equilibrium and kinetic models. Universal transport equations, boundary conditions. 8. Determination of d		
(non-aqueous phase liquids). 9. Heterogeneity of soil medium. 10. Flow and transport of substances in soils exhibiting preferential flow. 11. 12. Modeling of soil water regime in engineering and environmental problems. Ethical standards and interpretation of simulating	·	plications.
	Z,ZK	6
143WRME Water Resources Management and Watershed Modelling The subject is applied on practical introduction to modelling water balances, sediment and nutrient transport, including real ca		O
144DIPM Master Thesis	Z	28
144DWE Drinking Water Engineering	Z,ZK	6
The course focusses in the first part on drinking water distribution system including intake objects, treatment plant and storage and consuming water distribution system including intake objects, treatment plant and storage and consuming water distribution system including intake objects, treatment plant and storage and consuming water distribution system including intake objects.		-
lectures on water treatment in swimming pools and spas. The students will master technologies and processes used in drinking water and it		
and villages, including the application of water treatment technology in specialized environments such as swimming pools, spas		
144URDR Urban Drainage	Z,ZK	6
The course focusses on complex understanding of urban drainage and its consequences. The students will master urban hydrology processe	s of surface runoff formation an	d transport,
The course focusses on complex understanding of urban drainage and its consequences. The students will master urban hydrology processe transport and transformation processes in sewer system, impacts of urban drainage on surface waters, description of urban drainage per innovative technologies and purpose oriented mitigation measures planning and innovation.	rformance by monitoring and m	odelling,
The course focusses on complex understanding of urban drainage and its consequences. The students will master urban hydrology processe transport and transformation processes in sewer system, impacts of urban drainage on surface waters, description of urban drainage per innovative technologies and purpose oriented mitigation measures planning and innovation. 144WAQE Water Quality	rformance by monitoring and m	odelling,
The course focusses on complex understanding of urban drainage and its consequences. The students will master urban hydrology processe transport and transformation processes in sewer system, impacts of urban drainage on surface waters, description of urban drainage per innovative technologies and purpose oriented mitigation measures planning and innovation. 144WAQE Water Quality The course focuses on understanding of natural processes and human impacts determining water quality of surface waters and gives background in the course focuses on understanding of natural processes and human impacts determining water quality of surface waters and gives background in the course focuses on understanding of natural processes and human impacts determining water quality of surface waters and gives background in the course focuses on understanding of natural processes and human impacts determining water quality of surface waters and gives background in the course focuses on understanding of natural processes and human impacts determining water quality of surface waters and gives background in the course focuses on understanding of natural processes and human impacts determining water quality of surface waters and gives background in the course focuses on understanding of natural processes and human impacts determining water quality of surface waters and gives background in the course focuses on understanding of natural processes and human impacts determining water quality of surface waters and gives background in the course focuses on understanding of natural processes and human impacts determining water quality of surface waters and gives background in the course focus on the course focus on the course of the course focus on the course focus on the course focus on the course of the course focus on the course focus on the course of the course of the course focus on the course of the	rformance by monitoring and m Z,ZK ground to water quality modellin	odelling, 6 g in natural
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