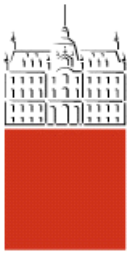
University
of Ljubljana

Faculty
of Civil and Geodetic Engineering



Presentation of the study programme

1st CYCLE ACADEMIC STUDY PROGRAMME
WATER SCIENCE AND ENVIRONMENTAL ENGINEERING (BA)

Valid from study year 2018/19

1. Information about the study programme

The first cycle bachelor degree study programme *Water Science and Environmental Engineering* is a 180-credit 3-year programme (6 semesters). The study programme does not include orientations. The study program is carried out as a regular and a part-time study.

2. Basic goals of the programme

Graduates of the bachelor's study programme Water Science and Environmental Engineering will acquire general fundamental knowledge of natural and social sciences, as well as applicable expert (civil)engineering skills for solving elementary administrative procedures and designing, planning, implementing and maintaining less 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, students will also learn the traditional principles of water science and the latest achievements of the profession, 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 the essentials of interdisciplinary 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 in business with clients in administrative procedures, procedures of public procurement, and designing of structures and measures. The students will have the opportunity to test all the acquired theoretical 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 bachelor'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 second cycle (i.e. master's degree) programmes.

3. General competences

General competences acquired by the graduates of the bachelor'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 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 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 fundamental knowledge of basic natural and social sciences and fundamental expertise from the area of civil engineering, water science and municipal engineering,
- ability to consider the basics of engineering economy and 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 less demanding civil engineering structures in the area of water management,
- independently designing of individual elements of less demanding civil engineering structures in the area of water management but does not design the entire structures,
- independently and creatively performing certain (less demanding) tasks from the area of water management, environmental and municipal engineering,
- taking part (within a group) in planning, design and implementation of different interventions into the aquatic environment
- involvement in the preparation of spatial planning acts,
- coordinating work between investors, designers and contractors,
- knowing the basics of legal, institutional and administrative system essential for water management and for managing and recording water resources,
- the graduates are qualified to oversee smaller water management companies.

5. Conditions for enrolment

The first cycle bachelor's study programme *Water Science and Environmental Engineering* is available to the candidates who:

a) passed the general matura exam;
b) passed the professional matura exam at a secondary school programme and additionally one of the courses of the general matura exam; the selected course should not be the same as already passed by the candidate for the professional matura exam;
c) finished any of the four-year secondary school programmes before 1. 6. 1995.

The study programme is also available for candidates who acquired equivalent education abroad.

The number of places is determined in the Call for enrolment into first 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:

the candidates under items a) and c) shall be selected according to their:	
general success in general matura exam or school-leaving exam	60 %
general success in the 3rd and 4th years of the secondary school	40 %
the candidates under item b) shall be selected according to:	
general success in the professional matura exam	40 %
general success in the 3rd and 4th years of the secondary school	40 %
success in extra matura examination	20 %

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 skills, 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 – e.g. exams, preliminary exams, etc. - 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 are allowed to enrol to the second study year after completing by the end of the academic year all the obligations foreseen by the study plan thus achieving 60 credit points according to ECTS. Students may enrol to the third study year after completing by the end of the academic year the obligations foreseen by the study plan and achieving at least 54 credit points according to ECTS.

Under exceptional circumstances students may be permitted to proceed without successful completion of the obligations defined to proceed to the higher year of the study programme, provided they have justifiable reasons as defined by 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 45 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 bachelor's study programme *Water Science and Environmental Engineering*. Students have class mentors in all three years, and smaller groups of students have individual tutors who will either be academic staff members or higher 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 bard the principles of faster progress are determined.

9.2 Conditions for repeated enrolment in the same year

Failing to meet the obligations defined by the study programme for advancement in the next 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 first cycle bachelor 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 first 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 first cycle bachelor 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 higher year of the first cycle bachelor study programme *Water Science and Environmental Engineering*, the candidate may enrol to the higher year of the first cycle bachelor study programme *Water Science and Environmental Engineering*.

11. Conditions for completion of the study

Students finish the study by accomplishing the prescribed obligations totalling 180 credit points according to ECTS, including practical training and diploma thesis.

12. Conditions for completion of individual parts of the programme

The Study is uniform.

13. Qualification, professional or academic title

diplomirani inženir okoljskega gradbeništva (UN)
(first cycle graduate in water science and environmental engineering)

diplomirana inženirka okoljskega gradbeništva (UN)
(first cycle graduate in water science and environmental engineering)

14.Qualification, professional or academic title (abbreviation)

dipl. inž. ok. gradb. (UN)

15. Classifications

- KLASIUS-SRV: Higher university education (first cycle Bologna)/higher university education (first cycle Bologna) (16204)
- ISCED: architecture, urbanism and civil engineering (58)
- KLASIUS-P: Civil engineering (other) (5829)
- Frascati: Technical sciences (2)
- Level SOK: Level SOK 7
- Level EOK: Level EOK 6
- Level EOVK: First cycle

16. Study programme courses, Syllabus

1st YEAR									
	Contact hours								
1st semester	**L**	**S**	**ST**	**LT**	**FW**	**OW**	**ΣCH***	**ΣSO***	**ECTS***
Mathematics I	75	-	75	-	-	-	150	**300**	**10**
Physics	75	15	45	-	-	-	135	**270**	**9**
Fundamentals of Freshwater Ecology	30	-	-	20	10	-	60	**120**	**4**
Introduction to Environmental Engineering	45	15	30	-	-	-	90	**180**	**6**
Total 1st semester	**225**	**30**	**150**	**20**	**10**	**-**	**435**	**870**	**29**
2nd semester	**L**	**S**	**ST**	**LT**	**FW**	**OW**	**ΣCH***	**ΣSO***	**ECTS***
Mathematics II	60	-	60	-	-	-	120	**240**	**8**
Basic chemistry	30	-	-	30	-	-	60	**120**	**4**
Geodetic Engineering	30	-	-	30	-	-	60	**120**	**4**
Hydrology	30	25	-	30	5	-	90	**180**	**6**
Construction and Building Materials	30	-	-	30	-	-	60	**120**	**4**
Digital Design and Programming	15	-	-	60	-	-	75	**150**	**5**
Total 2nd semester	**195**	**25**	**60**	**180**	**5**	**-**	**465**	**930**	**31**

2nd YEAR									
	Contact hours								
3rd semester	**L**	**S**	**ST**	**LT**	**FW**	**OW**	**ΣCH***	**ΣSO***	**ECTS***
Hydromechanics	45	-	-	30	-	-	75	**150**	**5**
Introduction to Structural Mechanics	75	-	45	-	-	-	120	**240**	**8**
Mathematics III	60	-	45	-	-	-	105	**210**	**7**
Secondary and Waste Materials Management	45	-	45	-	-	-	90	**180**	**6**
Elective course Statistics	30	-	30	-	-	-	60	**120**	**4**
Total 3rd semester	**255**	**-**	**165**	**30**	**-**	**-**	**450**	**900**	**30**

4th semester	L	S	ST	LT	FW	OW	ΣCH*	ΣSO*	ECTS*
Introduction to Sanitary Engineering	30	-	-	30	-	-	60	**120**	**4**
Hydraulics	30	15	-	30		-	75	**150**	**5**
Applied Ecology and Ecotoxicology	30	-	-	30	-	-	60	**120**	**4**
Soil Mechanics and Engineering Geology	60	-	-	40	5	-	105	**210**	**7**
Communal Technical Infrastructure	30	-	30	-	-	-	60	**120**	**4**
Organization of Construction Works and Operation	45	-	45	-	-	-	90	**180**	**6**
Total 4th semester	**225**	**15**	**75**	**130**	**5**	**-**	**450**	**900**	**30**

3rd YEAR									
5th semester	Contact hours								
	L	S	ST	LT	FW	OW	ΣCH*	ΣSO*	ECTS*
Introduction to Economic Analysis	45	-	-	-	-	-	45	**90**	**3**
Roads and Traffic	45	-	-	45	-	-	90	**180**	**6**
Introduction to timber and steel structures	30	-	30	-	-	-	60	**120**	**4**
Geotechnical Engineering	45	10	-	30	5	-	90	**180**	**6**
Introduction to Drainage Engineering	40	-	15	-	5	-	60	**120**	**4**
Fundamentals of Spatial Planning	45	-	-	60	-	-	105	**210**	**7**
Total 5th semester	**250**	**10**	**45**	**135**	**10**	**-**	**450**	**900**	**30**
6th semester	**L**	**S**	**ST**	**LT**	**FW**	**OW**	**ΣCH***	**ΣSO***	**ECTS***
Introduction to Concrete and Masonry Structures	45	-	45	-	-	-	90	**180**	**6**
Practical Training	6	-	-	-	-	80	34	**120**	**4**
Elective course 2	60	-	45	-	-	-	105	**210**	**7**
Elective course 3	60	-	60	-	-	-	120	**240**	**8**
Diploma work	-	-	-	-	-	75	75	**150**	**5**
Total 6th semester	**171**	**90**	**135**	**-**	**-**	**80**	**424**	**900**	**30**

ELECTIVE PROFESSIONAL COURSES	Contact hours								
	L	S	ST	LT	FW	OW	ΣCH*	ΣSO*	ECTS*
Elective course Statistics:									
a) Basic statistics in water science	30	-	30	-	-	-	60	**120**	**4**
b) Advanced statistical methods in water science	30	-	30	-	-	-	60	**120**	**4**
Construction Technologies in Water Works	30	-	30	-	-	-	60	**120**	**4**
Operational research in civil engineering	45	-	30	-	-	-	75	**150**	**5**
Hydroinformatics	10	10	-	40	-	-	60	**120**	**4**
Hydrometry	30	-	20	-	10	-	60	**120**	**4**
Natural Disasters and their Impact on Environment and Society[1]	60	30	-	-	-	-	90	**180**	**6**

L – lectures; S – seminar; SP – seminar practicals; LP – laboratory practicals; FW – field work; OW – other work; CH – contact hours; SO – study obligations

* student obligations total 60 ECTS/year, which agrees with 1800 hours/year; hours include contact hours + independent work

[1] The course is intended exclusively to students of other study programmes, mainly from social sciences.

17.Possibilities of elective courses and mobility

The bachelor's study programme *Water Science and Environmental Engineering* foresees elective courses totalling 19 ECTS. One elective course is foreseen in the 3rd semester and two in 6th semester. 8 ECTS may be selected freely (from other study programs at the University of Ljubljana). Students are recommended to select their courses from the four professional elective courses proposed at the study programme *Water Science and Environmental Engineering* or among other professional elective courses proposed at the first cycle study programmes of UL FGG. They are recommended to select courses from the areas of civil engineering in either municipal or traffic module, and from the area of geodesy and geoinformatics.

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

18.Presentation of individual courses

18.1 Obligatory courses

Mathematics I (10 ECTS)

Sets and mappings: operations with sets, domain, range, equality of maps, composition, graph, injectivity, surjectivity, bijectivity, inverse map. Natural, real and complex numbers: induction principle, exact upper and lower bound (inf and sup), absolute value, complex numbers: geometric representation, operations, polar form, de Moivre formula, fundamental theorem of algebra. Geometric vectors: sum, product with scalars, linear combination, linear independence, basis, scalar product, vector product, mixed product, analytic geometry.

Numerical sequences and series: boundedness and convergence, Cauchy criterium, limit, computation rules, convergence of a series, geometric and harmonic series, convergence criteria. Limit and continuity of functions of one real variable: limit of a function at a given point, computation rules, generalized limits, asymptotae, continuity of a function, properties of continuous functions on closed bounded interval. Derivative of functions of one real variable: definition, tangent on a graph of a function, computation rules, theorem of Rolle and Lagrange, stationary points and local extrema, global extremum on a closed interval, l'Hospital rule, higher derivatives, Taylor formula, differential, concavity, convexity, inflection point, plotting graphs. Matrices: matrix operations, inverse matrix, matrix form of a system of linear equations, structure of solutions, Gauss elimination method, matrix equations, determinant, eigenvalues and eigenvectors, characteristic polynomial, diagonalization. Integral of functions of one real variable: definite integral, Riemannian sum, integrability, properties, Newton-Leibniz formula, primitive function, indefinite integral, substitution, integration by parts (per-partes), application of definite integral. Power series: convergence radius, derivation, integration.

Physics (9 ECTS)
Physics and measurements; (*)kinematics ; forces, torques, dynamics; momentum and angular momentum; work, power, energy; gravitation (Keppler's laws, Newton's gravity law, potential energy, motion of satellites); oscillations and waves; (*) structure of matter; (*) elastic deformations; (*) static of fluids: pressure, pressure measurements, Buoyant forces; temperature, various temperature scales, thermal expansion, equation of state for ideal gas; the first law of thermodynamics, internal energy, heat transfer(*) , phase changes; electrostatics (*); electric current (Ohm's law, work and power, electric instruments (*)); magnetism; (*) induction; electromagnetic waves; radiation of heated bodies; visible light; light sources (Sun, absorption of light in atmosphere, photometry); geometric optics (reflection and refraction of light, mirrors, lenses, optic instruments); wave optics: polarization and interference of light; photons as quanta of light; special theory of relativity. Topics labelled with (*) will be discussed in more detail at seminars or as assigned exercises.

Fundamentals of Freshwater Ecology (4 ECTS)
The elucidation of the following terms: biology, microbiology, ecology, environmental protection; abiotic characteristics of the running and standing inland waters, the physical structure of ecosystems, habitats and ecological niches; Inland water chemistry, circulation of matter, with an emphasis on organic matter and nutrients; biotic characteristics of standing water, biological communities of plankton and benthos; tropic status, causes and consequences of eutrophication; biotic characteristics of running water, biological communities of periphyton and benthic invertebrates; saprophytic status, self-cleaning processes; methods of biological evaluation of the ecological status of inland waters; pollution and loading of aquatic ecosystems; biological treatments and the role of microorganisms in decomposition processes; tertiary treatment and ecoremediation.

Introduction to Environmental Engineering (6 ECTS)
Environmental Engineering brings together many disciplines in order to: ensure healthy living and natural conditions for people and all living creatures on our planet, use renewable natural resources in efficient and sustainable way, minimize negative and maximize positive human environmental impacts, ensure public health... Introduction to Environmental Engineering gives an overview to this complex interconnection of disciplines and uses practical examples to explain engineering methods for analyzing and predicting environmental processes.

Lectures are composed from the following main topics: introduction, mission, history, connection to present day environmental problems; mass balances; energy balances; basics of bio-geo-chemistry: basic elements' cycles; basics of chemistry kinetics; population dynamics; water, soil, air, biota; transport models and fate of pollutants; risk analysis; life cycle analysis; environmental impact assessment. Acquired knowledge will help students to overcome the gap between theoretical and practical subjects. Practical exercises will be designed in a way that students can predict and understand possible outcomes and facilitate the understanding of theoretical background.

Mathematics II (8 ECTS)
Scalar functions of several real variables: metrics of the space Rn, domain, graph, isohipses, limit and continuity of a multivariate real function, directional derivative, partial derivative, gradient, stationary points, constrained extrema, global extrema, higher partial derivatives, Taylor formula, Jacobi matrix for vector function of a vector argument, chain rule. Double and triple integral: Riemannian sum, integrability, properties, transformation of double (triple) integral to twice (three times) univariate integral, substitution (polar, cylindric, spheric coordinates). Integrals with parameter: integration, derivation, functions gamma and beta. Differential geometry: path, curve, parameterization, curve length, natural parameter, basic trihedron, inflection, torsion, curvature radius, Frenet-Serre formulae, smooth elementary surface, parameterization, tangent plane, area. Line integral: line integral of a scalar field along a curve, curve orientation, line integral of a vector field along an oriented curve, Green formula. Surface integral: surface integral of a scalar field on a surface, surface orientation, surface integral of order 2. of a vector field on an oriented surface. Integral theorems: differential operators: grad, div, rot, theorems of Gauss and Stokes, gradient (potential, conservative) vector fields. Ordinary differential equations: solution, ODE of first order (separate variables, homogenous, linear), initial problem, linear ODE of order n with constant coefficients.

Basic Chemistry (4 ECTS)
Structure of matter; atomic structure; elements and compounds; mass and energy in chemical reactions; the periodic table and the electronic structure of atoms; chemical bonds; ideal and real gases; water and solutions; crystals; chemical kinetics and chemical equilibrium; surface chemistry; electrolytes and nonelectrolytes; electrochemistry; the chemistry of the main group elements and transition elements; ecology: air, water, energy.

Geodetic Engineering (4 ECTS)
Definition of geodesy, fields of geodesy (geodetic engineering), tasks of geodetic engineering. Shape and dimensions of the Earth. Coordinate systems, coordinates, cartographic projections. Geodetic networks. Theory of geodetic surveying (measuring, basic principles of theory of errors and adjustment). Terrestrial surveying (tools, angle measurements, distance measurements, height difference measurements, relative measurement techniques). Modern measurement systems and methods (TPS systems, 3D scanners, GNSS measurements). Basic principles of point coordinate determination (observation and coordinate space - calculation). Detail surveying (spatial data acquisition). Plans and maps (characteristics, manufacturing methods, types, usability). Geodetic records (land cadastre, building cadastre, DTM, GIS). General about surveying in building construction and other spatial planning methods (land use, obtaining land use permits, implementation of intervention). Basic stakeout methods. Geodetic works for infrastructural engineering (stakeout, construction monitoring, determination of the stability of the building – practical examples). Geodetic work for infrastructural engineering (geodetic layers,

stakeout, construction monitoring, measuring the load tests, determination of stability and deformation of a structure - practical examples). Hydrographic measurements.

Hydrology (6 ECTS)
The overview of the development of the hydrological science in Slovenia and in the world; Physical and chemical characteristics of the water; Water and energy cycle; The use of probability theory and statistics in hydrology (basics of the probability, theoretical and empirical distributions, frequency factor and probability papers, return period, regression and correlation); Characteristics of the atmosphere and their measurement; Precipitation (measurements, errors, analyses, intercepted precipitation, snow); Remote sensing in hydrology; Evapotranspiration (measurements, calculation methods, Penman- Monteith equation); Runoff (flow duration curve); Soil characteristics; Different types of water in the soil (soil moisture, springs, groundwater, infiltration, Darcy's law); Water balance; Climate change and climate variability; Hydrometry (measurements of water depth, water level and velocity, measurement of discharge, stage – discharge relationship; Uncertainty of hydrometric measurements and analyses (theory of error); Basics of river hydraulics..

Construction and Building Materials (4 ECTS)
Systematic review of construction and building materials and their characteristics (classification according to chemical structure, application and origin). Basics of standardization, construction and building materials in standards and regulations for the design and construction of buildings and civil engineering structures (Construction Products Regulation, harmonized standards, Eurocodes). Fundamentals of chemical, physical and mechanical properties of construction and building materials and their identification and quantification by means of testing. Ceramics: stone; building ceramics and glass; mineral binders, mortars and renders and plasters; concretes. Metals: ferrous and non-ferrous metals and metal alloys. Polymer materials: plastics; bitumen and asphalt. Composite materials: plastic composites (particle- and fibre-reinforced plastic, properties, application); natural building materials (wood, paper and other natural fibre materials). Re-use and recycling of materials and construction products. Incorporation of secondary raw materials in the construction products. Selected methods of materials testing.

Digital Design and Programming (5 ECTS)
The basics of computer graphics: Classification: software package for computer graphics and management of geometrical shapes. CAD Basics: CAD environment, precision, scale, layers, lines, hatches, dimensioning, printing – model spaces and paper space, formats and exchange of geometrical data structures. Geometrically defined problem solving procedures (the use of geometry in civil engineering, in computational models, methods depending on complexity).
Data Structures: types of data structures (basic and derived data structures); organization and computer representation of geometrical and non-geometrical engineering data; design of relational databases (modelling, database normalization, first and second normal form); SQL basics for engineers (syntax and practical use of SQL); the design of database tables, queries, forms and reports.
Automatic processing and programming: computer assisted processing of data by problem type (pre- and post-processing and parsing); basics of deterministic regular expressions and its use of automatic data processing; OLAP – On-line analytical process, pivot tables and data visualization.
Programming for engineers: Algorithms, procedures and classification of functions Programming (basics of Matlab and/or Mathematica – practical examples of real-world scenarios); 2D and 3D graphics using built-in Mathematica functions.
Hydromechanics (5 ECTS)

Fluid properties, comparison of hydromechanics and solid mechanics (differences). Basic equations: continuity, momentum, energy, equation of state. Principles of solving hydrodynamic problems. Hydrostatics: pressures and forces on flat and curved planes, buoyancy, stability of floating bodies. Kinematics of ideal incompressible fluid: streamlines, path lines, streak lines. Velocity curl, examples of rotational flow, irrotational (potential) flow and examples from civil engineering practice. Dynamics of ideal incompressible fluid: energy, Bernoulli, Cauchy equations. Momentum theorem. Groundwater flow, Darcy's law. Flow of real fluid: dynamic similarity, laminar and turbulent flow, boundary layer, fluid drag. Convective-diffusion equation for mass turbulent transport in water.

Introduction to structural mechanics (8 ECTS)
Part 1: Engineering description of various types of structures and their supports and connections. Basic concepts of structural modelling by using trusses, beams, plates and shells. Models of structural loads. Statically determined planar trusses: concepts and definitions; principles of equilibrium; analytical solution methods. Statically determined planar frames: concepts and definitions; equilibrium equations; methods and methodology. Displacements, rotations and deformed shape in planar beams: concepts; differential equations for displacements; boundary conditions; integration of boundary-value problem for continuous tractions; engineering interpretation of results; deformed shape, internal forces and reactions. Simple statically indeterminate frames: degree of static indeterminacy; basic concepts of displacement- based method of analysis. Geometrical characteristics of planar cross- sections: area; static moment; inertial moment; composite cross-sections.
Part 2: Concept of continuum: body and its position in mathematical space. Strains: displacements, strain tensor, engineering meaning of small strains. Stresses: stress vector; stress tensor; normal and shear components; stress resultants; equilibrium equations and boundary conditions. Material equations (or constitutive equations): linearly elastic material as a material model for steel, concrete and soil; uniaxial, shear and triaxial tests; experimental determination of material parameters; effects of temperature; effects of shrinkage and creep in concrete.

Mathematics III (7 ECTS)
Ordinary differential equations: linear differential equations of order n with constant coefficients, linear systems of differential equations of first order, characteristic polynomial, independence of solutions, matrix solution of initial problem, phase diagrams in two dimensions, boundary value problem. Partial differential equations: classification, equations of mathematical physics, linear equations of first order, method of characteristics, vibrating infinite and finite string, d'Alembert solutions, heat equation, Fourier series, initial and boundary value problem. Basics on graph theory: vertices, edges, isomorphism, adjacency and incidency, matrix presentation, path, cycle, walk, tree, Hamiltonian and Eulerian cycle, the shortest path problem, directed graph, weighted graph, connectedness, spanning trees, planar graphs. Examples of mathematical modelling.

Secondary and Waste Materials Management (6 ECTS)
Historical overview of waste material management; environmental policies; international agreements and legislation; properties and characteristics of secondary raw materials and waste and classification of waste; processing and treatment of secondary raw materials: physical-chemical processing; biochemical treatment; heat treatment; MBO of mixed municipal waste; disposal of waste to landfills; re-use of non-hazardous waste in construction products; circular economy and role of engineer; requirements for engineering barriers in repositories of high level or low and intermediate level radioactive waste

Introduction to sanitary engineering (4 ECTS)
Historical development of sanitary engineering. A platform for water supply and treatment of drinking water: selection of drinking water sources, consumption and quality of water, water supply systems and facilities, preparation, technological methods and techniques of treatment of drinking water. A platform for extraction and purification of polluted water from settlements: types and quantities of contaminated water, design of drainage systems in urban areas and highways and their dimensioning, basic technological methods and techniques for wastewater treatment, facilities for sewage water systems and waste water treatment plants, basics of protection against natural and other disasters.

Hydraulics (5 ECTS)
Use of real fluid equations for the understanding of hydraulic systems and hydraulic boundary conditions for the analysis of conventional hydraulic structures. Hydraulic design of structures, watercourses and facilities that students learn about from the technological and operational aspects in other subjects within the water management area. Characteristics and dynamics of real fluids (flow regimes). Flow in conduits (local and linear losses, simple pipe problems, pumps, pipe systems, simulation software). Orifice flow and water level balancing in two vessels (steady and unsteady flow). Flow over weirs, sills and dams. Flow in open channels (normal flow, combined profiles, hydraulically efficient channel section, and local disturbances). Stable river sections (coated and uncoated water courses). Steady non-uniform flow (gradually varied flow profiles, calculation of water levels, simulation software).

Applied Ecology and Ecotoxicology (4 ECTS)
Ecotoxicology and ecology (basic definitions, historical overview); structure and functioning of ecosystem, examples of different ecosystems; effects of human activities on ecosystem (pollutants, climate changes etc.); pollution of environment (sources, ways of determining pollution); effects of chemicals on organisms, toxicity; toxicity tests (basic understanding, types of tests, analysis of toxicity tests data, environmental risk assessment); overview of routine toxicity testing; biomonitoring (biomarkers and bioindicators); environmental policy overview; emerging topics in environmental pollution (nanotoxicology, endocrine disruptors).

Soil mechanics and engineering geology (7 ECTS)
Basics of geology (mineralogy, petrology, hydrogeology, tectonics); rocks: magmatic, metamorphic, sedimentary – stratigraphy; geological maps; erosion phenomena in geo environment; basic physical and mechanical properties of soils and rocks; basics of soil behaviour, laboratory and field investigations; classification of soils; standards in geotechnics; primary and additional strengths in ground, ground deformations; ground water, concept of pore pressure, effective and total stresses, water streaming; soil consolidation; ground and slope stability.

Communal Technical Infrastructure (4 ECTS)
Basic conceptual definitions; concept and role of municipal activities; cost aspects of municipal activity implementation; technical infrastructure within spatial planning document; building permit and construction of technical infrastructure; acquisition and development of building land; technical – technological characteristics of municipal networks, structures and devices; design and location conditions of technical infrastructure; technical conditions of building land development.

Organization of construction works and operation (6 ECTS)
Fundamental concepts from the field of organisation; role, importance and relationships among construction project stakeholders; resources for construction process; production factors, productivity, economics of construction; design of technology process; fundamentals of work productivity and payment of work; fundamentals of building/structure price determination and payment options; time and motion studies Fundamentals of quality assurance in construction industry, industrialisation of construction. Organisation of construction project; preliminary investigation, preparation works, construction site organisation building/structure maintenance and refurbishment management life cycle of building/structure; relevant legislature fundamentals of planning and management, scheduling and planning techniques; critical Path Method resource and cost planning.

Introduction to Economic Analysis (3 ECTS)
Thinking like economist. The role of economic analysis for engineers. Fundamentals of demand and supply. Consumer behavior. Demand for water services, water demand management, supply of water services, regulation of market for water services. Fundamentals of production and cost theories Costs of water services, cost theory, scarcity of resources, deriving supply curve in the field of water service. Time equivalent of money, interests and principle of equivalence – theory of cost and benefit analysis. Present value and internal rate of return. Examples of evaluation in the field of water management (different mass evaluation, political decisions). Cost evaluation for engineers, evaluation of benefits, analysis of costs and benefits. Investment documentation, preparation of investment documentation, types of investment documentation, examples, treatment of investment documentation, risk management. How to choose the best project? C/B analysis, hierarchical decision trees, data models, cases. Market structures – perfect competition, monopoly, oligopoly. Economic analysis of public sector. Fundamentals of macroeconomics.

Roads and traffic (6 ECTS)
Transport policy; planning and environment; Road distribution; project documentation; Cross-section of the road; horizontal leading of road axis; vertical leading of road axis; space interaction of the road; sight field; friction; widening of the road; water management; surfacing; road objects; intersections; bicycle infrastructure; pedestrian infrastructure; traffic calming; parking facilities; traffic signalization.

Introduction to timber and steel structures (4 ECTS)
Timber structures: Advantages and disadvantages of timber structures. Physical, mechanical and rheological properties of structural timber in dependence of the environmental conditions; criteria for the classification of timber into strength classes. Bases for the design of wood structural elements. Ultimate resistance and design of structural elements made of solid timber at axial, axial-bending and shear loading. Specifics of calculation and limitations of deflections of timber structures. Measures for the protection of timber structures against the impacts of environment and fire. Basic rules for the execution of joints and detailing of timber structures.
Steel structures: mechanical properties of steel. Technological procedures of steel processing and standard steel qualities. Concepts of design of steel structures. Manufacturing and assembly of steel structures. Valid standards and regulations for the analysis and design of steel structural elements. Protection of steel structures against fire and corrosion. Connecting elements and joints (welds, bolts, rivets, pins).

Geotechnical engineering (6 ECTS)
Earth pressures; Limit stress states in the ground – bearing capacity; shallow foundations (ground investigations, design and technologies); fundamentals of deep foundations (technologies, bearing capacity, settlements); criteria for the choice of foundation type; retaining structures ; ground treatment and fundamentals of soil improvement; design and construction of embankments; design and construction of cuts ; balance of soil masses in earthworks; basic concepts of the use of geosynthetics; groundwater flow; fundamentals of design and construction of dams and dykes.

Introduction to drainage engineering (4 ECTS)
Capture, retention and discharging rainfall surface runoff waters: design and implementation of deep and shallow drainage, design of water reservoirs. Control of smaller surface waters: design and execution (roadside ditches, steep chutes, sills, overflows, canalettes, intake structures, culverts). Surface soil erosion during construction and anti-erosion measures during and after construction. High waters; temporary and permanent flood protection measures; flood-safe construction of buildings; assessment of adequate flood protection of urbanized areas against their own and rainfall surface runoff waters.

Fundamentals of Spatial planning (7 ECTS)
Fundamentals of spatial planning, basic terminology in spatial planning, searching for literature and resources on the World Wide Web and in libraries, mapping (surveying) groundwork and designs, databases and their accessibility, legislative framework of spatial planning and inclusion of the public in spatial planning, space as development potential spatial restrictions, basic planning tools, e.g. the map overlay method. In second part is following elaboration of spatial analyses, population (demography), settlement system, transport and other public infraworks, landscape (green systems). In conclusion succeed synthesis in spatial planning.

Introduction to concrete and masonry structures (6 ECTS)
Main mechanical and rheological properties of concrete and reinforcing steel. Starting points for the analysis and design of concrete structural members. Limit state design of concrete structures. Ultimate resistance and design of reinforced concrete cross-sections to combined bending and axial force (large and small uniaxial eccentricity of the axial force). Use of tables and interaction diagrams for the design of reinforced concrete cross-sections. Ultimate resistance and design of reinforced concrete elements exposed to shear and torsion. Simplified calculation of crack widths, crack spacing and deflections of reinforced concrete members. Basic principles and rules for reinforcing of concrete structural members. Mechanical properties of bricks, mortar and masonry. Load-bearing mechanisms and design of masonry structures subjected to bending, axial and shear loading. Execution of earthquake resistant simple masonry structures.

Practical Training (4 ECTS)
Preparation of hydrological studies; preparation of hydraulic accounts for less demanding installations; implementation of field measurements; implementation of less demanding installations in the context of public water management services; participation at construction sites in the construction of less complex objects; production of cartographic bases and presentations for the design of interventions in the water space; participation in procedures for issuing approvals for interventions in space in public administration at local and national level.

Diploma work (5 ECTS)
Thesis shall be made under the supervision of a selected teacher. The work is presented in public at the end of the study. It must include:

- Introduction
- The working hypothesis
- Overview of sources
- Material and methods
- Results
- Discussion
- Summary

The thesis will ordinarily deal with practical professional problems or research themes from the area of water science, environmental engineering or environmental civil engineering that provide solutions derived from the study and from the results of students' own work.

18.2 Elective courses

Basic statistics in water science (4 ECTS)
Introduction to statistics, data representation; theory of probability (introduction, event, probability of an event), Bayes theorem and its use in simple civil engineering cases, decision trees, project management; random variables and vectors, derived distributions, moments; distributions commonly used in technical applications: binomial, Poisson, exponential, Pearson, normal, log-normal, extreme value distributions; the use in hydrology, structural engineering, traffic engineering; sampling, characteristics of basic statistics, sample mean and variance; parameter estimation (point and interval estimates); hypothesis testing (introduction, some commonly used statistical tests, general statistical tests, e.g. hi-squared goodness- of-fit test); bivariate analyses (hypothesis testing of statistical and linear independence, linear and non-linear regression, the use of the least squares method); analysis of variance with some examples from civil engineering.

Advanced statistical methods in water science (4 ECTS)
Basic Monte Carlo method, random variate/vector generation, generation of random fields, variance reduction methods. Spatial statistics, random fields and processes, variogram, covariance function, kriging. Robust statistics, the definition of robustness measures of some basic statistics, comparison between common and robust statistics, application of robust statistics in linear regression. Analysis of variance, sampling with or without repetitions, post-ANOVA methods.

Construction Technologies in Water Works (4 ECTS)
General design principles in relation to water works types (riparian structures, weir structures etc.); field work and laboratory studies: (1) geological and tectonic investigations of the construction impact area (geological, geotechnical, geophysical investigation methods); (2) geomechanical investigations required for foundation work and investigation of material localities (geomechanical, seismotectonic investigations); (3) foundation and hydraulic stability of structures – anti-filtration measures. Construction site organisation in the impact area of water: (1) construction pit execution; In the dry and underwater; (2) construction pit protection measures (protection of banks, anti-filtration measures etc.); (3) construction machinery and equipment for execution and protection of construction pits under water. Technology of water works: (1) construction of riparian and weir constructions from conventional materials (concrete, earth, rockfill etc.); (2) construction of riparian and dam structures from non-conventional materials (roller compacted concrete, soil stabilization etc.);

(3) use of conventional and special linings for anti-erosion protection of structures; (4) choice and preparation of building materials (site analysis, off-site/on-site transport, preparation of material for building, organisation of building in relation to type, material etc.); (5) construction machinery; (6) provision and quality control in construction.

Operational research in civil engineering (5 ECTS)
Introduction to mathematical programming; linear programming, Simplex method; nonlinear programming, Newton's method, genetic algorithms; dynamic programming, discrete dynamic programming; basics of stochastic processes, Markov chains; problems of decisions, decision trees; introduction to simulations, different approaches and types of simulations; introduction to geoinformatics, the role of GIS technology; graphical data bases; the overview of spatial analyses.

Hydroinformatics (4 ECTS)
Theoretical basis of hydro-information systems. Review of data related to water management (state and municipal level). Spatial depiction of hydro-information systems (state and municipal level). Preparation of data sources (search, querying, linking, ... in databases) for water systems modelling. Data mining on hydro-information systems to support decision-making in water management.

Hydrometry (4 ECTS)
Basics of the measuring techniques: terminology and standards (ISO 772). Measurements of the stream channel: classic methods and remote sensing. Measurements of water level: classic methods. Discharge measurements: different methods and discharge curve. Measurements of river sediment transport: sediment sampling, turbidity measurements (suspended solids), measurements of bedload transport, water quality sampling and dissolved solids concentrations. Hydraulic structures for measuring surface flow: weirs. Network of hydrological stations: monitoring system. Analysis of measurement errors and quality control: data recording, data transmission and archiving (data bases), procedures of quality assurance, statistical and analytical errors, uncertainty. Special chapters: weather radar, satellite remote sensing, trace studies (isotopes), dendrochronology, sediment age analysis.

Natural Disasters and their Impact on Environment and Society[1] (6 ECTS)
Definition of the types of natural disasters. Organisation framework for performing the protection and rescue tasks: types and competences of state agencies, regional and municipal bodies in the field of civil protection and rescue; European institutions and mechanisms for civil protection and rescue; EU modules of civil protection and development of new modules; bilateral cooperation; standard protection and rescue cycle; process of activating the protection and rescue services; mechanisms and procedures of intervention management; sources of financing that enable the functioning of the civil protection and rescue system. Legislation in the field of: civil protection and rescue, communication/information and alarming. Behaviour and response of public in case of natural disasters. Mechanisms of risk evaluation, procedures of disaster damage assessment, disaster mitigation and risk reduction. Data validation and selection of adequate models of the final evaluation of consequences and of the scope of damage, and impact of the data validation process on the response planning. Natural disasters in the Republic of Slovenia for which risk assessments and protection/rescue plans are prepared. Rapid response systems and decision making process in the event of natural disaster: role of experts (environmental civil engineering) in the processes of the civil protection cycle; cooperation and response of the public in the civil protection cycle in the event of natural disaster. Influence of (measured and analysed) data reliability on adequate

and timely measures in the event of a disaster and the resulting scope of damage. Mitigation of natural disasters – competences and procedures. Perception and responses.

[1]The course is intended exclusively to students of other study programmes, mainly from social sciences.