Supplement to the curriculum for the

Master's Degree Programme in Geotechnical and Hydraulic Engineering

Supplement to the version: Curriculum 2015

This supplement was approved by the Curricular Committee of Graz University of Technology in the meeting dated 13 March 2017.

(Please note: The English version of this document is a courtesy translation. Only the German version is legally binding.)

Addition to §5a Catalogues of Elective Courses

The following course is added to the catalogues of electives *1a: Hydraulic Engineering*, *1b: Soil Engineering* and *1c: Rock Mechanics*.

Course	SSt	Typ	ECTS
Baubetriebslehre 1 *,**	2,5	VU	3

* Course name change with respect to the course previously offered under the title Baubetriebslehre. For completion of the degree programme only one of either the previous course or the new course can be validated.
** Course held in German.

The following course in the catalogue of electives *1c: Rock Mechanics* shall be renamed. The previous course and the new course are equivalent. The course completed under the previous name shall remain valid.

Course	SSt	Typ	ECTS
Survey Data Interpretation in NATM in Monitoring Data Interpretation (NATM)	1,5	VU	2

The following course is added to the catalogue of electives *2: Subject-specific Elective Courses*:

Course	SSt	Typ	ECTS	Semester
Construction Management and Call for Tender*	2	VO	3	S

*Course type change and change of semester allocation with respect to the previously offered course. For completion of the degree programme only one of either the previous course type or the new course type can be validated.

This supplement is effective from 1 October 2017.

Abbreviations: SSt: semester hours; *VU*: lecture with integrated exercises.

Supplement to the curriculum for the

Master's Degree Programme in Geotechnical and Hydraulic Engineering

Supplement to the version: Curriculum 2015

This supplement was approved by the Curricular Committee of Graz University of Technology in the meeting dated 29. February 2016.

(Please note: The English version of this document is a courtesy translation. Only the German version is legally binding.)

Addition to §5a Catalogues of Elective Courses

The following course in the catalogue of electives *1b: Soil Mechanics* shall be renamed. The previous course and the new course are equivalent. The course completed under the previous name shall remain valid.

Course	SSt	Typ	ECTS
Building Dynamics and Earthquakes 2 *in* Structural Dynamics and earthquakes 2	2	VU	3

The following course in the catalogue of electives *2: Subject-specific Elective Courses* shall be renamed. The previous course and the new course are equivalent. The course completed under the previous name shall remain valid.

Course	SSt	Typ	ECTS
Design and Construction of Headrace Pipelines in Design and Construction of Headrace Tunnels	2	VU	3

The following course is added to the catalogue of electives *2: Subject-specific Elective Courses*:

Course	SSt	Typ	ECTS
Landscaping in Hydraulic Engineering*	3	VU	4,5

* Course change (SSt, ECTS) with respect to the course previously offered under the same title. For completion of the degree programme only one of either the previous course or the new course can be validated.

This supplement is effective from 1 October 2016.

Abbreviations: SSt: semester hours; *VU*: lecture with integrated exercises.

Curriculum for the

master's degree programme in Geotechnical and Hydraulic Engineering

Curriculum 2015

This curriculum was approved by the Curricula Committee of Graz University of Technology in the meeting dated 12.01.2015. [1]

(Please note: the English version of this document is a courtesy translation. Only the German version is legally binding.)

On the basis of the Federal Act on the Organisation of Universities and their Studies (UG), Austrian Federal Law Gazette (BGBl.) No. 120/2002 as amended, the Senate of Graz University of Technology issues the following curriculum for the master's degree programme in Geotechnical and Hydraulic Engineering.

§ 1 General provisions

(1) The engineering sciences master's degree programme in Geotechnical and Hydraulic Engineering comprises four semesters. The total scope of the programme is 120 ECTS credit points.

(2) The master's degree programme in Geotechnical and Hydraulic Engineering is held in English according to § 64 para. 6 UG.

(3) Graduates of this programme are awarded the university degree of "Diplom-Ingenieurin"/"Diplom-Ingenieur", abbreviated: "Dipl.-Ing." or "DI". The international equivalent of this university degree is "Master of Science", abbreviated: "MSc".

(4) The content of this degree programme builds upon the content of a scientific subject-related bachelor's degree programme or other equivalent degree programme accord-

[1] The date of approval refers to the German version of this curriculum.

ing to § 64 para. 5 UG, for example the bachelor's degree programmes in Civil Engineering with Environment and Management or Civil Engineering and Construction Management of TU Graz. Graduates of these degree programmes named as examples are admitted to this master's programme without any prerequisites being imposed. Depending on the previous education of the applicant to the programme, up to 25 ECTS credit points from the courses of the above bachelor's degree programmes may be prescribed as part of the admission to the curriculum presented here for graduates of other bachelor's degree programmes. These prescribed courses reduce the workload outlined in the curriculum for achievements in elective subjects accordingly. However, a bachelor's degree programme that entitles the student to be admitted must comprise at least 180 ECTS credit points.

(5) In order to obtain an overall scope of 300 ECTS credit points for the graduate and postgraduate study programmes together, students shall not be assigned courses in the master's programme which they have already completed as part of their bachelor's degree and which were part of their qualification for the master's degree programme.

(6) The study programme is completed by writing a master's thesis and passing an examination before a committee according to § 7a below.

§ 2 Object of study programme and qualification profile

(1) Object of study programme

The master's degree programme in Geotechnical and Hydraulic Engineering provides students with an in-depth education in engineering, focussing on the field of civil engineering and its application and, through the three separate specialisation subjects offered, Soil Mechanics, Rock Mechanics and Hydraulic Engineering, is orientated towards the current international development of engineering subdisciplines. The degree programme reflects the principle of research-led teaching. In addition to providing detailed specialist, theoretical knowledge, special focus is placed on providing practical, social and media competencies. In extended exercises in laboratories and outdoors as well as on excursions, students learn to independently develop concepts and to put them into practice.

(2) Qualification profile

The master's degree in Geotechnical and Hydraulic Engineering at TU Graz is awarded to students who can demonstrate the following knowledge, skills and competencies.

Knowledge and understanding
Graduates of the master's degree programme in Geotechnical and Hydraulic Engineering have acquired the following intellectual and practical competencies:

- an in-depth knowledge of geology, soil mechanics, foundation engineering, rock mechanics, tunnelling, hydraulics and hydraulic engineering;
- excellent command of various working and analytical techniques in the defined subject areas;
- independent planning and implementation of scientific and applied projects according to the current state of science and technology;

- detailed knowledge of legal and economic decisions within the activities of planning, execution, management and maintenance of buildings;
- the ability to apply the acquired theoretical knowledge in a universal and interdisciplinary way;
- pronounced problem-solving skills to critically review existing solutions and the ability to develop appropriate alternatives;
- a readiness to develop new strategies, taking into account and assessing current research results;
- the ability to use modern information technologies;
- an awareness of possible ethical, societal and economic implications of the subject area, and
- social competence and the ability to work in a team.

Knowledge-based application and assessment
Graduates

- have learnt complex scientific methods in the fields of geotechnics and hydraulic engineering and are able to apply these;
- are capable of applying their knowledge and skills to solve problems, including in new and unfamiliar situations, and even beyond the fields of geotechnics and hydraulic engineering;
- are able to define and interpret the features, limits, terminology and schools of thought in their subject areas;
- are able to cope with complex theoretical and practical situations;
- are capable of formulating scientifically founded assessments even on the basis of incomplete or limited information, and
- are able to consider the societal, social and ethical implications of their professional or scientific actions.

Communicative, organisational and social competencies
Graduates

- master communication and presentation techniques;
- are able to compose scientific texts;
- are flexible, able to adapt and to work in a team, and
- have acquired learning strategies to independently acquire knowledge.

(3) Internationality

To be successful in professional life, the use of the English language, both spoken and written, as the lingua franca in science, technology and business is of fundamental importance. For this reason, English is used as the language of instruction. Even though it would be possible to hold an entire degree programme in English, specific courses from the curriculum are offered in German as a result of their content and geographical character.

Students are recommended to complete a stay abroad in the second or third semester of their degree programme.

(4) Demand for and relevance of the study programme for science and on the job market

The master's degree programme in Geotechnical and Hydraulic Engineering aims to provide graduates with theoretical knowledge and practical application skills for an independent career in industry or at a university, in all relevant subject areas.

This degree programme serves as a pre-vocational education for a successful (international) career in the fields of geotechnics, soil mechanics and foundation engineering, rock mechanics and tunnelling as well as hydraulics, hydraulic engineering and urban water management. The extensive choice of courses also provides students with an individual education and takes into consideration the constantly changing needs of the job market.

§ 3 ECTS credit points

In accordance with the European Credit Transfer and Accumulation System, the individual courses are assigned ECTS credit points that determine the relative share of the workload. The Universities Act (UG) determines the workload for one ECTS credit point to be an average of 25 full hours.

All achievements to be obtained by the students are assigned ECTS credit points. These ECTS credit points are used to determine the relative weight of the workload of the individual academic achievements; the workload of one year must comprise 1500 hours and 60 ECTS credit points are awarded for this workload. The workload comprises the self-study part and the semester hours/contact hours. One semester hour/contact hour corresponds to 45 minutes.

§ 4 Structure of the study programme

The master’s degree programme in Geotechnical and Hydraulic Engineering consists of:

1. a compulsory subject (Geotechnical and Hydraulic Engineering), (27.5 ECTS credit points);
2. elective subject 1, (a) Hydraulic Engineering or (b): Soil Mechanics or (c): Rock Mechanics, (30 ECTS credit points);
3. elective subject 2 (subject-specific elective courses), (20.5 ECTS credit points);
4. elective subject Soft Skills (6 ECTS credit points);
5. a free-choice subject (6 ECTS credit points), and
6. a master's thesis (30 ECTS credit points). The topic of the master’s thesis must be assignable to a course from the catalogue of compulsory subjects or a catalogue of electives.

For elective subject 1, courses with a total scope of 30 ECTS credit points from one of the three catalogues of electives 1a, 1b, or 1c are to be completed.
For elective subject 2, courses with a total scope of 20.5 ECTS credit points from catalogue of electives 2 or from the three catalogues of electives 1a, 1b, or 1c are to be completed.

§ 5 below contains a list of the individual courses of this master's programme and their allocation to the subjects. The semester allocation is a recommendation and ensures that the sequence of courses builds optimally on previous knowledge and that the workload of an academic year does not exceed 60 ECTS credit points.

Courses that were used to complete the bachelor's degree programme to grant admission to this programme are not part of this master's degree programme. If compulsory courses that are provided for in this curriculum were already used as part of the bachelor's degree programme described above, they are to be replaced by additional elective courses comprising the same workload.

§ 5 Course content and semester plan

Master's degree programme in Geotechnical and Hydraulic Engineering								
Subject	**Course**		**Type of**		**Semester incl. ECTS**			
		SSt	**course**	**ECTS**	**I**	**II**	**III**	**IV**
Compulsory subject Geotechnical and Hydraulic Engineering								
	Engineering Geological Investigation	2	VO	3	3			
	Soil Mechanics and Foundation Engineering	2.5	VU	4	4			
	Rock Mechanics and Tunnelling	2.5	VO	4		4		
	Hydraulic Engineering	2.5	VU	4		4		
	Hydraulics 1	1	VO	1.5	1.5			
	Hydraulics 1	1.5	SE	1.5	1.5			
	Finite Element Method	2	VU	3	3			
	Geotechnical Monitoring	3	VU	4	4			
	Petrology	1	VO	1.5	1.5			
	Petrology	1	UE	1	1			
Total compulsory subjects		25		27.5	19.5	8		
Total elective subjects according to § 5a below				50.5	6	17	27.5	
Total Soft Skills according to § 5a below				6	2	2.5	1.5	
Master's thesis				30				30
Free-choice subject								
	Free-choice courses according to § 5b below			6	2.5	2.5	1	
Total				**120**	**30**	**30**	**30**	**30**

Abbreviations: SE: seminar; SSt: semester hours/contact hours; UE: exercise; VO: lecture; VU: lecture with integrated exercises;

§ 5a Catalogues of free electives

Master's degree programme in Geotechnical and Hydraulic Engineering

Subject	Course	SSt	Type of course	ECTS	Semester incl. ECTS I	II	III	IV
Catalogue of electives 1a: Hydraulic Engineering								
	Baubetriebslehre*	2.5	VU	3	3			
	Hydraulics 2	4	VU	6	6			
	Hydrology	2	VO	3	3			
	Testing Technology and Laboratory Tutorial in Hydraulics	3	LU	4		4		
	River and Sediment Hydraulics	2	VU	3		3		
	Risiko- und Katastrophenmanagement*	3	VU	4			4	
	Project Planning and Supervision of Hydraulic Structures	3.5	VU	5			5	
	Seismic Evaluation of Water Retention Structures	2	VU	3			3	
	Field Excursion Hydraulic Engineering	1.5	EX	1.5		1.5		
	Master Project Hydraulic Engineering	4	SP	5			5	
	Geotechnical Earthquake Engineering	2	VU	3		3		
	Fundamentals of Grouting	2	VO	3			3	
Catalogue of electives 1b: Soil Mechanics								
	Baubetriebslehre *	2.5	VU	3	3			
	Advanced Soil Mechanics and Foundation Engineering	6	VU	8		8		
	Case Studies in Foundation Engineering	4	VU	6			6	
	Computational Geotechnics	4.5	VU	6			6	
	Soil Mechanics Laboratory	1.5	LU	2	2			
	Building Dynamics and Earthquakes	2	VU	3		3		
	Master Project Soil Mechanics	4	SP	5			5	
	Field Excursion Soil Mechanics	1.5	EX	1.5		1.5		
	Geomorphology and Geology of the Quaternary	1.5	VU	1.5		1.5		
	Geotechnical Earthquake Engineering	2	VU	3		3		
	Fundamentals of Grouting	2	VO	3			3	
	Landslides and Slope Processes	2	VO	3			3	
Catalogue of electives 1c: Rock Mechanics								
	Baubetriebslehre *	2.5	VU	3	3			
	Advanced Rock Mechanics and Tunnelling 1	4	SE	6		6		
	Advanced Rock Mechanics and Tunnelling 2	3	SE	4		4		
	Rock Mechanics Laboratory Testing	2.5	LU	3.5		3.5		

	Survey Data Interpretation in NATM	1.5	VU	2			2	
	Numerical Methods in Rock Mechanics	2	VU	3			3	
	Field Methods in Rock Mass Characterization	2	VU	3			3	
	Ventilation and Tunnel Safety	1.5	VU	2		2		
	Construction Contract	2	VU	3	3			
	Fundamentals of Grouting	2	VO	3			3	
	TBM Excavation	1.5	VU	2			2	
	Field Excursion Rock Mechanics	1.5	EX	1.5		1.5		
	Master Project Rock Mechanics	4	SP	5			5	
Catalogue of electives 2: Subject-specific elective courses								
	Wahrscheinlichkeitstheorie und Statistik*	2	VU	3		3		
	Messtechnik*	2	VO	3			3	
	Field Excursion Geotechnics and Hydraulic Engineering	3	EX	3		3		
	Wasserwirtschaft*	3	VU	4	4			
	Numerics in Hydraulic Engineering	3	VU	4.5			4.5	
	Energy Economy	1.5	VO	2	2			
	Advanced Hydraulics	2	VU	3			3	
	Landscaping in Hydraulic Engineering	2	VO	3	3			
	Design and Construction of Headrace Pipelines	2	VU	3			3	
	Design of Hydraulic Steel Structures	2	VU	3		3		
	Engineering Geological Field Excursion	4	EX	4		4		
	Engineering Geological Mapping	3	EX	3		3		
	Clay and Clay Minerals in Geotechnics	1.5	VO	2			2	
	Approval procedures	2	VO	3		3		
	Geotechnical risk assessment	2	VU	3		3		
	Boundary Element Methods	2	VU	3	3			
	Construction management and invitation and call for tenders	2.5	VU	3	3			
	Theory of Materials	2	VU	3		3		
	Continuum Mechanics	3	VU	4.5			4.5	
	Hydrochemistry	1	VO	1.5	1.5			
Catalogue of electives Soft Skills								
Courses from the programme of the TU Graz service department Languages, Key Competencies and In-House Training, the Centre for Social Competence of the University of Graz and the Inter-University Research Centre for Technology, Work and Culture (IFZ). A foreign language course (German for non-native German speakers, English for native German speakers) is highly recommended.					2	2.5	1.5	
Total Soft Skills in the catalogue of electives				6	2	2.5	1.5	

Abbreviations: EX: excursion-type course; LU: laboratory course; SE: seminar; SP: seminar project; SSt: semester hours/contact hours; VO: lecture; VU: lecture with integrated exercises

Note: The courses in the table above marked with an asterisk (*) are held in German.

Note: Possible amendments to the catalogue of electives are published in the University Gazette of TU Graz.

§ 5b Free-choice subject

Courses with a total scope of 6 ECTS credit points are to be completed as part of the free-choice subject.
The courses to be completed as part of the free-choice subject are designed to provide individual emphasis and further development of the students. They can be freely selected from the courses offered by any recognised Austrian or foreign university, as well as universities of applied sciences and university colleges for education.
Students are recommended to spread free-choice courses over the entire length of the programme.
If a course is assigned the same number of ECTS credit points in all curricula in which it is a compulsory or an elective course, it shall be allocated the same number of ECTS credit points when taken as a free-choice subject. If a course has been allocated varying numbers of ECTS credit points, the minimum number of assigned ECTS credit points is to be allocated to the course when taken as a free-choice subject.
Courses that are not intended either as a compulsory course or as an elective course are assigned 1 ECTS credit point for each semester hour (*SSt*). However, if such courses are lecture-type courses (VO), they are assigned 1.5 ECTS credit points for each semester hour.

§ 6 Admission to examinations

Admission to examinations is not subject to any prerequisites.

In order to assist students in completing their degrees in a timely manner, courses with continual assessment must allow students to submit, supplement or repeat partial course requirements no later than two weeks after commencement of the semester following the course.

§ 6 a Guidelines for the allocation of places on courses

(1) If the number of students registered for a course exceeds the number of available places, parallel courses are to be provided. If necessary, these parallel courses may also be provided during the semester break.

(2) If it is not possible to offer a sufficient number of parallel courses (groups), the students are to be admitted to the course according to the following priority ranking:
   a) Students who are required to complete the course according to their curriculum have priority.
   b) Further students are to be ranked according to the sum of the successfully completed courses of the respective study programme (total ECTS credit points).
   c) Students who have met the participation requirement at an earlier date are ranked by date.
   d) Students who have already been placed on a waiting list or who have to repeat the course are to be given priority on the next course.
   e) The further ranking is made according to the grade of the examination or the

average grade of the examinations (weighted on the basis of the ECTS credit points) of the respective course(s) that are specified as the participation requirement.

f) Students who do not need to complete such courses in order to fulfil their curriculum are only considered based on the number of free places. It is possible to be included on a separate waiting list. The above-mentioned provisions shall apply accordingly.

(3) Students who complete a part of their studies at TU Graz in the context of mobility programmes are given priority for up to 10% of the available places.

§ 7 Examination regulations

Courses are evaluated individually.

1. Examinations for courses held as lectures (VO) cover the complete content of the course.
2. For courses held as lectures with integrated exercises (VU), exercises (UE), design exercises (KU), laboratory courses (LU), projects (PR) and seminars (SE), seminars/projects (SP), and excursions (EX), a student's performance is continually assessed on the basis of that student's contributions and/or through accompanying tests. The assessment must always consist of at least two examinations.
3. Examinations with positive results are to be assessed as "very good" (1), "good" (2), "satisfactory" (3) or "sufficient" (4); those with negative results are to be assessed as "insufficient" (5). Specially indicated courses and excursion-type courses are assessed as "successful participation" or as "unsuccessful participation".
4. If a subject includes separate examinations for the relevant courses, the overall subject grade is to be determined by:
   a) multiplying the grade of each examination result in connection with the subject with the ECTS credit points of the corresponding course;
   b) adding the values calculated according to lit. a);
   c) dividing the result of the addition by the sum of the ECTS credit points of the courses, and
   d) rounding the result of the division to a whole-numbered grade if required. The grade must be rounded up if the decimal place exceeds 0.5. Otherwise, the grade must be rounded down.

The types of courses are explained in Part 4 of the Annex.

In addition to the types of courses, the following maximum group sizes are set forth:

1. The maximum group size for exercises (UE), exercise components of lectures with integrated exercises (VU) and for design exercises (KU) is 15 students.
2. The maximum group size for projects (PR), seminars (SE) and excursions (EX) is 10 students.
3. The maximum group size for laboratory courses (LU) is 6 students.

Lectures with integrated exercises (VU) are divided into lecture and exercise components, with 1/2 of the semester hours (*SSt*) being allocated to lecture components and 1/2 being allocated to exercise components.

§ 7 a Final examination before a committee

Admission to the master's degree examination before a committee requires proof of the positive assessment of all examination results according to § 4 and § 5 above as well as proof of the positive assessment of the master's thesis.

During the master's degree examination before a committee, students must present their master's thesis written in accordance with the regulations, and must defend the thesis before the members of the examination senate in the subsequent oral examination.

§ 7 b Diploma

The master's degree diploma is composed of:

a) all examination subjects according to § 5 above and their assessments;
b) the title and the assessment of the master's thesis;
c) the assessment of the final examination before a committee;
d) the entirety of the ECTS credit points for successfully completed free-choice courses from the free-choice subject, as defined in § 5b above, and
e) the overall assessment according to § 73 para. 3 UG.

§ 8 Transitional provisions

Regular students who started their master's degree programme in Civil Engineering – Geotechnics and Hydraulic Engineering before 1 October 2015 are entitled to continue and complete their studies until 30.09.2018 according to the previously valid curriculum as published in the University Gazette of TU Graz dated 23.05.2011 (academic year 2010/2011, published on 23 May 2011, 16th issue, 16th special issue). If the study programme is not completed within this period of time, students are subject to this curriculum for the rest of the study period. Students are entitled to voluntarily opt for the new curriculum at any time within the admission periods. To this end, a written irrevocable declaration must be sent to the Registration Office.

§ 9 Legal validity

This curriculum shall come into effect on 1 October 2015.

Annex to the curriculum for the master's degree programme in Geotechnical and Hydraulic Engineering

Part 1 of the Annex:

Subject descriptions

Compulsory subject: Geotechnical and Hydraulic Engineering

Subject content:
This subject covers the following topics:

- methods and applications of engineering geologic investigation, with particular emphasis on geologic mapping and documentation, engineering classification and description of soils, rock mass classification, exploration and production drilling, water testing and permeability, surface geophysical methods, and remote sensing techniques;
- foundations of the methods used for geo-measurements and the design of measurement programs with emphasis on correct sensor selection and sensor placement;
- applied fluid mechanics (engineering hydraulics), stationary fluid flow with a free surface, stationary motion in pipelines, and principles of unsteady wave motion: wave propagation in pipes and free surface flows;
- different kinds of dams in hydraulic engineering: weirs (standard weirs, solid weirs, weirs with gates, intake weirs, special cases), dams (standard dams, fill dams, auxiliary and small fill dams, gravity and buttress dams, arch dams, operating devices, gates), water conduits (intake and siltation structures, canals, free flow and pressure flow tunnels and shafts, pipelines, gates, special structures), each with structural, hydraulic, static and constructional details, and
- failure modes of rocks, characterisation of rock masses, failure modes of rock masses (slopes and underground structures), design concepts, supports for slopes and underground structures, excavation methods, analysis methods, observation and monitoring, contractual aspects, Earth pressure for supporting structures, raft foundations, determination of soil parameters, shear strength of soils, stiffness of soils, stress paths and theory of consolidation.

Learning outcomes:
Students will learn to design comprehensive programs for engineering geologic investigation based on the applications and limitations of diverse exploration technologies. They will learn to design measurement programs to solve geotechnical problems and will gain the ability to assess structural stability based on measurement data.
Further, students will study rock engineering methods and applicable construction methods for different ground and boundary conditions. They will understand the theoretical basics of soil mechanics and hydraulic engineering and will be able to determine different kinds of dams and their application in hydraulic engineering.
Basics and essential applications for design and construction of hydraulic structures will be studied.

Prerequisites:
There are no compulsory courses, but students must have previously covered the topics examined in the courses Geotechnics Basics (Soil Mechanics, Foundation Engineering, Rock Mechanics), Hydraulics Basics, and Hydraulic Engineering Basics.

Elective subject 1a: Hydraulic Engineering

Subject content:
This subject covers the following topics:

- basics of construction management, job preparation, site facilities, performance in construction management, earthwork, transportation equipment, lifting equipment, concrete processing, underground construction, and foundation engineering;
- advanced knowledge of numerical and hydrological methods in hydrology, probabilistic and stochastic methods, deterministic modelling, precipitation-discharge modelling, rain gauges and discharge measurement;
- history of river hydraulic systems, water systems, river morphology, hydraulic calculation approaches, river engineering projects, topographical water level recordings, sole material characteristics, sediment transport: initial sediment transport, bed forms, bed load and suspended load (calculation, measurement, tutoring models, etc.), reservoir sedimentation and emptying methods, scours, measures for erosion and aggradation, cross works (crashes, thresholds, ramps, trusses); flood retention facilities, flood protection: emergence of floods; measures against floods (active, passive flood protection); focus on the design of hydraulic structures, mainly on hydropower development and flood protection; maintenance, monitoring and renewal of hydraulic structures, and
- natural hazards: types, causes, formation, worldwide distribution, frequency, effects, failure of technical structures, e.g. dams (causes, effects, risk analysis), methods, risk analysis, scenario building with examples, determining the probability of occurrence with examples, determining damage potential with examples, illustration of risk: prospects, mapping of hazard zones and risk zones with examples; risk assessment methods; risk mitigation measures, overview, example of flood protection measures: active and passive hydraulic engineering, selection, dimensioning with examples, structural design.

Learning outcomes:
Students will acquire advanced knowledge of engineering duties in the areas of construction management. They will be given an overview of hydrological processes and methods and will learn to deal with the system water and sediment in a drainage area. Further they will learn how to take measurements and analyse and evaluate measurement data for field applications.
They will learn how to apply risk analysis methods and will be able to choose sustainable risk reduction measures in regard to natural hazards in general and floods in particular. They will gain specialised knowledge of different organisational units in risk and disaster management.
Students will focus on the design and construction of hydraulic structures, including monitoring and maintenance and they will gain a deeper understanding of the design of hydro projects.

Prerequisites:
There are no compulsory courses, but students must have previously covered hydraulics basics, basics of hydraulic structures and basics of hydrology.

Elective subject 1b: Soil Mechanics

Subject content:
This subject covers the following topics:

- performance in construction management, earthwork, transportation equipment, lifting equipment, concrete processing, underground construction, foundation engineering;
- Eurocode 7, construction faults in geotechnics, construction of embankments, geotechnical reports, geotechnical modelling, planning and building regulations, case studies, international geotechnical projects, and methods of heavy underground engineering;
- plastics in geotechnics, deep vibrotechnics in geotechnics, introduction to unsaturated soils, cone penetration tests, hydraulic failure mechanisms, serviceability limit states, settlements, reinforced earth structures, stone settlements, etc.;
- basic concepts of dynamic loading, system with one degree of freedom: free vibration, forced harmonic vibration, response spectrum; systems with multiple degrees of freedom, equation of motion – determination of eigenfrequencies; modal analysis, numerical methods – finite differences; Newmark earthquake analysis, method of response spectrum, discussion of case histories, design procedure for various geotechnical problems, analysis of case histories by means of conventional methods, analysis of case histories by means of numerical methods, comparison and discussion of results, overview of numerical methods, and specific aspects of geomechanics;
- basics of finite element method, elasticity, plasticity, elastic-plastic behaviour, mathematical description with respect to numerical methods and determination of soil parameters, perfect plasticity models, nonlinear computations, critical state models, hardening soil model, undrained soil behaviour, consolidation, jointed rock models, tunnelling, and deep excavations, and
- injection grouting as a method to improve soil settlement and strengthen characteristics and to decrease permeability of soil and rock masses; properties of cementitious and chemical grouts, procedures for cement and chemical grouting, field monitoring and verification, grouting rock under dams, practical testing in the laboratory of techniques according to soil mechanics as well as evaluation and interpretation of results.

Learning outcomes:
Students will acquire advanced knowledge of engineering duties in the areas of construction management. They will learn how to assess the most appropriate technologies for structures in foundation engineering according to the local ground conditions and verify ultimate and serviceability limit states based on realistic modelling.
Further, students will learn how to write geotechnical reports and how to understand and apply Eurocode 7. They will acquire an understanding of the dynamic response of building structures and of generally established calculation methods. The transfer of knowledge of different numerical methods will allow students to able to understand commercial dynamic software. They will also gain experience in the design of foundation engineering structures based on theoretical aspects. Students will be able to apply the finite element method for solving simplified geotechnical problems and will develop an understanding of the advantages and limitations of elasto-plastic constitutive models for soils.
Students will be able to develop approaches to geotechnical grouting operations based on knowledge of grout materials and the selected application of construction techniques.

Prerequisites:
There are no compulsory courses, but students must have previously covered the topics soil mechanics and foundation engineering, construction management, construction economy, measurement systems (sensors, precision of measurements), building materials, technology of construction, and basics of construction economics.

Elective subject 1c: Rock Mechanics

Subject content:
This subject covers the following topics:

- performance of construction management, earthwork, transportation equipment, lifting equipment, concrete processing, underground construction, foundation engineering;
- application of the skills obtained in the course Rock Mechanics and Tunnelling with the help of real surface and subsurface projects, interpretation of the geological conditions, evaluation of laboratory data, ground characterisation, determination of ground behaviours and potential failure modes, selection of appropriate construction methods, support design, determination of system behaviours, construction scheduling, cost estimate, and design report, as well as basics of construction contracts suitable for geotechnical works and which address issues of risk sharing between contractor and client;
- basics of construction management: job preparation, site facilities, and
- application of the observational method in underground construction with special emphasis on the NATM, development of a monitoring project, determination of normal rock behaviour under various boundary conditions, prediction of displacement development in relation to progress and time, evaluation and display options, geotechnical safety management, introduction to rock mechanical analyses, fundamental approaches, available methods of analysis, determination of input parameters, evaluation of results, and practical exercises with UDEC, Phase2, and other applicable programs.

Learning outcomes:
Students will acquire advanced knowledge of engineering duties in the areas of construction management. They will be able to assess the most appropriate technologies for structures in foundation engineering according to the local ground conditions and verify ultimate and serviceability limit states based on realistic modelling.
Students will also learn to work on tasks independently and will develop a deeper understanding of the methods and the related business aspects. They will be able to develop approaches to geotechnical grouting operations based on knowledge of grout materials and the selected application of construction techniques. They will be able to interpret monitoring data according to the state of the art. They will also be able to understand rock mechanical analyses, as well as conduct analyses on their own.

Prerequisites:
There are no compulsory courses, but students must have previously covered the topics soil mechanics and foundation engineering, construction management, construction economy, measurement systems (sensors, precision of measurements), building materials, technology of construction, and basics of construction.

Elective subject 2: Subject-specific elective courses

Subject content:
This subject covers the following topics:

- probability and statistics, measurement technologies, water resources management, numerics in hydraulic engineering, energy industry, landscaping in hydraulic engineering, design and construction of headrace pipelines, design of hydraulic steel structures, engineering geological mapping, clay and clay minerals in geotechnics, approval procedures, geotechnical risk assessment, boundary element methods, construction management and invitation and call for tenders, theory of materials, continuum mechanics, and hydrochemistry.

Learning outcomes:
Students will learn to design specific components of hydropower plants (power shafts, power cavern, specific lining concepts, injections and drainage concepts, surveillance and maintenance of power conduits). They will be able to produce a final engineering geologic map in combination with cross sections, together with a summary report describing site geology and quaternary processes. They will be familiar with different well-established acquisition methods of rock mass structure for rock engineering and be able to present field data in a quantitative and statistically reliable way.

Prerequisites:
No compulsory requirements.

Part 2 of the Annex:

Equivalence list

Courses for which the equivalence or recognition is defined in this part of the Annex to the curriculum do not require separate recognition by the Dean of Studies. Individual recognition awarded by official decision from the Dean of Studies according to § 78 UG is also possible.

An equivalence list defines the equivalence of successfully completed courses of this curriculum and of the previous curriculum. This equivalence applies in both directions, that is, successfully completed courses of the previous curriculum may be credited in this curriculum and successfully completed courses of this curriculum may be credited in the previous curriculum.

Courses that are the same with regard to name and type, number of ECTS credit points and the number of semester hours are considered to be equivalent, and are thus not explicitly listed in the equivalence list.

Present curriculum 2015				Previous curriculum 2010, version 2011			
Course	SSt	Type	ECTS	Course	SSt	Type	ECTS
Approval procedures	2	VO	3	Facility Management	2	VU	3
Geotechnical Monitoring	3	VU	4	Geotechnical Monitoring	3	VU	4.5
Engineering Geological Mapping	3	EX	3	Baustofflehre VA	2	VO	3
Hydraulic Engineering Hydraulics 1 Hydraulics 1	2.5 1 1.5	VU VO SE	4 1.5 1.5	Konstruktiver Wasserbau	5.5	VU	7
Hydraulics 2	4	VU	6	Hydraulik	4	VU	6
Advanced Hydraulics	2	VU	3	Poren- u. Kluftwasserhydraulik	2	VU	3
Fundamentals of Grouting	2	VO	3	Rock Mass Characterization	2	VO	3
Rock Mechanics and Tunnelling	2.5	VO	4	Felsmechanik und Tunnelbau	3	VO	4.5
Soil Mechanics and Foundation Engineering Engineering Geological Investigation	2.5 2	VU VO	4 3	Bodenmechanik und Grundbau	4.5	VU	6.5
Numerics in Hydraulic Engineering	3	VU	4.5	Numerik im Wasserbau	2.5	VU	4
Landscaping in Hydraulic Engineering	2	VO	3	Landschaftsgestaltung im Wasserbau Hydraulik VA	1 1	VO VU	1.5 1.5
Testing Technology and Laboratory Tutorial in Hydraulics	3	LU	4	Versuchstechnik u. Laborübungen im Wasserbau	2.5	LU	3.5
Water Resources Management	3	VU	4	Wasserwirtschaft	2	VU	3
Hydrology	2	VO	3	Hydrogeologie	2	VO	3
Field methods in Rock Mass Characterization	2	VU	3	Field Methods in Rock Mass Characterization	2	UE	3
Advanced Soil Mechanics and Foundation Engineering	6	VU	8	Bodenmechanik und Grundbau VA	5	VU	7
Survey Data Interpretation in NATM	1.5	VU	2	Messdateninterpretation in der NATM	1	VO	1.5
Advanced Rock Mechanics and Tunnelling 1	4	SE	6	Felsmechanik und Tunnelbau VA	4,5	VU	6
Advanced Rock Mechanics and Tunnelling 2	3	SE	4	Technische Numerik	2	VO	4
Soil Mechanics Laboratory	2	LU	2	Bodenmechanik Labor	1.5	LU	2
Case Studies in Foundation Engineering	4	VU	6	Fallstudien im Grundbau Fachexkursion Geotechnik	2.5 2	VO EX	3.5 2
Computational Geotechnics	4	VU	6	Computational Geotechnics	4	VU	5.5
Field Excursion Soil Mechanics	1.5	EX	1.5	Fachexkursion Geotechnik	2	EX	2
Field Excursion Rock Mechanics	1.5	EX	1.5	Fachexkursion Geotechnik	2	EX	2
Geotechnical Earthquake Engineering	2	VU	3	Betontechnologie	3	VU	4
Master Project Hydraulic Engineering	4	SP	5	Master Projekt 213	4	PR	5
Master Project Soil Mechanics	4	SP	5	Master Projekt 217	4	PR	5
Master Project Rock Mechanics	4	SP	5	Master Projekt 220	4	PR	5
Petrology Petrology	1 1	VO UE	1.5 1	Gesteinslehre	2	VU	2.5
Design and Construction of Headrace Pipelines	2	VU	3	Druckstollenbau	1.5	VU	3

Abbreviations: EX: excursion-type course; LU: laboratory course; SE: seminar; SP: seminar project; SSt: semester hours/contact hours; UE: exercise; VO: lecture; VU: lecture with integrated exercises

Part 3 of the Annex:

Recommended free-choice courses

Free-choice courses can be freely chosen from the courses offered at any recognised Austrian and foreign university, universities of applied sciences and university colleges for education according to § 5b of this curriculum.
In order to broaden students' basic knowledge in the subjects of this study programme, courses in foreign languages, social competence, technology assessment and women's and gender studies are recommended. In particular, we would like to refer students to the courses offered by the TU Graz service department Languages, Key Competencies and In-House Training, the Centre for Social Competence of the University of Graz as well as the Inter-University Research Centre for Technology, Work and Culture (IFZ).

Part 4 of the Annex:

Types of courses offered by TU Graz

The types of courses are defined in the relevant regulations of the standard curriculum (decision of the Senate of Graz University of Technology dated 6 October 2008, announced in the University Gazette No. 5 dated 3 December 2008), as follows:

1. Lectures (VO)
   In lecture-type courses, students are given a didactically well-structured introduction to the sub-areas of the subject and its methods. In lectures, the content and methods of a subject are presented.

2. Exercise-based courses (UE, KU, PR, EX)
   In exercises, abilities and skills are taught as part of a scientific pre-vocational education to deepen or broaden the subject matter of the respective lectures. These exercises may comprise practical, experimental, theoretical or design work. The curriculum may specify that the successful completion of the exercise is a requirement to register for the examination of the respective lecture.

   a) UE
      In exercises, students develop the ability to apply their subject knowledge to solve specific problems.

   b) KU
      In design exercises, abilities and skills are taught as part of a scientific pre-vocational education to deepen or broaden the subject matter of the respective lectures by means of design work. Special equipment or a specially equipped room is required.

   c) PR
      In projects, experimental, theoretical or design applied work is carried out, or

small research papers are written, taking into account all necessary steps. Projects are completed with a written paper that is part of the assessment. Projects can be carried out as teamwork or individual work; in the case of teamwork, it must still be possible to assess individual performance within the team.

d) EX
Excursion-type courses help to illustrate and consolidate the content of this type of course. Due to their practical relevance outside the place of study, excursions help to illustrate the content developed in other types of courses.

3. Lecture with integrated exercises (VU)
In addition to the introduction in sub-areas of the subject and its methods, lectures with integrated exercises (VU) also offer guidance on independent acquisition of knowledge or independent application using examples. The percentage of lectures and exercises is specified in the curriculum. These courses are courses with continual assessment.

4. Laboratory courses (LU)
Laboratory courses (LU) deepen and/or broaden the subject matter of the respective lectures by means of practical, experimental or design work. Students are taught abilities and skills as part of a scientific pre-vocational education and training with particularly intensive tutoring. An essential component of the laboratory courses is the drawing up of short logs on the work carried out.

5. Seminar-type courses (SE, SP)
Seminar-type courses enhance scientific work and discussion, and are intended to introduce students to expert-level discourse and argumentation. In this context, students have to write papers or give an oral presentation and take part in critical discussions. Seminars are courses with continual assessment.

a) SE
Seminars introduce students to scientific methods, to the development and critical assessment of their own work results, to special topics in scientific literature and provide them with exercises in technical discussions.

b) SP
In seminar projects, students apply scientific methods to work on experimental, theoretical or design applied problems; or they carry out short research assignments, taking into account all the necessary steps. Seminar projects are completed with a written paper and an oral presentation that are part of the assessment. Seminar projects can be carried out as teamwork or individual work; in the case of teamwork, it must still be possible to assess individual performance within the team.

The regulations referred to at the beginning also encompass provisions concerning the implementation and assessment of the different types of courses. In particular, they stipulate the following:

In lectures (type of course VO), the assessment takes place by way of a final examination that – at the discretion of the examiner – may be a written examination, an oral examination, a written and an oral examination, as well as a written or an oral examination. The examination procedure must be announced in the course description.

Courses of the type VU, SE, SP, UE, KU, PR, EX and LU are courses with continual assessment.