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*** *Václav Matoušek (Gar.)*	Z,ZK	6	3P+2C	Z	z
141HYLE	**Hydrology** *Tomáš Vogel, Michal Dohnal, Jaromír Dušek, Jana Votrubová* ***Michal Dohnal*** *Tomáš Vogel (Gar.)*	Z,ZK	6	2P+3C	Z	z
144WAQE	**Water Quallty** *Ivana Kabelková* ***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 (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 water structures.			
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.			
144WAQE	Water Quallty	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** *Pavel Fošumpaur, Milan Zukal, Tomáš Dally* ***Milan Zukal*** *Pavel Fošumpaur (Gar.)*	Z,ZK	6	3P+2C	L	z
143GWHM	**Ground Water Hydraulics and Modelling** *Martin Šanda, Martina Sobotková* ***Martin Šanda*** *Martin Šanda (Gar.)*	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	Z,ZK	6
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	Z,ZK	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:

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
142RIAE	**Risk Analysis** *Ivana Kabelková, Jana Nábělková, Miroslav Brouček* ***Miroslav Brouček*** *Miroslav Brouček (Gar.)*	Z,ZK	6	2P+3C	Z	z
141PJTB	**track based Project** *Václav Matoušek, Josef Krása, David Stránský* ***Václav Matoušek*** *Josef Krása (Gar.)*	Z	6	4C	Z	z

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

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 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, Miroslav Brouček, David Stránský, Michal Sněhota* ***Michal Dohnal*** *Michal Dohnal (Gar.)*	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

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:

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 **Petr Sklenář** Petr Sklenář (Gar.)*	Z,ZK	6	3P+2C	L	PS
142IWWS	**Inland Waterways and Weir Structures** *Miroslav Brouček **Miroslav Brouček** Miroslav Brouček (Gar.)*	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 Bílková, Jiří Souček **Eva Bílková** 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

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.			
141REFP	River Engineering and Flood Protection	Z,ZK	6
The course addresses the design and dimensioning of river engineering works to create and ensure the sufficient capacity of a channel as well as to ensure the ecological 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 landscapes.			
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.			
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 different 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.			
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.			

Name of the block: Compulsory elective courses
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, Tailin Li **David Zumr** Josef Krása (Gar.)*	Z,ZK	6	2P+3C	Z	PV
143EMAM	**Environmental Monitoring and Data Assimilation Methods** *Martin Šanda, Jana Nábělková, David Stránský, Michal Sněhota **Martin Šanda** Michal Sněhota (Gar.)*	Z,ZK	6	2P+3C	L	PV
143VZHE	**Vadose Zone Hydrology** *Tomáš Vogel, Jaromír Dušek, Michal Sněhota, David Zumr, Milena Císlerová **David Zumr** Michal Sněhota (Gar.)*	Z,ZK	6	2P+3C	L	PV
144URDR	**Urban Drainage** *Ivana Kabelková, David Stránský **Ivana Kabelková** David Stránský (Gar.)*	Z,ZK	6	2P+3C	L	PV
143SCRT	**Subsurface Contamination & Remediation Technologies** *Martin Šanda, Michal Sněhota **Martin Šanda** Michal Sněhota (Gar.)*	Z,ZK	6	2P+3C	Z	PV
143SLWM	**Sustainable Landscape and Water Management** *Josef Krása, David Zumr, Tomáš Dostál **David Zumr** Tomáš Dostál (Gar.)*	Z,ZK	6	2P+3C	Z	PV
144DWE	**Drinking Water Engineering** *Jana Nábělková, Bohumil Šťastný, Filip Horký **Filip Horký** Bohumil Šťastný (Gar.)*	Z,ZK	6	2P+3C	Z	PV
144WWWT	**Water and Waste Water Treatment** *Kateřina Slavíčková, Jaroslav Pollert **Kateřina Slavíčková** Kateřina Slavíčková (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 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			
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 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			
144URDR	Urban Drainage	Z,ZK	6
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	6
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.			
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. 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.			
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 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	Z,ZK	6
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* ***Václav Matoušek*** *Václav Matoušek (Gar.)*	Z	28	12C	L,Z	S1
142DIPM	**Master Thesis** ***Ladislav Satrapa***	Z	28	12C	L,Z	S1
143DIPM	**Master Thesis** *Michal Sněhota* ***David Zumr*** *Tomáš Dostál (Gar.)*	Z	28	12C	L,Z	S1
144DIPM	**Master Thesis** ***David Stránský*** *David Stránský (Gar.)*	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 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.			
142DIPM	Master Thesis	Z	28
The 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 professional topic.			
143DIPM	Master Thesis	Z	28
Master thesis typically focusses on modelling of hydraulic/hydrological processes in particular applications, case studies in water and environmental engineering or short design 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 supervisors) 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 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
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 water structures.			
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 selected track.			
141REFP	River Engineering and Flood Protection	Z,ZK	6
The course addresses the design and dimensioning of river engineering works to create and ensure the sufficient capacity of a channel as well as to ensure the ecological 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 landscapes.			
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 different 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
The 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 professional topic.			
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 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.		
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 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.		
143DIPM	Master Thesis	Z	28
	Master thesis typically focusses on modelling of hydraulic/hydrological processes in particular applications, case studies in water and environmental engineering or short design 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 supervisors) 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 assist the student.		
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		
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. 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.		
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. 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. 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.		
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 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		
143WRME	Water Resources Management and Watershed Modelling	Z,ZK	6
	The subject is applied on practical introduction to modelling water balances, sediment and nutrient transport, including real case studies and applications.		
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 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.		
144URDR	Urban Drainage	Z,ZK	6
	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.		
144WAQE	Water Quallty	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.		
144WWWT	Water and Waste Water Treatment	Z,ZK	6
	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.		

For updated information see http://bilakniha.cvut.cz/en/FF.html
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