University
of Ljubljana
Faculty
of Civil and Geodetic Engineering

Presentation of the study programme

2nd CYCLE MASTER STUDY PROGRAMME
WATER SCIENCE AND ENVIRONMENTAL ENGINEERING (MA)

Valid from study year 2018/2019

1. Information about the study programme

The second cycle master's study programme *Water Science and Environmental Engineering* is a 120-credit 2-year programme (4 semesters). The study programme does not include orientations. During the second year of study (3rd semester), students select among 3 elective modules. The study program is carried out as a regular and a part-time study.

2. Basic goals of the programme

Graduates of the master's study programme *Water Science and Environmental Engineering* will acquire fundamental knowledge of natural sciences, as well as applicable expert (civil engineering) skills for solving demanding administrative procedures and designing, planning, implementing and maintaining more demanding (according to the Construction Act) civil engineering structures (according to the uniform classification of types of constructions CC-SI) in the areas of water management, municipal and environmental engineering.

Besides gaining general theoretic knowledge about hydraulics and geotechnics, students will also learn the modern principles of water science and the latest achievements of the profession in individual areas of environmental and civil engineering, presented in a modern way using state-of-the-art technology. By working in groups, involvement in project work, field work and by solving problem tasks, students will acquire essential teamwork and public speaking skills and will be able to coherently present scientific and engineering ideas to expert and lay public. They will become acquainted with project management in the fields of environmental civil engineering and water management, and especially designing specialised construction types and measures. The students will have the opportunity to test all the acquired expert knowledge to the largest possible extent within practical exercises and real-life case studies, which will help them, together with practical training as part of the study, to get involved in practical work after the finished master's study. Another goal of the programme is also to provide the students with sufficient basic engineering knowledge to allow the development of abstract thinking and successful continuation of the study at different third cycle (i.e. doctoral) programmes (e.g. civil engineering or environment protection).

3. General competences

General competences acquired by the graduates of the master's study programme *Water Science and Environmental Engineering* are:

- general overview of academic areas,
- development of abilities to frame, comprehend and creatively solve problems, principles and theories,
- high level of creativity and innovation as a result of the interdisciplinary nature of the study,
- critical reading and understanding of relevant literature, independent knowledge gathering and literature search,
- development of the abilities of critical, analytical and synthetic thinking,
- competences for transferring and applying theoretical knowledge into practice and solving demanding professional and practical problems,
- development of professional and ethical responsibilities,
- development of verbal and numerical literacy, public speaking skills and competences to communicate with clients as well as the lay and professional public,
- ability to use a foreign language in professional written and oral communication,
- ability to use information and communication technologies, also in an international setting,
- ability to establish local and international interdisciplinary connections,

- compliance with safety, functional, economic and environmental aspects of work,
- development of high ethical and moral standards (maintaining integrity when working with clients, providing unbiased advice, sustaining independence and expertise according to valid legislation),
- developing an objective view of the environment and society,
- accepting responsibilities to customers and employers as well as the society as a whole,
- ability to design and implement demanding constructions in compliance with quality and price standards and carry out independent technical evaluations supported by scientific analysis and synthesis, all based on the acquired in-depth knowledge of natural sciences and specialised expertise from the area of water science, environmental and environmental civil engineering,
- ability to recognise and take into account the environmental risk associated with construction and to consider the issues of environment protection in designing structures in the area of environmental civil engineering.

4. Course-related competences

Course-specific competences the students acquire within the program *Water Science and Environmental Engineering* are mainly the following:

- understanding the role and importance of water management in modern society,
- taking part in planning, organisation, management and implementation of the construction of demanding civil engineering structures in the area of water management,
- designing individual elements as well as entire more demanding civil engineering structures in the area of water management,
- independently and creatively performing demanding tasks from the area of environmental civil engineering, environmental engineering and water management,
- managing groups in planning, design and implementation of different interventions into the aquatic environment, including construction in endangered areas,
- involvement in the preparation of spatial planning acts,
- coordinating work between investors, designers and contractors,
- knowing the legal, institutional and administrative system essential for water management and for managing and recording water resources and endangered areas,
- after suitable practical experience, the students are qualified to oversee larger water management companies.

5. Conditions for enrolment

The second cycle master's study programme *Water Science and Environmental Engineering* is available to the following candidates:

a) graduates of a first cycle study programme from the area of Civil Engineering;

b) graduates of a first cycle study programme from other expert areas (e.g. technical or biotechnical), if prior to the enrolment the candidates complete other study obligations essential for the continuation of the study totalling 10-60 ECTS. These obligations are defined according to the nature of the expert area, and the candidates may complete them during the first cycle study or by taking exams before the enrolment in the master's study *Water Science and Environmental Engineering*. Requirements for individual bridging programmes are defined by the Study Board of the Department of Environmental Civil Engineering according to the missing knowledge of the candidate not obtained during previous education. This also applies to the enrolment of students from other higher education institutions in Slovenia, EU and elsewhere.

The number of places is determined in the Call for enrolment into second cycle study programmes of the University of Ljubljana individually for each academic year.

6. Selection criteria when enrolment is restricted

In case of restricted enrolment the following conditions shall be considered: grade obtained in the first cycle study (100%).

7. Criteria for recognising knowledge and skills acquired before enrolment in the programme

Certain knowledge and skills comparable to the content and scope of the programme *Water Science and Environmental Engineering* can be recognised by the Study Board of the Department of Environmental Civil Engineering UL FGG. The Board makes decisions regarding the recognition of knowledge and skills acquired before enrolment based on the student's written application, enclosed certificates and other documents evidencing successfully acquired knowledge and contents, and in accordance with the Rules on the procedure and criteria for the acknowledgement of informally acquired knowledge and skills, adopted on 29 May 2007 at the 15th meeting of the Senate of UL.

The recognition process considers the following:

- certificates and other documents (recognition of »non-typical certificates«, portfolios, documents about finished courses and other forms of education),
- evaluation of finished products, services, publications and other original works of the student (possibility of performing study obligations – e.g. exams, preliminary exams, etc.
  – by evaluating products, e.g. projects, made by the student before the enrolment),
- evaluation of knowledge acquired by the student with self-education or empirical learning (possibility of completing study obligations without participation at lectures, practical work, seminars),
- adequate work experience (e.g. recognition of practical training and other course units of the program that are based on practical work and experience).

Should the Study Board of the department establish that the acquired knowledge may be recognised, this shall be evaluated with the same number of credits according to ECTS as the number of credits in the subject.

8. Methods of assessment

The assessment methods are in accordance with the Statute of University of Ljubljana and listed in the Course Syllabi.

9. Conditions for progression through the programme

9.1 Conditions for progression from one year to another

Students may enrol in a higher year if they complete all the obligations foreseen by the study plan amounting to at least 45 ECTS-credits by the end of the study year.

Under exceptional circumstances students may be permitted to proceed without successful completion of 45 ECTS, i.e. the obligations defined to proceed to the higher year of the study programme, provided they have justifiable reasons as defined by Article 153 of the Statute of UL

(maternity, extended illness, exceptional family and social circumstances, certified status of a person with special needs, active participation in top expert, cultural and sports events, active participation on University bodies).

Under the conditions set out in the above paragraph, students may enrol in a higher year with at least 30 ECTS-credits collected. The decision to permit enrolment is adopted by the Study Board of the Department of Environmental Civil Engineering of UL FGG.

Faculty of Civil and Geodetic Engineering has an established tutorship and supervision system in place for its students, offered also in the framework of the master's study programme *Water Science and Environmental Engineering.* Students of both years have class mentors, and smaller groups of students have individual tutors who will either be academic staff members or second year students who will help their protégés in choosing study orientations, elective courses etc.

Students with above average study results will be allowed faster advancement, if applicable with regard to the study process. Based on the student's application the decision is adopted by the Study Board of the Department of Environmental Civil Engineering of UL FGG. With a decree of the Study board the principles of faster progress are determined.

9.2 Conditions for repeat enrolment in the same year

Failing to meet the obligations defined by the study programme for advancement in a higher year, students may enrol in the same year for the second time, provided that they have obtained at least 30 ECTS-credits.

10. Transfers between study programmes

Transfer between programmes shall mean termination of education in the student's original study programme (first programme) and continuation of education in the second cycle master study programme of *Water Science and Environmental Engineering* (second programme), in which a part of the completed study requirements from the first study programme are recognised as completed.
Transfers are possible from the second cycle study programmes, and until their expiration also from the undergraduate academic study programmes adopted before June 11 2004, where the competences of the finished studies are comparable and according to the acknowledgement criteria at least half of the obligations according to ECTS from the first study programme related to compulsory courses of the second study programme can be acknowledged. Considering the scope of acknowledged obligations from the first study programme in the Republic of Slovenia or abroad student may enrol to the same or higher year in the second study programme. Transferring students shall fulfil the conditions for the enrolment to the second study programme.

Applications of candidates for the transfer to the second cycle master study programme *Water Science and Environmental Engineering* and the scope of acknowledged obligations in the study programme will be examined individually by the Study Board of the Department of Environmental Civil Engineering. If in the procedure of acknowledging obligations for the purpose of transfer the candidate is approved at least the amount of credit points and those point that are required for the enrolment to the second year of the second cycle master study programme *Water Science and Environmental Engineering*, the candidate may enrol to the second year of the second cycle master study programme *Water Science and Environmental Engineering.*

11. Conditions for completion of the study

Students finish the study by accomplishing all the prescribed obligations totalling 120 points according to ECTS, including practical training and submission and defence of the Master thesis.

12. Conditions for completion of individual parts of the programme

The Study is uniform.

13. Qualification, professional or academic title

- magister inženir okoljskega gradbeništva (second cycle graduate in environmental civil engineering)
- magistrica inženir okoljskega gradbeništva (second cycle graduate in environmental civil engineering)

14. Qualification, professional or academic title (abbreviation)

- mag. inž. ok. grad.

15. Classifications

- KLASIUS-SRV: Master higher education (second cycle Bologna)/Master higher education (second cycle Bologna) (17003)
- ISCED: architecture, urbanism and civil engineering (58)
- KLASIUS-P: Civil Engineering (other) (5829),
- Frascati: Technical sciences (2)
- Level SOK: Level SOK 8
- Level EOK: Level EOK 7
- Level EOVK: Second cycle

16. Study programme courses, Syllabus

* student obligations total 60 ECTS/year, which agrees with 1800 hours/year; hours include contact hours + independent work
L – lectures; S – seminar; SP – seminar practicals; LP – laboratory practicals; FW – field work; OW – other work;
CH – contact hours; SO – study obligations

1. YEAR										
	Contact hours						**ΣCH***	**ΣSO***	**ECTS***
1st semester	**L**	**S**	**ST**	**LT**	**FW**	**OW**			
Hydraulic modelling	45	15	-	60	-	-	120	240	8
Hydrological modelling	30	-	-	60	-	-	90	180	6
Drinking water supply and treatment	45	15	-	55	5	-	120	240	8
Project management	30	-	-	30	-	-	60	120	4
Basics of spatial sociology	45	-	-	-	-	-	45	90	3
Total 1st semester	**195**	**30**	**-**	**205**	**5**	**-**	**435**	**870**	**29**
	Contact hours						**ΣCH***	**ΣSO***	**ECTS***
2nd semester	**L**	**S**	**ST**	**LT**	**FW**	**OW**			
River engineering	60	30	15	-	15	-	120	240	8
Drainage and irrigation	40	-	-	45	5	-	90	180	6
Water protection	30	15	15	-	-		60	120	4
Open sea and coastal area	30	-	20	-	10	-	60	120	4
Environmental geotechnics	30	-	-	30	15	-	75	150	5
Remote sensing in environ. civil eng.	30	-	-	30	-	-	60	120	4
Total 2nd semester	**220**	**45**	**50**	**105**	**45**	**-**	**465**	**930**	**31**
2. YEAR									
	Contact hours						**ΣCH***	**ΣSO***	**ECTS***
3rd semester	**L**	**S**	**ST**	**LT**	**FW**	**OW**			
Elective module	165	45	75	60	15	-	360	720	24
Elective course 1	45	-	45	-	-	-	90	180	6
Total 3rd semester	**210**	**45**	**120**	**60**	**15**	**-**	**450**	**900**	**30**
	Contact hours						**ΣCH***	**ΣSO***	**ECTS***
4th semester	**L**	**S**	**ST**	**LT**	**FW**	**OW**			
Master thesis	-	-	-	-	-	450	450	900	30
Total 4th semester	**-**	**-**	**-**	**-**	**-**	**450**	**450**	**900**	**30**

Elective module Environmental engineering (2nd year)									
	Contact hours						**ΣCH***	**ΣSO***	**ECTS***
3rd semester	**L**	**S**	**ST**	**LT**	**FW**	**OW**			
Urban drainage and cleaning of waste water	45	15	-	55	5	-	120	240	8
Water management systems	10	15	30	-	5	-	60	120	4
Torrent, erosion, rockfall and avalanche control	35	-	15	-	10	-	60	120	4
Mathematical model. of environmental processes	45	-	-	30	-	-	75	150	5
Meteorology	30	-	15	-	-	-	45	90	3
Total	**165**	**30**	**60**	**85**	**20**	**-**	**360**	**720**	**24**

Elective module Flood risk management (2nd year) **Note: Module in English language**									
	Contact hours						**ΣCH***	**ΣSO***	**ECTS***
3rd semester	**L**	**S**	**ST**	**LT**	**FW**	**OW**			
Spatial planning for flood protection	37	38	-	-	-	-	75	150	5
Socioeconomical assessment of flood risk	37	38	-	-	-	-	75	150	5
Torrent, erosion, rockfall and avalanche control	35	-	15	-	10	-	60	120	4
Numerical methods in fluid dynamics	45	-	15	30	-	-	90	180	6
Environmental technologies	30	-	30	-	-	-	60	120	4
Total	**184**	**76**	**60**	**30**	**10**	**-**	**360**	**720**	**24**

Elective module Hydraulic engineering (2nd year)									
	Contact hours						**ΣCH***	**ΣSO***	**ECTS***
3rd semester	**L**	**S**	**ST**	**LT**	**FW**	**OW**			
Hydraulic structures	60	-	60	-	-	-	120	240	8
Water management systems	10	15	30	-	5	-	60	120	4
Hydroelectric power	30	-	30	-	-	-	60	120	4
Urban drainage and cleaning of waste water	45	15	-	55	5	-	120	240	8
Total	**145**	**30**	**120**	**55**	**10**	**-**	**360**	**720**	**24**

PROFESSIONAL ELECTIVE COURSES	Contact hours						ΣCH*	ΣSO*	ECTS*
	L	S	ST	LT	FW	OW			
Slope stabilisation	35	-	15	-	10	-	60	120	4
Hydraulic machines and devices	30	-	30	-	-	-	60	120	4
Water policy	30	-	30	-	-	-	60	120	4
Decision support systems in water management	45	15	-	15	-	-	75	150	5
Landscape management	30	-	30	-	-	-	60	120	4
Introduction to research work	30	15	-	15	-	-	60	120	4
Project in infrastructural systems	30	30	-	-	-	-	60	120	4
Selected topics from mathematics III	30	-	30	-	-	-	60	120	4
Ecohydrology	30	10	15	-	5	-	60	120	4
Geotechnics of infrastructural facilities	45	-	45	-	-	-	90	180	6
Practical training	6	-	-	-	-	120	126	252	6

17. Possibilities of elective courses and mobility

The master's study programme *Water Science and Environmental Engineering* foresees elective courses totalling 13 ECTS. Students shall select professional elective courses from the 2nd cycle study programmes *Water Science and Environmental Engineering* or *Civil Engineering – Orientation Geotechnical and Hydraulic Engineering.* Subjects in the amount of 6 ECTS (5%) may be selected freely. Elective courses are selected at student's own discretion or among other elective courses at other master's study programmes. In this respect, students are recommended to select courses from the 2nd cycle study programmes *Civil Engineering* (Orientations *Geotechnical and Hydraulic Engineering* and *Infrastructural Engineering*) or the 2nd cycle study programme *Geodesy and Geoinformatics*. Subjects at other faculties of the University of Ljubljana, other Universities in Slovenia or abroad may also be chosen.

Students may also chose elective courses from other faculties that are members of UL, other universities and higher education institutions in Slovenia, or internationally. They are recommended to select courses from the areas of law, economics, administration, statistics, geophysics, computer science, foreign languages, geomorphology, etc.

Students may transfer 30 ECTS-credits of the programme (one study semester, regardless of compulsory and elective units) from any other environmental or hydraulic engineering programme in Slovenia or abroad, provided that UL FGG has a signed agreement with the institution in question.

18. Presentation of individual courses

Hydraulic Modelling (8 ECTS)

Hydraulics II.

Steady non-uniform flow (complex cases of boundary conditions, a description of the software). Physical hydraulic models (dimensional analysis, principals of the similarity theory, distorted models, process of model construction, criteria for the physical and mathematical model selection). Modelling of the hydraulic structures (a description of the hydraulic characteristic of particular structures or facilities and their modelling, boundary conditions and verification of technical requirements). Modelling of the complex pipe systems and performance analysis with artificial intelligence optimization tools (description of hydraulic properties characteristic elements of modelling and operating conditions, verification – calibration - validation of hydraulic models of pipe systems).

Hydraulics of unsteady flow

Unsteady free surface flow (types of waves, fundamental St. Venant equations, methods of solving – methods of characteristics, explicit and implicit finite difference methods, initial and boundary conditions, basics of a two-dimensional problems, basics and examples of the movements of non-Newtonian fluids – avalanches, debris flow). Water hammer in pipes under pressure (a description of the phenomenon, derivation of dynamic and continuity equations, the method of characteristics, initial and boundary conditions, measures for water hammer mitigation). Surge tanks (description, derivation of continuity and dynamic equations, equation of undamped oscillation, methods of solving, stability of surge tanks, types of surge tanks, and the choice and methods of computations). Small amplitude wave theory, analytic solutions of the basic equations.

Hydrological modelling (6 ECTS)

The student learns about models, their classification and application of basics of systems theory. He/she is introduced with basics of application of stochastic in hydrology, unit hydrograph (UH) and synthetic unit hydrograph, different hydrological models in combination with the basic GIS tools for the model input data assessment, calibration and validation of the models, methods for estimation of accuracy of modeling

results, regionalisation in hydrology and hydrological forecast. He/she learns about groundwater modeling and about the influence of individual structures on changes in water regime.

Drinking Water Supply and Treatment (8 ECTS)

This course covers the following topics from water supply systems: Water demand analyses and water uses; Water sources and water catchment; Types and classification of water supply systems; Elements of water supply systems; Pipes and pumps; Hydraulics of water supply systems; Water quality; Basic concepts of water treatment; Filtration – sand and membranes; Settling and flotation, coagulation and flocculation; Softening, ion exchange, treatment of iron and manganese; Primary and secondary disinfection, disinfection by-products; Advanced water treatment processes.

Project Management (4 ECTS)

Project as a system, project goals, components and relations in a project, environmental aspects. Organisation of project implementation, permanent and temporary project organisation. Fields of project management. Specifics and phases of civil engineering projects. Project structuring, responsibility matrix. Project planning and follow-up. Building a project team.

Basics of Spatial sociology (3 ECTS)

Sociological approaches to understanding space and built infrastructure; social ecological theories and processes; availability in space and social consequences; information technologies and their influence on the process of spatial structuring; sociological characteristics of spatial planning; interventions into space and social consequences; methods and techniques of assessing social effects of interventions into space; "NIMBY effects" and how to handle them; wastes and their perception in society; environmental and spatial policies in modern world; sociological aspects of managing natural sources.

Sewerage and waste water treatment (8 ECTS)

Historical development of the profession and problems of dying people in large cities due to contaminated water with the cholera epidemic and diarrhea. Basics of planning canal systems and sewage treatment plants. Based on water consumption one will get acquainted with discharge and its composition. Particular attention will be paid to the runoff of contaminated storm water and its controlled drainage. Most important choices of the type and design of systems for drainage of contaminated water will be discussed. One will need to acquire different procedures for dimensioning and canal systems and facilities based on the analysis of precipitation, retention and relieving the burdens canal or water. Critical outflow of a sewage treatment plant.

Mathematical modelling of environmental processes (5 ECTS)

Basic principles of modelling of natural processes in water: hydrodynamic circulation, transport and dispersion of pollutants, bio-chemical processes. Comparison of principles, advantages and drawbacks of physical and mathematical models. Basic natural principles of modelling of processes. Description of equations: continuity, momentum, convection-diffusion equation for mass transport, the influence of turbulent models and thermal or density stratification, equations to describe bio-chemical processes. The principle of connecting hydrodynamic, transport-dispersion and bio-chemical modules into complex ecological model. The applicability of 1D, 2D and 3D models and presentations of case studies.

Remote sensing in environmental civil engineering (4 ECTS)

Basics of different technologies in remote sensing (satellite and airborne platforms – especially optical imaging systems, radar and lidar); digital image processing: useful techniques for pre-processing, enhancement, transformations and image classifications; visual image interpretation; current systems of remote sensing, types of products and procedures of data ordering; national topographic sources as spatial data layers for treating physical space: review of sources and their characteristics (vector/raster, contents, quality etc.); examples of applications in environmental civil engineering (planning, monitoring of environmental phenomena, dealing with natural disasters etc.).

Environmental Geotechnics (5 ECTS)
Fundamentals (origin of regulations, implications of regulations on engineering design, standards); Soil types and functions; soil as a conductor, isolator (barrier) or accumulator of pollutants; Fundamentals of contaminant release and contaminant transport in soils and groundwater; Techniques for the subsurface characterisation and monitoring of contaminant plumes and buried wastes; Physical and chemical characteristics of wastes; Landfills: introduction, design and construction of bottom and cover liner systems, Remediation of polluted land and abandoned landfills; Geosynthetics in environmental geotechnics; Solid wastes as a source of alternative construction material.

Meteorology (3 ECTS)
Composition of the atmosphere, basic meteorological variables, air pressure field and its changes, quasi-stationary winds at upper levels and close to the ground. Air pressure and temperature measurement, temperature field. Diabatic and adiabatic changes, stability of the atmosphere, convection, moisture in the atmosphere, phase changes for water in the air, formation of clouds, fog and precipitation. Energy balance of ground surface, heating/cooling of the ground and air close to it. Synoptic processes and phenomena: cyclones, anticyclones, fronts. Macro- and meso-meteorological phenomena: planetary boundary layer, thunderstorms. Principles of weather forecasting, numerical weather prediction. Elements of climatology, physical bases of climate and climate change.

Open Sea And Coastal Area (4 ECTS)
Marine legislation, EU Marine strategy framework directive. Basic terminology of oceanography, differences between open and coastal seas. Mass, heat and salinity balance. Equations of motion and forcing factors in marine environment; barotropic and baroclinic flows, Coriolis force, Ekman transport and Ekman pumping. Wind waves, tides and other sea-waves. Use of numerical models in simulations of sea dynamics. Boundary conditions and source/sink terms in mass conservation, momentum and advection-dispersion equations. Forces and stress, mass and heat fluxes at boundaries with other environmental compartments. Near-shore processes due to waves, tides and river inflows. Basic measures for protection of coastal regions (off- and on-shore). A two-day excursion and field-work, practical cases.

River engineering (8 ECTS)
River engineering basics: river hydraulics, river mechanics (bed load and suspended loads), river morphology, erosion and sedimentation. Classic river engineering: flood protection works, river channel works, dimensioning and maintenance of different river structures, weirs and fish passages. Natural river engineering: river corridor, hydromorphological status of rivers, basics of bioengineering, catalogue of river bioengineering river works, planning and maintenance of river bioengineering works. Modeling of river water and sediment flow on a physical (hydraulic) model. Hydraulic computation of a selected river reach.

Water policy (4 ECTS)
Baseline water management and environmental protection. Culture and tradition in water management. Legal basics, principles and doctrines of water law. Characteristics and interests of different activities. Floods and droughts. Information systems in water policy. Geographic information systems, characteristics, standards. Determination of water balance. Determination of the impact on the environment and their evaluation. Evaluating and comparing interventions in the water regime. Economic base of water policy. Methods for determination of optimal solutions. Water policy and public participation.

Drainage and irrigation (6 ECTS)

The importance and types of drainage and irrigation systems, drainage and irrigation programme in Slovenia and abroad. Impact of the climate change. Principles of soil hydrology: water in nature, soil water balance, analysis of the parameters, plant and water, soil and water. Drainage: types of drainage systems, soil science, groundwater, planning, construction and maintenance of drainage systems, drainage in specific circumstances, project of the drainage system. Structures for flood protection. Irrigation: the importance and impact of the irrigation on food production, types of irrigation systems, natural resources and the selection of irrigation system, irrigation methods, design, construction and maintenance of irrigation systems, use of pesticides and herbicides. Facilities in the irrigation system. Economics of drainage and irrigation: the profitability of investments in land improvements, financing methods. Land improvements and protection of the environment: space and nature conservation aspects of drainage and irrigation. Integrated land reclamation: a comprehensive approach to regulating land and agricultural infrastructure, agricultural land planning. Protection of water resources. Planning of water resources use.

Water protection (5 ECTS)

Acquainting with types and sources of pollution and pollutants. Short description of monitoring surface waters. Basic of hydrological and biological cycles (hydrological, oxygen, carbon, nitrogen, sulfur, metals). Basic concepts of kinetics and modeling of natural processes (rivers, lakes, ground water, sea) and in artificial wastewater treatment plants will be described. Engineering methods of integration of natural processes (self-cleaning ability of nature) with artificially controlled processes in sewage treatment plants and other man-made systems will be discussed. You will learn basics of applied limnology and optimization measures to protect the water. We will stress importance of integrating natural self-cleaning ability of water and soil in the planning of water protection works and engineering methods to protect watercourses and artificial fertilization of groundwater. You will learn the designing discharges of water flowing into the sea and base protection of bathing water.

Water Management Systems (4 ECTS)

Placement of water management in classification of activities, conceptual design of watermanagement systems and regulations, water management postulates, principles, goals and tasks (in public interest), approaches included in water management (BEP, BAP, PPP, FCR, etc.). Institutional frameworks of water management activities, organisational structure of stakeholders and public participation, policy regarding water and legal status of waters, comparison with international conventions and organisations, concept of control, monitoring and data sources, and conformity with adequate EU directives. Integral water management principles, development directions of water management systems and regulations, connection to water environment protection planning, sectorial, spatial and financial planning.

Practical Training (6 ECTS)

Students become acquainted with and perform the work carried out by graduates of this master's programme. They mainly learn about the organisational structure of a construction company and the day-to-day activities in a construction company. They may also work in the field at open building sites, or perform less demanding tasks on current projects in the office.

Spatial planning for flood protection (5 ECTS)

Introduction and to spatial planning, foundations of sustainable planning and overview of legal foundations of spatial planning. Overview of state of the art in spatial planning in EU countries. International planning. Planning on state level. Regional planning. Urban and landscape planning. Local and detail planning. Flood control on all level of spatial planning.

Legal aspects of spatial planning. Comprehensive and sect oral planning. Sustainable planning. Examine of good practice. Planning with respect to flood protection on state, regional and local levels, Local and

site planning with respect to flood control and protection and flood mitigation by spatial planning. Methods and .techniques. Site analysis. Spatial data collection and procession. Attractiveness vulnerability mapping, Flood impact analysis, environmental impact analysis and spatial planning. Methods and techniques of urban planning with respect to flood control. Project planning and flood protection by structural and non-structural measures.

Socioeconomical assessment of flood protection (5 ECTS)

Introduction in socioeconomics aspect of water policy and flood protection. Communication and public participation in water policy (Aarhus c.). Sociological aspects of flood risk perception. Legitimization and communication of emergency information. Public opinion v. expert knowledge. Public perception of floods and emergency information vulnerability. Stakeholders competences in communicating flood warnings. Basic principles of water policy. Social and economical aspects of decision making process. Different cultural and political aspect in up-down and down-up decision making process. Historical overview.

Understanding o social assessment problems of flood protection. Economy of flood protection. Cost-benefit analyse of flood protection measures and decision making. Economical methods for damage evaluation. Economic incentives for flood prevention and regulative aspects. Risk management.

Slope processes (4 ECTS)

Forms of slope processes, causes of their formation, triggering factors, field research. Hydrotechnical and geotechnical measures for mitigation and stabilisation of landslides and rockfalls. Basics of handling natural risks: legislation, arrangements, active and passive measures, documentation of landsliding, mapping of phenomena and hazards. Mitigation of landslides in Slovenia.

Torrent, Erosion, Rockfall and Avalanche control (4 ECTS)

Introduction to torrent control: historical overview, problematic and control concepts, legislation and planning, standardisation. Basics of torrent, erosion, rockfall and avalanche control: headwaters hydrology, soil erosion, torrent hydraulics, initiation and dynamics of mass movements (debris flows and mudflows, stone falls and rockfalls, mechanics and dynamics of snow cover and avalanches, sediment balance. Torrent, erosion, rockfall, and avalanche control: soil erosion control (soil bioengineering), torrent control (torrent control works), avalanche control (avalanche protection works).

Environmental Technologies (4 ECTS)

This course will present the latest environmental technologies as well as integrated solutions for environmental problems. Topics include: Earth's carrying capacity, climate change impacts, natural resources –water supply in particular and advanced treatment and management of drinking and waste water; advanced treatment of leachate and highly loaded wastewater with membrane and advanced oxidation processes and cavitation; remediation of soils; gas treatment; ecoremediation; water reuse, zero waste paradigm and approaches for integrated solutions of environmental problems. Students are expected to analyse given environmental problem from different aspects.

Numerical methods in fluid dynamics (5 ECTS)

Basic equations of fluid dynamics: continuity, dynamic, equation of state, energy equation, advection-diffusion transport equation, source terms for biogeochemical processes. Basic principles of solving hydrodynamic problems, initial and boundary conditions. Unsteady free surface flows: waves in fluids, St.Venant equations, numerical methods, initial and boundary conditions. Two-dimensional problems, movement of non-Newtonian fluids (debris flows, snow avalanches).Water hammer analysis in pipeline systems under pressure. Computation of mass oscillations in surge tanks. Description of three-dimensional numerical models for computation of flows and pollutant spreading in surface waters: Reynolds equations, turbulence models, numerical methods.

Hydraulic machines and devices (4 ECTS)
Knowledge of basic physical laws of energy conversations and specifics. Knowledge of hydrodynamic phenomena in water management systems, equipped with hydraulic machinery and devices. Fields of application and connection with the environment, expressed through hydraulic boundary conditions. Facility design and operation conditions. Turbine machinery and water management equipment. Model testing of hydraulic machinery, determination of the integral characteristics and hydraulic conditions impact on them. Experimental methods on micro and macro scales. Technical requirements and integral operating conditions in the selection of the equipment. Measurements in laboratory. Transfer of model results to the situation in water structures.

Hydroelectric Power (4 ECTS)
Within this course the students will meet with the operation of electric power industry, the role of water energy in the overall energy balance, planning the energy usage of water resources: design of accumulations and other hydraulic structures, an assessment of energetic and economic factors for planning of hydropower production, planning of hydropower plants, operational optimization of hydropower plants, and environment aspects of planning. Acquired competence of this course is capability of designing and planning of hydropower plants and their role and placement in the frame of electric power industry.

Decision support systems in water management (5 ECTS)
Theory of decision making process and tools for the simulation of the decision making process; decision making process in the multi-objective environment, Pareto-optimal frontier, scenario identification; status identification and decision-making variables, tools for the status identification; resolution problem in decision-making process, aggregation, dis-aggregation; validation in complex system modelling, data and information redundancy; mechanisms and tools for the prevention against wrong/sub-optimal decisions; role of the DSS scope identification.
Managing uncertainties and risks in the DS process; end user experience, integration of user experience, back-loop approach in use and development of DSS, project definition, SCRUM approach, limits of SCRUM; OLAP (Online Analytical Processing) and concepts derived from it, dynamic status follow-up, concept of transactional understanding of the system and transactional modelling. Classification of the decision support systems (single use, multiple use, data driven, model driven etc.); uses of decision support systems in environmental engineering (engineering, economics, institutional; nowcasting, optimization. Classification systems as backbone to large decision support systems, role of classifications; challenges of the future DSS developments (international environment, automatic systems, learning systems).

Hydraulic Structures (8 ECTS):
Within this course the students will meet with the problem of designing, construction and exploitation of dams and other hydraulic structures: a historical overview of the dam construction development, preparing of the project for the planning of dam structures, basics of the design of typical dams (embankment dams, concrete-gravity dams, arch dams), monitoring and safety assurance during the exploitation of those structures, review and a plan of basic types of hydraulic gates, basics of the design of hydraulic structures (intake structures, channels, tunnels, surge tanks, …). Acquired competence of this course is capability of designing and planning the dams and other hydraulic structures.

Landscape Planning (4 ECTS):
Concept of landscape and basic starting points for landscape planning. Landscape analysis and valuation. Landscape protection, management and design. Influences of infrastructural interventions on landscape and measures for their reduction. Landscape repair. Landscape techniques: relief design, land

treatment, planting (selection of plants, planting forms, planting plan, realisation procedures), remediation of biotopes and arrangement of supplementary biotopes, plantation maintenance.

Introduction to research work (4 ECTS)
Basics of communication in research and scientific work; writing a rough draft; search and review of scientific literature; preparation of proposals; final works and dissertations; publication in scientific journals; text formatting; reviews and corrections; publication of data; professionalism, ethics and legal aspects of publishing research results; scientific presentations (scientific and professional seminars, job interviews); text message and visualization of presentations; oral presentations; poster presentations; round tables and debates; communication with the laymen.

Project in infrastructural systems (4 ECTS)
Infrastructure systems concept and infrastructure characteristics, infrastructure development and its impact on space, urban and regional development, the legal basis of infrastructure placement and infrastructure development, infrastructure as operational instrument of spatial planning documents, technical infrastructure financing, public infrastructure planning, management and disposal of infrastructure systems, public infrastructure records, infrastructure as a built public good, relationship between owner and public service contractor, accounting for assets depreciation and use of infrastructure, compensation for the use of infrastructure.

Selected topics from mathematics III (4 ECTS)
Ordinary differential equations: systems of linear equations, boundary problems; Fourier series; partial differential equations: the method of characteristics, wave and heat equations; examples of mathematical modelling

Ecohydrology (4 ECTS)
Ecohydrology as interconnection between hydrological, biogeochemical and biological processes. Cycling of water, matter, energy in hydrosphere and geosphere. Spatial and temporal changeability of rainfall runoff formation. Processes of flushing and dissolving of matter: erosion processes, inflow of dissolved matter in water bodies, dynamical equilibrium of ecosystems. Seasonal regimes: seasonal variability of hydrological conditions and processes; seasonal variability of biogeochemical conditions and processes. Anthropogenic impacts on hydrological and biogeochemical conditions in water bodies (agriculture, industry, urbanisation, river regulations). Monitoring of ecohydrological processes: hydrological monitoring, monitoring of physical and chemical water parameters. Modelling: modelling of hydrological processes, modelling flushing of matter, modelling of biogeochemical processes.

Geotechnics of Infrastructural Facilities (4 ECTS)
Methods of soil improvement (pre-loading, radial consolidation, dynamic compaction, stone columns, grouting, jet grouting, methods of surface and deep mixing with inorganic and organic binders). Groundwater flow through saturated isotropic and anisotropic soil (buoyancy, critical hydraulic gradient, hydraulic fracture (hydraulic failure, internal erosion, piping). Earth dams: flow of water through the dam, measures to reduce the adverse consequences, filter design, stability of earth dams under static and dynamic (seismic) conditions. Liquefaction of soil. Use of geosynthetics: sealing, filtration, separation and reinforcement. Analysis and management of geotechnical risks Fundamentals of rock mechanics (classification of rock, mechanical properties of rock, Hoek&Brown failure criterion, Structurally controlled instability of blocks and wedges Schmidt's projection, Markland test, analytical and numerical methods). Basics of design and construction of tunnels (technology, machinery, support measures, primary and secondary stress states, the principles and methods for the design, geotechnical monitoring). Fundamentals of numerical methods in geotechnics (nonlinear elasto-plastic models for soils, principles of non-linear numerical analysis).

Master's Thesis/Work (30 ECTS)

Master's thesis is made under the supervision of a selected habilitated teacher who participates in the study programme. The work is publically presented at the end of the study. It should contain: Introduction, Working hypothesis, Literature overview, Materials and methods, Results, Discussion, and Summary. The master's theses generally deal with practical problems of environmental civil engineering (mainly regarding water regulation and management and municipal infrastructure), to which they provide solutions based on the students' in-depth research.