UNIVERSITY OF MOSTAR

Faculty of Civil Engineering

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DEVELOPMENT PLAN OF THE STUDY PROGRAMME

for the Postgraduate Doctoral

University Study of Civil Engineering

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1. INTRODUCTION

1.1. REASONS FOR THE INTRODUCTION OF THE STUDY PROGRAMME

The field of civil engineering is one of nine fields in the area of technical sciences (see the Rulebook on methodological frameworks and principles for the development of the rulebook on classification of scientific areas, fields and branches, adopted by the University of Mostar Senate on 19 February 2015). The Faculty of Civil Engineering University of Mostar is the institution responsible for the civil engineering profession and the scientific field of civil engineering in Herzegovina and wider since its foundation in 1978 until this day. Besides, owing to its dynamics, civil engineering is also the driving force of development of every other area of domestic and foreign economies. The development of civil engineering initiates and promotes significant changes in other areas of life and work.

The field of civil engineering includes a wide range of scientific branches, and also participates in interdisciplinary branches together with other fields of technical sciences. Civil engineering is of strategic importance for the development of the entire society.

Constant and dynamic development of the field of civil engineering requires additional expansion of the education process due to new knowledge and achievements. Together with other components of the University, the Faculty of Civil Engineering University of Mostar entered the education system based on the principles of the Bologna Declaration in 2005 and has been continuously developing the system over the past decade. The good aspects of this development are reflected in several positive examples of accreditations/re-accreditations of the Faculty of Civil Engineering and its programmes since its entry into the new system until present days. In order to continue the indicated faculty evolution process and to keep pace with developed European and global related institutions, in the following years it is necessary to provide additional education that will bring progress in completing a high-quality, educational and competent scientific and professional base in the environment, but also encourage scientists from other regions to participate in further growth of the Faculty of Civil Engineering in different ways.

The development of the educational process would methodologically develop and improve systematic knowledge and experience with special emphasis on openness to new concepts and innovative solutions. That is why the most natural possible way is to

open the third cycle of studies at the Faculty of Civil Engineering University of Mostar, the postgraduate doctoral university study of civil engineering. It would educate scientists and professionals for top-quality scientific work, on the one hand, but also for managing complex and specific operations of the civil engineering profession in economy, science and public institutions, on the other hand.

1.2. OPENNESS OF THE STUDY AND STUDENT MOBILITY

The postgraduate doctoral university study of civil engineering is based on an advisory or mentoring system. With the assistance of his/her study advisor, and later also a mentor, by appropriately selecting courses a student can be directed to appropriate scientific branches or interdisciplinary research in the scientific field of civil engineering. Proposed general and elective courses are adopted in accordance with the ECTS credit system. The possibility to freely choose individual courses makes it possible for students to complete and deepen their knowledge in accordance with their scientific interests. Students are allowed to enrol in (up to two) courses from the doctoral studies of other members of the University of Mostar if they are compatible with the concept, or the curriculum, of the postgraduate doctoral university study of civil engineering (which is determined by the Doctoral Study Council). This achieves an additional level of interdisciplinarity of scientific and professional development. Similarly, students are allowed to enrol in courses from doctoral studies held at other related faculties of universities in the country and abroad. Again, it is possible to choose a maximum of two courses from a doctoral study at another university (which is also determined by the Doctoral Study Council). The exception is an international dual doctorate (the so-called *cotutelle*), but only in the case of an individual or general agreement on cooperation between universities (see *Cotutelle de these/Joint PhD Thesis Supervision*).

The Faculty of Civil Engineering University of Mostar is also open to the involvement of scientists from related institutions for doctoral and postdoctoral research in fields and branches of our activities. Furthermore, the postgraduate doctoral university study of civil engineering at the Faculty of Civil Engineering University of Mostar is also open to enrolment of students from other universities (to enrolment in full-time studies as well as to enrolment in individual courses for visiting students at the study).

The Rulebook on postgraduate doctoral university study of civil engineering of the Faculty of Civil Engineering University of Mostar (aligned with the Rulebook on doctoral studies of the University of Mostar) specifies the engagement of prominent foreign scientists and experts, especially in specialized scientific branches where there are no experts within the institution responsible for the study programme.

1.3. COMPLIANCE WITH THE MISSION OF THE UNIVERSITY OF MOSTAR AND RELATED PROGRAMMES FROM THE EUROPEAN UNION

At the Faculty of Civil Engineering University of Mostar, there are all prerequisites for the realization of the postgraduate doctoral university study of civil engineering. A significant number of teaching and non-teaching staff with appropriate scientific and professional qualifications are full-time employed and engaged in accordance with the standard teaching load stipulated by law and relevant regulations. Adequate space and part of equipment are also provided, in accordance with needs of quality studying. During the implementation of the postgraduate doctoral university study of civil engineering, it is planned to complete the laboratory equipment and additionally improve the conditions for scientific development.

The proposed postgraduate doctoral university study of civil engineering is aligned with short-term and long-term objectives and mission of the University of Mostar and the Faculty of Civil Engineering, or with the scientific strategy. By its structure and contents, the programme is fully aligned with similar studies in BiH, the European Union countries (Croatia, Slovenia, Austria) and Switzerland.

2. DESCRIPTION OF THE STUDY PROGRAMME

2.1. BASIC INFORMATION

Name of study:	Postgraduate Doctoral University Study of Civil Engineering
Type of study:	Postgraduate doctoral university study
Scientific area:	Technical sciences
Scientific field:	Civil engineering
Scientific branches:	**structural engineering / hydraulic engineering / geotechnics / transport engineering / construction management**
Institution responsible for the study:	Faculty of Civil Engineering University of Mostar
Duration:	6 semesters (3 years)
Number of ECTS credits:	180
Enrolment procedure and requirements:	Enrolment is made based on public competition. Enrolment requirements are given in Subsection 2.1.
Competences:	The competences of PhD in the scientific area of technical sciences, field of civil engineering, are acquired by completing the study. PhDs are trained primarily for the application of scientific methodology and future independent scientific and research work. Competences are acquired for leadership of scientific development based on new technologies, introduction of new scientific approaches based on design and research, as well as on scientific planning and decision-making using the most recent scientific methods of collecting, processing and analysing information.
Academic degree (or title) obtained by completing the study:	Doctor of Philosophy (PhD) in the area of technical sciences

2.2. REQUIREMENTS FOR ADMISSION TO THE DOCTORAL STUDY AND DURATION OF STUDY

The postgraduate doctoral university study of civil engineering is organized for a period of 6 semesters during which students should gain 180 ECTS credits. The study is organized as a full-time or part-time study. When enrolling in the study, each student submits a written statement on whether he/she will study full time or part time. Full-time study is concerned with students who devote full time to fulfilment of obligations required by the doctoral study. Students studying part time must submit a statement that their available time allows them to fulfil their student obligations according to the part-time study programme. The study curriculum is designed so as to enable scientific development of different categories of candidates.

The following are eligible to enrol in the postgraduate doctoral university study of civil engineering:

– **candidates with completed university undergraduate and graduate studies** and who have achieved at least 300 ECTS credits during their studies (master's degree) with a minimum average grade of 3.50 for all courses in previous two cycles through the five-year studying period (grades from all courses of undergraduate and graduate studies are considered in the calculation of the average);

  (Exceptionally, candidates who do not meet the requirement referred to in the previous paragraph can also enrol in the doctoral studies if they proved themselves in the profession and have recommendations from two professors from the relevant branch.);

  (Admission may also be granted to candidates who have completed graduate studies in related scientific fields or branches, at one of the technical faculties, subject to prior success in differential examinations due to programme differences. The contents of the differential examinations are established by the Doctoral Study Council for each individual enrolment application.);

– **candidates with completed higher-education graduate studies with VII/1 degree** (graduate civil engineer) at universities in Bosnia and Herzegovina and abroad (or at equivalent studies in countries where the study of civil engineering was a part of an interdisciplinary study programme at a faculty or university department) with a minimum average grade of 3.50 for all courses during the study;

(Exceptionally, candidates who do not meet the requirement referred to in the previous paragraph can also enrol in the doctoral studies if they proved themselves in the profession and have recommendations from two professors from the relevant branch.);

(Admission may also be granted to candidates who have completed graduate studies in related scientific fields or branches under the old system, at one of the technical faculties, subject to prior success in differential examinations due to programme differences. The contents of the differential examinations are established by the Doctoral Study Council for each individual enrolment application.);

– **candidates with completed postgraduate scientific master's study** under the old system (Master of Science) in the area of technical sciences, field of civil engineering, and also candidates who are MSc in some other field in the area of technical sciences subject to having achieved at least 30 ECTS credits in the courses covered also by the postgraduate master's study in the field of civil engineering (if this is not the case, they must pass up to 30 ECTS credits in differential courses, due to programme differences, which is determined by the Doctoral Study Council);

(At the enrolled doctoral study, a total of 60 ECTS credits are recognized for the candidates who have earned a degree of Master of Science in the area of technical sciences, field of civil engineering. Out of the recognized 60 ECTS credits, 48 ECTS credits are recognized from their first year of study at the doctoral study, and they should earn the remaining 12 credits from the first year by successfully passing two elective specialist courses. Twelve credits from the second year that are obtained in other extracurricular activities are also recognized for them.);

(For candidates who have obtained the scientific degree of Master of Science in some other field in the area of technical sciences or candidates who have not succeeded to fully complete postgraduate master's scientific study under the old system, an appropriate number of credits are recognized based on an analysis of the ECTS Credit Recognition Committee appointed by the Doctoral Study Council.);

Public competition for admission to postgraduate doctoral university study of civil engineering is announced by the University of Mostar Senate at the proposal of the Scientific and Teaching Council of the Faculty of Civil Engineering. The candidate

evaluation criteria include success in undergraduate and graduate studies, interest shown in scientific research, published papers in scientific journals and proceedings, professors' recommendations, and research topic proposal.

Each candidate must have a minimum level of knowledge of the English language for the use of international literature, which is assessed as satisfactory if corresponding at minimum to the A2 level according to the Common European Framework of Reference for Foreign Languages. Also, an interview with each applicant is an integral part of the admission procedure and an additional candidate evaluation criterion.

If all criteria are met, the Doctoral Study Council establishes a list of selected candidates for admission to the postgraduate doctoral university study of civil engineering and publishes it on the notice board and on the website of the Faculty of Civil Engineering. The deadline for complaints and the period for responding to complaints are announced. On the proposal of the Doctoral Study Council, the Scientific and Teaching Council of the Faculty of Civil Engineering makes a decision on admission of candidates to the doctoral study.

As a rule, the full-time doctoral study lasts three years, and can be extended up to six years with explanation. The part-time study lasts five years, and can be extended up to eight years with explanation, which is decided by the Doctoral Study Council. Upon expiration of eight years from the admission, the doctoral candidate loses the right to defend his/her doctoral dissertation.

In case the quality of work of the doctoral candidate, assessed through annual evaluation procedures conducted by the Doctoral Study Council, is not satisfactory, the Doctoral Study Council may decide that the doctoral candidate has lost his/her right to continue the studies.

2.3. STRUCTURE AND ORGANIZATION OF THE DOCTORAL STUDY

The postgraduate doctoral university study of civil engineering is conceived so that, after enrolling in the doctoral study, a student selects his/her study advisor on the basis of the scientific branch, proposed doctoral study module, or the desire and preference for a particular speciality. The institution responsible for the study should present a list of study advisors from among the teachers appointed to a scientific and teaching rank of full professor, associate professor or assistant professor. Study advisors should be available to candidates who selected them. The list of study advisors mainly includes teachers from the Faculty of Civil Engineering University of Mostar, but this is not the rule, it can also include teachers from other faculties. On the proposal of the Doctoral Study Council, teachers who have three or more candidates can be excluded from the list of study advisors.

To each student, the Doctoral Study Council assigns his/her study advisor after registration. The study advisor assists students in selecting courses, solving problems during their study and monitors and guides their work. The study advisor is also responsible for monitoring student progress during the study.

A study advisor does not need to (but can) be a mentor to his/her candidate for preparation of doctoral dissertation. A mentor is appointed during the dissertation topic registration and approval procedure. A study advisor may be the only mentor, and also a mentor within a dual mentorship for a candidate (if interdisciplinarity of work is involved or if the other mentor comes from another university where some research will also be conducted) but may also be a co-mentor to his/her candidate. After completion of the dissertation topic registration and approval, if the study advisor is not selected as mentor or co-mentor for the candidate whom he had previously monitored and guided, at that point his/her duties cease and are taken over by the selected mentor (and co-mentor).

At the beginning of each study year, the student should prepare an annual research plan that is jointly signed by the student and his/her study advisor (and later mentor), and send it to the Doctoral Study Council. At the end of each study year, the study advisor (and later mentor) submits an annual report on the work and progress of the student of the postgraduate doctoral university study to the Doctoral Study Council.

A mentor is assigned to a student pursuant to Article 11 of the Rulebook on doctoral studies of the University of Mostar and on the basis of a well-reasoned report and

proposal of the doctoral dissertation topic approval committee. The Doctoral Study Council proposes a mentor, and the Senate appoints him/her.

A teacher holding a rank of full or associate professor (or equivalent rank if the academic rank is earned abroad) can be appointed as a mentor. A mentor can also be an assistant professor if he/she has held that rank for at least three years or is the head of a research project. Also, a mentor can be professor emeritus. Mentor must be selected for the scientific area, field and branch in which the dissertation topic is proposed. In the case of interdisciplinarity of the topic, dual mentorship is proposed. In this case, each of them assumes the responsibility for a predetermined part of the research and the dissertation development process. As already indicated, in addition to a mentor, at the postgraduate doctoral study of civil engineering it is also possible to appoint a co-mentor from the institution responsible for the study or other institutions in the country and abroad. A co-mentor can also be appointed in case of appointment of two mentors, and he/she can be a teacher holding a rank of assistant professor, associate professor or full professor (or an equivalent rank in case of a co-mentor who has earned the academic rank abroad). A mentor who assumed mentorship before retirement has the right to continue with the mentorship until its completion, with consent of the Doctoral Study Council.

At the postgraduate doctoral study of civil engineering at the Faculty of Civil Engineering University of Mostar, one mentor can simultaneously guide a maximum of three doctoral candidates from this study. A mentor or co-mentor who is not an employee of the University of Mostar or its affiliated members shall sign a contract on cooperation and assumption of the responsibility for the candidate. Every mentor shall enclose a statement on the readiness to guide the candidate during preparation of the doctoral dissertation, and also a written permission of the head of the institution he/she is coming from.

The postgraduate doctoral university study programme is structured modularly. With the assistance of his/her study advisor, in addition to two mandatory general courses and a minimum of one (and a maximum of two) general elective courses, the student also selects specialist courses from one of the directing modules:

- **structural engineering,**
- **hydraulic engineering,**
- **geotechnics,**
- **transport engineering,**
- **construction management.**

In agreement with the selected study advisor, the student can also choose courses from doctoral studies of related programmes at the University of Mostar, or at other universities and faculties with which the University of Mostar or the Faculty of Civil Engineering has signed a cooperation agreement.
The postgraduate doctoral university study of civil engineering consists of defined teaching and extracurricular activities. 60 ECTS credits can be obtained through teaching activities, and extracurricular activities bring the remaining 120 ECTS credits. Extracurricular activities include, among other things, registration and defence of topic, and development and defence of doctoral dissertation.

Teaching activities are conducted through compulsory and elective courses, or through direct forms of teaching consisting of lectures, exercises, research seminars, workshops... Direct forms of teaching consist of compulsory teaching activities (48 ECTS credits) and elective teaching activities (12 ECTS credits).
The student takes two compulsory courses, and with the assistance of his/her study advisor selects a minimum of one and a maximum of two general elective courses, with each course (compulsory, general elective or modular elective) being worth 6 ECTS credits. Also, the student selects a minimum of four and a maximum of five elective courses from the module that he/she chooses. If a student chooses only one general elective course, then he/she can choose the other course from the group of courses of some other module, and not the one that he/she has chosen. Mainly, he/she must select at least four elective courses from "his/her own" module, or the programme that he/she has chosen. The student should choose at least one elective course from "his/her own" module (with the assistance of the study advisor and possible future mentor), which is related to the planned topic of his/her future dissertation, as an introduction into it. If such a course is not included in the list of elective courses, the study advisor (and possibly later the mentor) should submit a request to the Doctoral Study Council with a proposal to include the specified course (at least one course and not more than two), whose holder would be the study advisor and/or mentor.

If interdisciplinary research is involved, on the request of the candidate (with the counter-signature of the study advisor), the Doctoral Study Council determines how the number of modular elective courses will be distributed "by weight" to different modules (depending on the interdisciplinarity branches).

By successfully passing compulsory courses, the student earns 12 ECTS credits, and by passing all elective courses, he/she earns 36 ECTS credits, which makes a total of 48 ECTS credits for compulsory teaching activities. The rest of the teaching activities are elective teaching activities (12 ECTS credits). Thus, all teaching activities, or direct forms of teaching, make up 33% (60 credits) or one third of the total obligations stipulated by the postgraduate study programme.

Extracurricular activities consist of the implementation of scientific research with guidance and supervision of a study advisor (and later mentor), and preparation of scientific papers, presentations, laboratory works, training on related institutions in the country and abroad or other forms of work aimed at preparing the dissertation. Extracurricular activities make 66% of the total obligations planned by the study programme, or 120 ECTS credits.

After acquiring 90 ECTS credits through teaching and extracurricular activities, the student initiates the procedure of earning a doctoral degree by submitting a dissertation topic proposal to the Doctoral Study Council. Also, the student then proposes a mentor with whom he/she arranges the conditions of work. The application for initiation of the procedure contains general information about the doctoral candidate, curriculum vitae and list of papers of the doctoral candidate, title of the proposed topic, information on the proposed mentor and his/her competences, explanation of the topic, anticipated original scientific contribution of the proposed research and research cost estimate.

The Doctoral Study Council proposes a mentor and a topic evaluation and defence committee to the Scientific and Teaching Council, and the Senate appoints them. The doctoral candidate must also submit a statement that he/she did not register a doctoral dissertation with the same subject at a study of another university. The topic of doctoral dissertation is registered on the form of the University of Mostar.

The topic evaluation and defence committee consists of three or five members, where at least one member is not a teacher or an employee of the Faculty of Civil Engineering University of Mostar. Majority of the committee members must be from the scientific branch in which the topic is registered. The mentor can be a member of the topic evaluation and defence committee, but cannot be the chair of the committee. The

proposed topic is defended publicly, before the topic evaluation and defence committee and others who are interested. The Scientific and Teaching Council shall present their opinion on the proposal of the topic evaluation and defence committee, which is passed to the Senate for decision making.

The doctoral candidate acquires 10 ECTS credits by registering the dissertation topic, and earns new 20 ECTS credits with public presentation and successful defence of the topic. By a majority vote of the total number of members, the committee may accept the proposed topic, may send it for revision, and may also completely reject it. If the registered topic is fully rejected, the candidate also loses the 10 ECTS credits earned by registering the topic. Public presentation of the doctoral dissertation topic is an integral part of the report and proposal of the dissertation topic approval committee.

When it comes to the procedures of submitting, evaluation, defence and storage of a doctoral dissertation, and doctoral degree award ceremony, they are regulated in the Rulebook on doctoral studies at the University of Mostar (Article 12 through Article 15).

By developing and successfully defending the doctoral dissertation, the doctoral candidate earns the remaining 60 ECTS credits, thereby completing the study with a total of 180 ECTS credits.

2.4. REQUIREMENTS FOR ADMISSION TO THE NEXT YEAR OF STUDY AND REQUIREMENTS FOR TRANSFER OF ECTS CREDITS FROM OTHER FACULTIES

Before enrolling in the next year of postgraduate doctoral university study of civil engineering, a student should meet the appropriate requirements. To enrol in the second study year, a minimum of 30 ECTS credits must be earned, of which at least 24 ECTS credits must be acquired through compulsory teaching activities. So, 24 or 30 ECTS credits must be earned by successfully completing four or five compulsory and elective courses. If a minimum of 30 ECTS credits for enrolment in the second year are earned, a maximum of 6 ECTS credits of this amount can be obtained from elective teaching activities.

A student must earn a total of 120 ECTS credits to enrol in the third year of study. In order to enrol in this, final year of study, he/she must have an article (published or accepted for publication) in journals indexed in Current Contents, Science Citation Index or Science Citation Index Expanded (or an article in journals indexed in other relevant databases defined as recognized publications in the Rulebook on minimum requirements for appointment to scientific and teaching ranks of the University of Mostar). Otherwise, the final year of study consists of the preparation and defence of the doctoral dissertation, which rounds the amount of 180 ECTS credits of the doctoral study.

Each course at this postgraduate doctoral university study of civil engineering can be enrolled by students of related postgraduate studies from the University of Mostar and other universities in the country and abroad, which is decided by the Doctoral Study Council. Also, students from this study can choose courses from other postgraduate studies in the country and abroad, which they will attend and for which they will take exams. The Doctoral Study Council assigns credits for the courses completed in this manner in accordance with its study programme and includes the ECTS credits in student's credit scores at the study. Students who earn credits at some other postgraduate studies are required to enrol in and complete at least four courses of the postgraduate doctoral study of civil engineering at the Faculty of Civil Engineering University of Mostar. The criteria and conditions for transfer of ECTS credits are regulated by the university's general acts or agreements between faculties.

2.5. TEACHING AND EXTRACURRICULAR ACTIVITIES

As indicated in Subsection 2.3, which describes in detail the structure and organization of the postgraduate doctoral university study of civil engineering, the study consists of defined teaching and extracurricular activities. 60 ECTS credits can be obtained through teaching activities, and extracurricular activities bring the remaining 120 ECTS credits. Teaching activities consist of compulsory teaching activities (48 ECTS credits) and elective teaching activities (12 ECTS credits).

Extracurricular activities consist of the implementation of scientific research with guidance and supervision of a study advisor (and later mentor), and preparation of scientific papers, presentations, laboratory works, training on related institutions in the country and abroad or other forms of work aimed at preparing the dissertation. Extracurricular activities make 66% of the total obligations planned by the study programme, or 120 ECTS credits.

TEACHING ACTIVITIES – 60 ECTS

Compulsory teaching activities – 48 ECTS

The methodology of scientific research (6 ECTS)

Selected chapters of applied and numerical mathematics (6 ECTS)

Elective courses: general (one or two) and of individual module (four or five) (36 ECTS)

Elective teaching activities – 12 ECTS

EXTRACURRICULAR ACTIVITIES – 120 ECTS

Other extracurricular activities – 30 ECTS

Extracurricular activities related to the dissertation – 90 ECTS

Registration of the topic (10 ECTS)

Defence of the topic (20 ECTS)

Preparation and defence of the dissertation (60 ECTS)

PLAN OF TEACHING AND EXTRACURRICULAR ACTIVITIES BY YEARS

1st year – 60 ECTS

- Compulsory teaching activities – 48 ECTS

The methodology of scientific research (6 ECTS)

Selected chapters of applied and numerical mathematics (6 ECTS)

Elective courses: general (one or two) and of individual module (four or five) (36 ECTS)

- Elective teaching activities – 12 ECTS

2nd year – 60 ECTS

- Other extracurricular activities – 30 ECTS

- Registration and defence of the topic – 30 ECTS

(Registration of the topic 10 ECTS + Defence of the topic 20 ECTS)

3rd year – 60 ECTS

- Preparation and defence of the dissertation – **60 ECTS**

DEFINING ELECTIVE TEACHING ACTIVITIES

(12 ECTS credits – 1st year of study)

1. Holding professional or scientific workshops or lectures organized by the Faculty of Civil Engineering University of Mostar (or related institution in the country or abroad) within the annual plan of professional and scientific workshops or lectures. (Every workshop conducted with obligatory presentation brings 3 ECTS credits and a lecture held 1 ECTS credit. The duration of every workshop is at least four academic hours, and of a scientific lecture at least one academic hour. The minimum number of participants in a workshop is eight. The candidate's performance at the workshop as well as his/her lecture must be related to the dissertation topic. After holding the workshop or lecture, it is necessary to submit a report to the head of the doctoral study.)

maximum 3 ECTS

2. Pedagogical-psychological and didactic-methodical education (one specialized course/seminar with selected chapters in the maximum amount of 6 ECTS credits).

maximum 6 ECTS

3. Cooperation in teaching on subjects of university undergraduate or graduate studies (seminars, exercises), thus earning ECTS credits in a way that 1 ECTS credit equals 20 hours of active participation in teaching, where the sum cannot be greater than 6 ECTS credits.

maximum 6 ECTS

4. Authorship or co-authorship of a university textbook, book, and editorship (editor-in-chief) of peer-reviewed professional, teaching or scientific publications - the review must be signed by a teacher holding a rank in the branch treated by the specified publication (worth 6 ECTS credits).

maximum 6 ECTS

5. Authorship or co-authorship of peer-reviewed teaching materials from individual teaching units - the review must be signed by a teacher holding a rank in the branch treated by the teaching material (worth 3 ECTS credits).

maximum 3 ECTS

DEFINING OTHER EXTRACURRICULAR ACTIVITIES
(CREDITS RELATED TO THE TOPIC AND DISSERTATION ARE NOT INCLUDED)
(30 ECTS credits – 2nd year of study)

1. Scientific paper (published or accepted for publication) in journals indexed in Current Contents, Science Citation Index or Science Citation Index Expanded. (The student obtains the entire amount of 30 ECTS credits with a single paper.)

30 ECTS

2. Scientific paper (published or accepted for publication) in journals indexed in other relevant databases defined as recognized publications in the Rulebook on minimum requirements for appointment to scientific and teaching ranks of the University of Mostar. (One paper is worth 10 ECTS credits, so a student can have a maximum of 3 papers.)

10 ECTS

3. Papers from international scientific conferences published in proceedings and orally presented.

10 ECTS

4. Papers from international scientific conferences published in proceedings and presented on posters.

8 ECTS

5. Papers from international scientific conferences published in proceedings, but not presented either orally or on posters.

6 ECTS

6. Stay at other domestic or foreign universities or scientific institutions for a period of minimum one month during the postgraduate study (only one stay can be considered for evaluation - at a university in the country 6 ECTS credits, and at a university abroad 12 ECTS credits).

12 ECTS

* If the student has fulfilled all his/her obligations to mandatory and elective teaching activities (60 ECTS credits) and has collected 30 ECTS credits from previously defined other extracurricular activities, he/she can proceed with dissertation topic registration (10 ECTS credits) and then dissertation topics defence (20 ECTS credits).
However, if the 30 ECTS credits collected for other extracurricular activities do not contain the paragraph 1 or 2 (a scientific paper in journals indexed in Current Contents, Science Citation Index or Science Citation Index Expanded, or a scientific paper in journals indexed in other relevant databases defined as recognized publications in the Rulebook on minimum requirements for appointment to scientific and teaching ranks), the student must have a paper from paragraph 1 or 2 published or accepted for publication as a requirement for admission to the third year of study, or for the official beginning of dissertation preparation.

** Papers from other extracurricular activities, published pursuant to paragraphs 1, 2, 3, 4 and 5, are evaluated and apply to all papers published by the student from the date of enrolment in the postgraduate doctoral university study of civil engineering (and ECTS credits can be obtained for them) provided that they are related to the subject of scientific research at the doctoral study and the future dissertation topic (which is certified in writing by the candidate's study advisor).

*** Review of the papers published in scientific journals and proceedings from international scientific conferences should have the form that is used in appointments to ranks at the University of Mostar, and the specified form is an annex and integral part of the of the Rulebook on minimum requirements for appointment to scientific and teaching ranks of the University of Mostar.

3. LEARNING OUTCOMES AND COURSE SYLLABI

Course title	Methodology of scientific research			*Course code*	P-O-1
Study programme Cycle	Postgraduate university doctoral study of civil engineering			*Study year*	First
ECTS credit value:	6 ECTS	*Semester*	1st	*Hours per semester (l+e+s)*	15+0+15
Course status:	mandatory	*Prerequisites:*		*Corequisites:*	
Access to the course:				*Class schedule:*	
Course holder/teacher:	Prof. Ivo Čolak, Ph.D.				
Contact hours/consultations:	as agreed				
E-mail address and phone number:	ivo.colak@gf.sum.ba 036-355-012				
Assistant					
Contact hours/consultations:					
E-mail address and phone number:					
Course objectives:	Developing general scientific abilities and capacities, developing knowledge and skills for evaluation of different parameters using the methodology of scientific research.				
Learning outcomes (general and specific competences):	- Description and interpretation of basic features of science and scientific research; - Analysis of scientific areas, fields and branches, scientific and teaching positions, analysis of scientific papers, knowledge of the characteristics of scientific, scientific-professional and professional works; - Adopting methodological approaches in the development of scientific and professional works and adopting scientific methods; - Defining and studying the subject of scientific analysis, defining the structure of scientific work, defining hypothesis and plan of scientific research, ability to search world literature and to form research paper; - Analysis, categorization and evaluation of scientific publications and results of scientific research.				
Brief syllabus content:	- The concept of science, development of science and relationship between science and technology - Scientific classification, theories of science and scientific categories - Scientific theoretical research, scientific experimental research and their symbiosis - Classification of scientific methods - Scientific problem detection and its formulation, establishing a hypothesis, preparing a scientific research plan, collecting and studying literature, preparing the structure of the scientific work, solving the set problem, formulating research results, analysis of results, application of research results and control of the application of research results - Publishing and presenting the results of scientific research				

Instruction method (mark in bold)	**lectures**	exercises	**seminars**	**individual assignments**
	consultations/tutorials	**mentoring**	field instruction	other
	Remarks:			
Student obligations	- to attend classes and participate in the teaching process - to write seminar papers and present them			
Student monitoring and evaluation (mark in bold)	**Class attendance**	**Activities in classes**	**Seminar paper**	Practical work
	Oral exam	Written exam	Continuous assessment	Essay

Detailed description of evaluation within the European Credit Transfer System

STUDENT OBLIGATIONS	HOURS (ESTIMATE)	SHARE IN ECTS	SHARE IN GRADE
Class attendance	24*	0.8	10 %
Individual assignments	45	1.5	25 %
Seminar papers (two)	75	2.5	40 %
Oral exam	36	1.2	25 %

**1 class attendance=3/4 of hour*

1 ECTS=30 hours
According to study rules, the final grade is obtained as follows:
0 – 55 % insufficient (1)
55 – 66 % sufficient (2)
67 – 78 % good (3)
79 – 90 % very good (4)
91 – 100 % excellent (5)

Mandatory reading:	Silobrčić, V.: Kako sastaviti, objaviti i ocijeniti znanstveno djelo, 5. dop. izd., Medicinska knjiga, Zagreb, 2003.
Supplementary reading:	Zelenika, R.: Metodologija i tehnologija izrade znanstvenog i stručnog djela, 4. izdanje, Ekonomski fakultet Sveučilišta u Rijeci, Rijeka, 2000.
Additional course information	

Course title	Numerical modelling of the dynamic water-soil-structure interaction				*Course code*	P-I-K6
Study programme Cycle	Postgraduate university doctoral study of civil engineering				*Study year*	First
ECTS credit value:	6 ECTS	*Semester*	2^{nd}		*Hours per semester (l+e+s)*	15+5+10
Course status:	elective	*Prerequisites:*		*Corequisites:*		
Access to the course:				*Class schedule:*		
Course holder/teacher:	Assistant prof. Goran Šunjić, Ph.D.					
Contact hours/consultations:	as agreed					
E-mail address and phone number:	goran.sunjic@gf.sum.ba 036 355-005					
Assistant						
Contact hours/consultations:						
E-mail address and phone number:						
Course objectives:	Understanding the need for modern methods of solving the problems of interaction of structures in and with different media (water, soil, air, etc.). Reaching a level sufficient for inclusion in the teaching process in courses related to the numerical interaction of structure, soil/air and water.					
Learning outcomes (general and specific competences):	Ability to identify different approaches to solving problems of coupled fields. Ability to develop different models for simulating the interaction of concrete structures, fluids and soil. Understanding the need for experimental research of the dynamic fluid-soil-structure interaction problem					
Brief syllabus content:	Methods for solving the problems of coupled fields. Modelling of fluids. Modelling of structures. Modelling of the fluid-structure interaction with linear and nonlinear fluid and structure models. Models for simulating the interaction of concrete structures and fluids (plane problems, shells, spatial problems) with a special model for simulation of reinforced concrete. Some calculation aspects of implementing the numerical analysis of individual and coupled fields: spatial and temporal discretization, eigenvalue problem, nonlinear problem solutions, modelling of mass, stiffness and damping, numerical integration, limit problems, nonlinear behavior of materials etc. Experimental research of the dynamic fluid-soil-structure interaction. Open research problems.					
Instruction method (mark in bold)	**lectures**	**exercises**	**seminars**	**individual assignments**		
	consultations/tutorials	**mentoring**	field instruction	other		
	Remarks:					

Student obligations	- to attend classes and participate in the teaching process - to write a seminar paper and present it - to write test tasks			
Student monitoring and evaluation (mark in bold)	**Class attendance**	**Activities in classes**	**Seminar paper**	Practical work
	Oral exam	Written exam	Continuous assessment	Essay

Detailed description of evaluation within the European Credit Transfer System

STUDENT OBLIGATIONS	HOURS (ESTIMATE)	SHARE IN ECTS	SHARE IN GRADE
Class attendance	24*	0.8	10 %
Individual assignments	36	1.2	20 %
Seminar paper	75	2.5	45 %
Oral exam	45	1.5	25 %

**1 class attendance=3/4 of hour*

1ECTS=30 hours
According to study rules, the final grade is obtained as follows:
0 – 55 % insufficient (1)
55 – 66 % sufficient (2)
67 – 78 % good (3)
79 – 90 % very good (4)
91 – 100 % excellent (5)

Mandatory reading:	(1) Šunjić, G., Numeričko modeliranje ponašanja betonskih brana pod utjecajem seizmičkih opterećenja, Doktorska disertacija, Građevinski fakultet Sveučilišta u Mostaru, Mostar, 2016. (2) Radnić, J., Harapin, A., Brzović, D., "Modeliranje dinamičke interakcije tekućine i konstrukcije", Odabrani članci iz područja numeričkog modeliranja dinamičkog međudjelovanja tekućina - tlo - konstrukcija.
Supplementary reading:	1) Radnić, J., "Modeliranje interakcije fluida i konstrukcije“, doktorska disertacija, 1987. (2) Harapin, A., "Numerička simulacija dinamičkog međudjelovanja tekućine i konstrukcije", doktorska disertacija, 2000.
Additional course information	

Course title	Creation of bearing systems of bridges and structures				*Course code*	P-I-K6
Study programme Cycle	Postgraduate university doctoral study of civil engineering				*Study year*	First
ECTS credit value:	6 ECTS	*Semester*	2^{nd}		*Hours per semester (l+e+s)*	15+5+10
Course status:	elective	*Prerequisites:*		*Corequisites:*		
Access to the course:				*Class schedule:*		
Course holder/teacher:	Prof. Mladen Glibić, Ph.D.					
Contact hours/consultations:	as agreed					
E-mail address and phone number:	mladen.glibic@gf.sum.ba 036 355-004					
Assistant						
Contact hours/consultations:						
E-mail address and phone number:						
Course objectives:	Upgrading the knowledge of creation of load-bearing systems of structures gained up to doctoral studies. Reaching a level sufficient for inclusion in the teaching process in courses related to bridges and structures.					
Learning outcomes (general and specific competences):	Ability to carry out an advanced and technologically up-to-date bridge design procedure. Ability to distinguish between different technological bridge construction procedures, with the skill of making optimal and rational decisions. Understanding the need for scientific approach when creating bearing systems of bridges and structures.					
Brief syllabus content:	Materials and appropriate load-bearing structures. Basic bearing systems of bridges: plate, girder, frame, strut, arch, suspension, cable-stayed, stress ribbon, complex. Bridges of complex structures: arch with deck below and cable-stayed girder, deck through arch and cable-stayed girder, arch with deck above and cable-stayed girder, suspension and cable-stayed bridge, arch and stress ribbon, stress ribbon and tension cable etc. Girder bridges with prefabricated concrete girders of extreme spans. Bearing systems of bridges for extreme spans. Submerged bridges. Creating seismically resistant bridge systems. Beam girders externally reinforced by cables. Tensile bearing structures: cables, membranes, guys and mixed tensile structures. Experimental testing of seismic resistance of new bearing systems. Basic bearing systems of buildings. Creating seismically resistant building structures. New high-quality materials for new bearing systems and extreme spans. Open research problems.					
Instruction method (mark in bold)	**lectures**	**exercises**	**seminars**	**individual assignments**		

	consultations/tutorials	**mentoring**	field instruction	other
	Remarks:			
Student obligations	- to attend classes and participate in the teaching process - to write a seminar paper and present it - to write test tasks			
Student monitoring and evaluation (mark in bold)	**Class attendance**	**Activities in classes**	**Seminar paper**	Practical work
	Oral exam	Written exam	Continuous assessment	Essay

Detailed description of evaluation within the European Credit Transfer System

STUDENT OBLIGATIONS	HOURS (ESTIMATE)	SHARE IN ECTS	SHARE IN GRADE
Class attendance	24*	0.8	10 %
Individual assignments	45	1.5	20 %
Seminar paper	75	2.5	45 %
Oral exam	36	1.2	25 %

**1 class attendance=3/4 of hour*

1 ECTS=30 hours
According to study rules, the final grade is obtained as follows:
0 – 55 % insufficient (1)
55 – 66 % sufficient (2)
67 – 78 % good (3)
79 – 90 % very good (4)
91 – 100 % excellent (5)

Mandatory reading:	(1) Androić, B. i suradnici, Čelični i spregnuti mostovi, 2006. (2) Ryall, M. J., Parke G.A.R. & Harding J. E., Manual of bridge engineering, 2002. (3) Horvatić, D., Šavor, Z., Metalni mostovi, 1998. (4) Strasky, J., Stress ribbon and cable-supported pedestrian bridges, 2005. (5) Walther, R. et al., Cable stayed bridges, 1988. (6) Melbourne, C., Arch bridges, 1995. (7) Marić, Z., Mostovi I. 2016. (8) Radnić, J., Harapin, A., Osnove betonskih konstrukcija, interna skripta. (9) Radnić, J., Harapin, A., "Mostovi", interna skripta.
Supplementary reading:	(1) Radić, J.: Mostovi, 2003. (2) Other reading by agreement.
Additional course information	

Course title	Theory of plates and shells - selected chapters			*Course code*	P-I-K6
Study programme Cycle	Postgraduate university doctoral study of civil engineering			*Study year*	First
ECTS credit value:	6 ECTS	*Semester*	2nd	*Hours per semester (l+e+s)*	15+5+10
Course status:	elective	*Prerequisites:*		*Corequisites:*	
Access to the course:				*Class schedule:*	
Course holder/teacher:	Prof. Ivo Čolak, Ph.D.				
Contact hours/consultations:	as agreed				
E-mail address and phone number:	ivo.colak@gf.sum.ba 036-355-012				
Assistant					
Contact hours/consultations:					
E-mail address and phone number:					
Course objectives:	A more detailed introduction to the theory of plate and shell girders and introduction to the techniques and methods for solving them.				
Learning outcomes (general and specific competences):	- Analysis of a differential equation of plate according to the Kirchhoff-Lowe theory of thin plates and according to the Mindlin-Reissner theory of moderately thick plates; - Analysis of differential equations of thin and moderately thick shells; - Definition of finite elements for modelling plates and shells and their application; - Adoption and knowledge of the most significant finite elements for plates and shells that are used when solving typical numerical models from the literature.				
Brief syllabus content:	- The Kirchhoff-Lowe theory - Derivation of plate equation - Closed-form solutions - Open-form solutions - Approximate solutions - Finite difference method - R-function method . Finite element method - Fragment collocation method using the Fup functions - Linear analysis of shells - Numerical modelling of a shell and beam connection - Complex engineering structures				
Instruction method (mark in bold)	**lectures**	**exercises**	**seminars**	**individual assignments**	
	consultations/tutorials	**mentoring**	field instruction	other	

	Remarks:			
Student obligations	- to attend classes and participate in the teaching process - to write a seminar paper and present it - to write test tasks			
Student monitoring and evaluation (mark in bold)	**Class attendance**	**Activities in classes**	**Seminar paper**	Practical work
	Oral exam	Written exam	Continuous assessment	Essay

Detailed description of evaluation within the European Credit Transfer System

STUDENT OBLIGATIONS	HOURS (ESTIMATE)	SHARE IN ECTS	SHARE IN GRADE
Class attendance	24*	0.8	10 %
Individual assignments	42	1.4	20 %
Seminar paper	75	2.5	45 %
Oral exam	39	1.3	25 %

**1 class attendance=3/4 of hour*
1ECTS=30 hours
According to study rules, the final grade is obtained as follows:
0 – 55 % insufficient (1)
55 – 66 % sufficient (2)
67 – 78 % good (3)
79 – 90 % very good (4)
91 – 100 % excellent (5)

Mandatory reading:	Girkmann, K., Flächentragwerke: Einführung in die elastostatik der scheiben, platten, schalen und faltwerke, Springer-Verlag, Wien, 1959. Gotovac, B., Kozulić, V., Čolak, I., Uvod u numeričko modeliranje prostornih konstrukcija, Sveučilište u Mostaru, Mostar, 2001. Gould, P. L., Analysis of Shells and Plates, CMAME, Springer, 1988. Timoshenko, S. P., Voinowsky-Krueger, S., Theory of Plates and Shells, McGraw-Hill, New York, 1952.
Supplementary reading:	Gotovac, B., Numeričko modeliranje inženjerskih problema pomoću glatkih finitnih funkcija, Doktorska disertacija, Fakultet građevinskih znanosti Sveučilišta u Zagrebu, Zagreb, 1986. Owen, D. R. J., Hinton, E., Finite Elements in Plasticity: Theory and Practice, Pineridge Press, Swansea, U.K., 1980. Timoshenko, S. P., Goodier, J. N., Theory of Elasticity, McGraw-Hill, New York, 1951.
Additional course information	

Course title	Selected chapters of concrete structures				*Course code*	GAKA 14
Study programme Cycle	Postgraduate university doctoral study of civil engineering				*Study year*	First
ECTS credit value:	6 ECTS	*Semester*	2nd		*Hours per semester (l+e+s)*	15+5+10
Course status:	elective	*Prerequisites:*		*Corequisites:*		
Access to the course:				*Class schedule:*		
Course holder/teacher:	Assistant prof. Dragan Ćubela, Ph.D.					
Contact hours/consultations:	as agreed					
E-mail address and phone number:	dragan.cubela@gf.sum.ba 036 355 011 ;					
Assistant						
Contact hours/consultations:						
E-mail address and phone number:						
Course objectives:	Upgrading the knowledge of creation of complex concrete structures gained up to doctoral studies. Reaching a level sufficient for inclusion in the teaching process in courses related to concrete structures.					
Learning outcomes (general and specific competences):	The student will be qualified for: Selection of models for calculation and evaluation of results for complex stress states in simple and complex concrete elements/sections; Selection of models for analysis of cracks and deflections/displacements, and calculation of crack widths and deflections for simple and complex concrete elements; Creation, critical discussion and evaluation of the selected solution of a complex RC / PSC element/structure; Creation, critical discussion and evaluation of reinforcement placement methods in complex concrete structures; Creation, critical discussion and evaluation of cable laying methods in complex prestressed structures; Selection of structural solutions, and selection/development of models and calculation of tall buildings.					
Brief syllabus content:	(1) General information on materials: plain concretes, high-strength concretes, special concretes. Influence and calculation of rheological effects of concrete: creep, shrinkage and ageing. Calculations of crack widths of complex sections and elements. Calculation of deflections of concrete elements. Dimensioning of slender compression elements. Dimensioning of sections for simultaneous effect of bending, transverse forces and torsion. (2) Design and calculation of complex reinforced concrete structures: frame structures, structures with concrete walls, mixed structures made of concrete walls and frames, truss structures, deep beams, arched girders, slabs, foundation structures, prefabricated structures, composite structures. Design of reinforcement (classic and prestressed). (3) Design and calculation of complex prestressed concrete structures. (4) Design and calculation of seismically resistant structures.					

	(5) Specific concrete structures: large concrete bridges, tall buildings, silos, bunkers, suspended structures. (6) Overview of applicable standards for concrete structures.			
Instruction method (mark in bold)	**lectures**	**exercises**	**seminars**	**individual assignments**
	consultations/tutorials	**mentoring**	field instruction	other
	Remarks:			
Student obligations	- to attend classes and participate in the teaching process - to write a seminar paper and present it - to write test tasks			
Student monitoring and evaluation (mark in bold)	**Class attendance**	**Activities in classes**	**Seminar paper**	Practical work
	Oral exam	Written exam	Continuous assessment	Essay

Detailed description of evaluation within the European Credit Transfer System

STUDENT OBLIGATIONS	HOURS (ESTIMATE)	SHARE IN ECTS	SHARE IN GRADE
Class attendance	24*	0.8	10 %
Individual assignments	42	1.4	20 %
Seminar paper	75	2.5	45 %
Oral exam	39	1.3	25 %

**1 class attendance=3/4 of hour*

According to study rules, the final grade is obtained as follows:

0 – 55 % insufficient (1)
55 – 66 % sufficient (2)
67 – 78 % good (3)
79 – 90 % very good (4)
91 – 100 % excellent (5)

Mandatory reading:	1) I. Tomičić: Betonske konstrukcije, DHGK Zagreb, 1996., 2) J. Radić i suradnici: Betonske konstrukcije - Priručnik, GF Zagreb, 2006., 3) J. Radić i suradnici: Betonske konstrukcije – Riješeni primjeri, GF Zagreb, 2006., 4) Z. Sorić, T. Kišiček: Betonske konstrukcije 1, GF Zagreb, 2014., 5) Z. Sorić, T. Kišiček: Betonske konstrukcije 2, GF Zagreb, 2018.,
Supplementary reading:	1) J. Radnić, A. Harapin: „Osnove betonskih konstrukcija“, interna skripta; 2) J. Radnić, D. Ćubela, A. Harapin: „Spregnute konstrukcije – Numerički model za analizu pod kratkotrajnim mirnim opterećenjem, 2006.; 3) J. Radnić, L. Markota, A. Harapin: „ Raspucavanje betona – Numerički model proračuna širina pukotina savijanih betonskih nosača, GAF Split, 2005. ; 4) A. Hadrović, V. Hasanović: Betonske konstrukcije prema EN 1992 – prvi dio, GF Univerziteta "Džemal Bijedić" Mostar, 2016.; 5) Other reading by agreement.
Additional course information	

<table>
<tr><td>Course title</td><td colspan="3">SELECTED CHAPTERS FROM ROCK MECHANICS</td><td>Course code</td><td></td></tr>
<tr><td>Study programme Cycle</td><td colspan="3">University doctoral study, field Civil Engineering, branch Geotechnics - 3rd cycle</td><td>Study year</td><td></td></tr>
<tr><td>ECTS credit value:</td><td>6</td><td>Semester</td><td></td><td>Hours per semester (l+e+s)</td><td>30+0</td></tr>
<tr><td>Course status:</td><td>elective</td><td>Prerequisites:</td><td>1st and 2nd cycle</td><td>Corequisites:</td><td></td></tr>
<tr><td>Access to the course:</td><td colspan="3">Students of the first year of the postgraduate doctoral study, field Civil Engineering, branch Geotechnics</td><td>Class schedule:</td><td>According to schedule</td></tr>
<tr><td colspan="2">Course holder/teacher:</td><td colspan="4">Prof. Predrag Mišćević, Ph.D.</td></tr>
<tr><td colspan="2">Contact hours/consultations:</td><td colspan="4">as agreed</td></tr>
<tr><td colspan="2">E-mail address and phone number:</td><td colspan="4">/</td></tr>
<tr><td colspan="2">Assistant</td><td colspan="4">/</td></tr>
<tr><td colspan="2">Contact hours/consultations:</td><td colspan="4">as agreed</td></tr>
<tr><td colspan="2">E-mail address and phone number:</td><td colspan="4">/</td></tr>
<tr><td>Course objectives:</td><td colspan="5">·</td></tr>
<tr><td>Learning outcomes (general and specific competences):</td><td colspan="5">The student will:
critically judge and improve the methods of measuring the parameters of cracks, rock and rock mass
independently reconsider rock mass classifications
develop rock mass models
develop methods for the analysis of weathering in soft rocks
select and plan the parameters necessary for solving engineering problems in rock masses</td></tr>
<tr><td>Brief syllabus content:</td><td colspan="5">Program of investigation works for the development of designs and construction of structures in rock masses. Correlation dependencies of individual engineering geological elements (cracks, core percentage, RQD, etc.) and geotechnical properties of rock mass. Rock and rock mass models. Weathering and soft rocks. Guidelines for the design and calculation of foundations, high slopes, retaining structures and underground structures (engineering geological model, geotechnical model, calculation model). Application of numerical methods in solving engineering problems in rock masses.</td></tr>
<tr><td rowspan="3">Instruction method (mark in bold)</td><td colspan="2">lectures</td><td>exercises</td><td>seminars</td><td>individual assignments</td></tr>
<tr><td colspan="2">consultations/tutorials</td><td>mentoring</td><td>field instruction</td><td>Other: seminar paper</td></tr>
<tr><td colspan="5">Remarks: After completing the theoretical and practical part of the course, the</td></tr>
</table>

	student prepares a seminar paper, and after successfully defending it, he or she can take the written and oral parts of the exam.			
Student obligations	- to attend classes or other way of participation in the teaching process - participation in field/laboratory research as part of instruction - to write and present the seminar paper - oral exam (make-up exam in regular examination periods)			
Student monitoring and evaluation (mark in bold)	**Attending classes or other forms of teaching process**	**Activities in classes**	**Seminar paper**	Practical work
	Oral exam	Written exam	Preliminary exams (continuous assessment)	Essay

Detailed description of evaluation within the European Credit Transfer System			
STUDENT OBLIGATIONS	HOURS (ESTIMATE)	SHARE IN ECTS	SHARE IN GRADE
Attending classes or other form of teaching process	24*	0.8	10%
Independent work	96	3.2	45%
Seminar paper	60	2.0	45%

**1 class attendance=3/4 of hour*

1 ECTS=30 hours
Additional explanations:
Assessment and examination is conducted through oral presentation of the seminar paper.

Mandatory reading:	(1) Hudson J.A. &Harrison J.P. (1997.), Engineering rock mechanics, an introduction to the principles, Pergamon. (2) Duncan C. W. (1999.), Foundation on Rock, E & FN Spon, second edition. (3) Hoek E.(2007.), Practical Rock Engineering, www.rocscience.com. (4) Maidl B., Thewes M. &Maidl U. (2013.), Handbook of tunnel engineering, Vol. 1. i 2., Ernst & Sohn. (5) Wittke W. (2014.), Rock mechanics on an anisotropic jointed rock model, Ernst &Sohn. (6) Zhang L. (2017.), Engineering properties of rock, Elsevier
Supplementary reading:	(1) Hanna T.H. (1982.), Foundations in tension, ground anchors, Trans Tech Publications. (2) Duncan C. Wyllie and Christopher W. Mah (2004.), Rock slope engineering, Civil and mining, 4th edition, Spon Press. (3) Goodman R.E. (1989.), Introduction to Rock Mechanics (second edition), John Wiley&Sons.(4) Bhawani Singh & R. K. Goel (2011.), Engineering rock mass classification: tunneling, foundations, and landslides, Elsevier. (5) Muir Wood D. (2004.), Geotechnical modelling, Spon Press.
Additional course information	

Course title	**SOIL MECHANICS MODELS**			*Course code*	
Study programme Cycle	*University doctoral study, field Civil Engineering, branch Hydraulic Engineering - 3rd cycle*			*Study year*	
ECTS credit value:	*6*	*Semester*		*Hours per semester (l+e+s)*	*30+0*
Course status:	*elective*	*Prerequisites:*	*1st and 2nd cycle*	*Corequisites:*	
Access to the course:	*Students of the first year of the postgraduate doctoral study, field Civil Engineering, branch Geotechnics*			*Class schedule:*	*According to schedule*
Course holder/teacher:	*Associate prof. Maja Prskalo, Ph.D.*				
Contact hours/consultations:	*As agreed*				
E-mail address and phone number:	*maja.prskalo@gf.sum.ba*				
Assistant					
Contact hours/consultations:					
E-mail address and phone number:					
Course objectives:	.				
Learning outcomes (general and specific competences):	*The student will:* • *critically judge the latest knowledge available in the existing literature with special attention to the area of small strains;* • *comment on correlations, strengths and weaknesses in the application of known and recognized soil models;* • *in the laboratory, on the existing equipment, independently determine input parameters for some of the known soil models;* • *evaluate the obtained laboratory data and apply them on an idealized numerical model of soil;* • *evaluate the obtained solutions by comparing multiple variants;* • *express a reasoned opinion on the possibility of adapting theoretical solutions for solving natural phenomena in geotechnics, which are suitable for subject research.*				
Brief syllabus content:	*Fundamentals of continuum mechanics. Soil as a two-phase continuum. Differential equations of equilibrium and motion. Simpler constitutive equations for soil. The effect of nonlinearity in soil behaviour. Drained and undrained conditions; water flow in soil and consolidation. Boundary and initial conditions. Basic rules in numerical modelling of geotechnical constructions. Limitations and criteria. Nonlinear soil models and finite element method. Electronic computer programs: requirements and features. Selection of input data. Criticality in simplifying problems. Acceptability of results of numerical analysis. Numerical modelling of complex geotechnical constructions: earthfill structures, anchored retaining structures etc.*				

Instruction method (mark in bold)	**lectures**	exercises	seminars	individual assignments
	consultations/tutorials	mentoring	field instruction	**Other: seminar paper**
	Remarks:			
Student obligations	- to attend classes or other way of participation in the teaching process - to write a seminar paper and present it - to take preliminary exams - oral exam (make-up exam in regular examination periods)			
Student monitoring and evaluation (mark in bold)	**Attending classes or other forms of teaching process**	Activities in classes	**Seminar paper**	Practical work
	Oral exam	**Written exam**	**Preliminary exams (continuous assessment)**	

Detailed description of evaluation within the European Credit Transfer System

STUDENT OBLIGATIONS	HOURS (ESTIMATE)	SHARE IN ECTS	SHARE IN GRADE
Attending classes or other form of teaching process	24*	0.8	5%
Seminar paper	66	2.2	30%
Preliminary exams: 1st preli. exam 2nd preli. exam	 30 60	 1.0 2.0	 30% 35%
Oral exam	90	3.0	65%

**1 class attendance=3/4 of hour*

1 ECTS=30 hours
Additional explanations:
Seminar paper is prepared on a given topic and publicly presented. Presentation topics and times are determined during the course of instruction and teaching process.
Preliminary exams (continuous assessments) are conducted after completion of the part of lectures in the form of written tests - problems and oral (theoretical) part of the exam. A student who does not successfully pass the first preliminary exam is required to take the written and oral exam (make-up exam in regular examination periods). A student who does not successfully pass the second preliminary exam is required to take the written and oral exam (make-up exam in regular examination periods). A student who passes the first and second preliminary exams is exempt from the oral exam.

Mandatory reading:	(1) Mechanics of Geomaterials: Rocks, Concrete, Soils, Z.P. Balant ed., John Wiley & Sons, Inc., New York, 1985. (2) Naylor, D.J., Pande, G.N., Simpson, B., Tabb, R.: Finite Elements in Geotechnical Engineering, Pineridge Press Ltd., Swansea (UK), 1981.
Supplementary reading:	(1) Roscoe, K.H., Burland, J.B.:. *On the generalised stress-strain behaviour of an idealised wet clay*. U: Heineman i Leckie (ur.), Engineering plasticity, (1968), Cambrige University Press, 535-609. (2) Chen, W.F.,: *Limit analysis and soil plasticity*. Elsevier, New York, 1975. (3) Chen, W.F., Saleeb, A.F., *Constitutive Equations for Engineering Materials*. *Vol 1- Elasticity and Modeling*, Wiley, New York, 1982. (4) GeoSlope, *Manual Sigma/W define,* version 5.01. (5) ABAQUS, *Theory Manula version 6.3*. (6) Mihanović, A:, Marović, P., Dvornik, J.: *Nelinearni proračuni armirano betonskih konstrukcija.* Društvo hrvatskih građevinskih konstruktora, Stručna biblioteka, Serija priručnici, knjiga 7, Zagreb, 1993. (7) P.I.S.A. *Program for incremental stress analysis*; Elastic models, Plastic models, Critical state models. (8) Atkinson, J.H.; Bransby, P.L.: 1978. *The mechanics of soils, An introduction to critical state soil mechanics*, McGrow-Hill, London. (9) Britto, A.M., Gunn, M.J., 1987. *Critical State Soil Mechanics via Finite Elements*, John Wiley and Sons. (10) Časopisi: Geotechnique; Engineering Modelling; Soils and Foundations; Journal of Solis Mech. And Fuond. Engineering, ASCE.
Additional course information	

Course title	**SPECIAL CHAPTERS OF FOUNDATION ENGINEERING**			*Course code*	
Study programme Cycle	*University doctoral study, field Civil Engineering, branch Geotechnics - 3rd cycle*			*Study year*	
ECTS credit value:	*6*	*Semester*		*Hours per semester (l+e+s)*	*30+0*
Course status:	*elective*	*Prerequisites:*	*1st and 2nd cycle*	*Corequisites:*	
Access to the course:	*Students of the first year of the postgraduate doctoral study, field Civil Engineering, branch Geotechnics*			*Class schedule:*	*According to schedule*
Course holder/teacher:	*Associate prof. Maja Prskalo, Ph.D.*				
Contact hours/consultations:	*As agreed*				
E-mail address and phone number:	*maja.prskalo@gf.sum.ba*				
Assistant					
Contact hours/consultations:					
E-mail address and phone number:					
Course objectives:	.				
Learning outcomes (general and specific competences):	*The student will:* • *review the state of technology for realisation of unusual foundation engineering methods from available literature;* • *review the current possibilities for improving foundation soil and comment critically on them;* • *model unusual foundation work and improvement of foundation soil for the same geotechnical conditions and given parameters;* • *on a concrete example, compare and evaluate all aspects of quality, type and effect of unusual foundation work and improvement of foundation soil;* • *examine the effects of changes in values of particular input data on an individual model of unusual foundation and/or improvement of foundation soil;* • *be qualified to select the most favourable solutions in complex conditions of foundation engineering.*				
Brief syllabus content:	*Foundation of silos and reservoirs; foundation of towers, chimneys, power line and antenna towers; foundation of arch, suspension and other bridges (abutments and piers); deep massive foundations; foundation in deep water (jetties, platforms); coastal structures, foundation and support of horizontal forces; overcoming the buoyancy acting on submerged structures (dry docks, lock gates, dam freeboard). Straightening leaning structures. Change of stresses in the structure due to temporal development of settlement. (The content will be adapted to wishes of the candidate considering that it is too extensive for the scheduled hours)*				
Instruction method (mark in bold)	**lectures**	exercises	seminars	individual assignments	
	consultations/tutorials	mentoring	field instruction	**Other: seminar**	

				paper
	Remarks:			
Student obligations	- to attend classes or other way of participation in the teaching process - to write a seminar paper and present it - to take preliminary exams - oral exam (make-up exam in regular examination periods)			
Student monitoring and evaluation (mark in bold)	**Attending classes or other forms of teaching process**	Activities in classes	**Seminar paper**	Practical work
	Oral exam	**Written exam**	**Preliminary exams (continuous assessment)**	

Detailed description of evaluation within the European Credit Transfer System

STUDENT OBLIGATIONS	HOURS (ESTIMATE)	SHARE IN ECTS	SHARE IN GRADE
Attending classes or other form of teaching process	24*	0.8	5%
Seminar paper	66	2.20	30%
Preliminary exams: 1st prelim. exam 2nd prelim. exam	 30 60	 1.0 2.0	 30% 35%
Oral exam	90	3.0	65%

**1 class attendance=3/4 of hour*

1 ECTS=30 hours
Additional explanations:
Seminar paper is prepared on a given topic and publicly presented. Presentation topics and times are determined during the course of instruction and teaching process.
Preliminary exams (continuous assessments) are conducted after completion of the part of lectures in the form of written tests - problems and oral (theoretical) part of the exam. A student who does not successfully pass the first preliminary exam is required to take the written and oral exam (make-up exam in regular examination periods). A student who does not successfully pass the second preliminary exam is required to take the written and oral exam (make-up exam in regular examination periods). A student who passes the first and second preliminary exams is exempt from the oral exam.

Mandatory reading:	(1) Fang, H.-Y.: Foundation Engineering Handbuk, Chapman & Hall, London, 1991. (2) Zeevaert. L.: Foundation Engineering for Difficult Subsoil Conditions, Van Nostrand Reinhold Company, New York, 1973. (3) Agatz, A.; Lackner, E.: Erfarungen mit Grundbauwerken, Springer – Verlag, Berlin, 1977.

Supplementary reading:	(1) Desai, C.S.. Christian, J.T.: Numerical Methods in Geotechnical Engineering, McGraw-Hill Book Company, New York, 1977. (2) Bowles, J.E.: Foundation Analysis and Design, McGraw-Hill Book Company, New York, 1988. (3) Kany, M.: *Berechnung von Flächengründungen,* Wilhelm Ernst&Sohn, 1974, Berlin. (4) Prudon, L. *Traveau maritime, Bibliothèque de l'ingénieur de travaux publics,* Dunod, 1936. Paris.
Additional course information	

Course title	*SELECTED CHAPTERS FROM KARST HYDROGEOLOGY*				*Course code*	
Study programme Cycle	*Postgraduate university doctoral study of civil engineering* *3rd cycle*				*Study year*	*1st*
ECTS credit value:	*6*	*Semester*		*1st*	*Hours per semester (l+e+s)*	*30+0*
Course status:	*Elective*	*Prerequisites:*	*Hydrogeology*		*Corequisites:*	
Access to the course:	*Students who enrolled in the 1st semester of the 1st year of the university doctoral study, the programme of hydraulic engineering*				*Class schedule:*	*According to schedule*

Course holder/teacher:	*Amira Galić*
Contact hours/consultations:	*As agreed*
E-mail address and phone number:	*amira.galic@gf.sum.ba*
Assistant	-
Contact hours/consultations:	-
E-mail address and phone number:	-
Course objectives:	*To introduce students into geotectonic and structural tectonic characteristics of karst as well as investigation methodology. To present to students the development of relief and laws of groundwater flow in karst. To familiarize students with karstification stages and morphological phenomena in karst. To present the geological basis of hydrogeological phenomena in karst. To introduce students into positive and negative impacts on karst development, genesis of karst fields and hydrogeological phenomena in the underground. Present the problem of water losses from reservoirs in karst.*
Learning outcomes (general and specific competences):	*After successfully completing the course, the student will be able to:* - *Identify the characteristics of karst morphological phenomena and correlate them with groundwater flows.* - *Organise different terrains depending on permeability.* - *Integrate the knowledge of karst morphology and ground permeability for the purpose of proposing sanitary protection zones.* - *Present hydrodynamic zones in karst.* - *Conduct the procedures of calculating water losses from reservoirs in karst.*
Brief syllabus content:	*Cause-and-effect relationship between geotechnics and karst. Karstification stages. Marphological elements of karst. Geological background of hydrological phenomena in karst. Positive and negative impacts on the development of karst. Karst fields (poljes). Water in the underground and specificities of its movement. Hydrogeological phenomena in the underground. The quality and self-purification of water in karst. Investigations in karst. The problems of reservoirs in karst.*

Instruction method (mark in bold)	**lectures**	exercises	**Research seminar paper**	individual assignments
	consultations/tutorials	mentoring	field instruction	other
	Remarks:			
Student obligations	- to attend classes and participate in the teaching process - to write a research seminar paper and present it - to take oral exam			
Student monitoring and evaluation (mark in bold)	**Class attendance**	Activities in classes	**Research seminar paper**	Practical work
	Oral exam	Written exam	Continuous assessment	Essay

Detailed description of evaluation within the European Credit Transfer System

STUDENT OBLIGATIONS	HOURS (ESTIMATE)	SHARE IN ECTS	SHARE IN GRADE
Class attendance	24*	0.8	10%
Seminar paper	60	2.0	35%
Oral exam	96	3.2	55%

**1 class attendance=3/4 of hour*

1 ECTS=30 hours

Mandatory reading:	*(1)Drew, D., Goldscheider, N. 2007 - Methods in Karst Hydrogeology* *(2)Ford, D., Wiliams, P. 2007 - Karst Hydrogeology and Geomorphology*
Supplementary reading:	*(1)Bonacci, O. 1987.:Karst Hydrology With Special Reference to the Dinaric Karst (2) K. Urumović (2003): Fizikalne osnove dinamike podzemnih voda. RGN Fakultet Zagreb*
Additional course information	

<table>
<tr><td>Course title</td><td colspan="3">ANALYSIS OF HYDROLOGICAL TIME SERIES</td><td>Course code</td><td></td></tr>
<tr><td>Study programme Cycle</td><td colspan="3">Doctoral study</td><td>Study year</td><td>1st (first)</td></tr>
<tr><td>ECTS credit value:</td><td>6.0</td><td>Semester</td><td>2nd (second)</td><td>Hours per semester (l+e+s)</td><td>30+25+5</td></tr>
<tr><td>Course status:</td><td>Mandatory</td><td>Prerequisites:</td><td>-</td><td>Corequisites:</td><td>-</td></tr>
<tr><td>Access to the course:</td><td colspan="2"></td><td colspan="2">Class schedule:</td><td></td></tr>
<tr><td colspan="2">Course holder/teacher:</td><td colspan="4">Associate prof. Gordan Prskalo, Ph.D.</td></tr>
<tr><td colspan="2">Contact hours/consultations:</td><td colspan="4"></td></tr>
<tr><td colspan="2">E-mail address and phone number:</td><td colspan="4">gordan.prskalo@gf.sum.ba</td></tr>
<tr><td colspan="2">Assistant</td><td colspan="4"></td></tr>
<tr><td colspan="2">Contact hours/consultations:</td><td colspan="4"></td></tr>
<tr><td colspan="2">E-mail address and phone number:</td><td colspan="4"></td></tr>
<tr><td>Course objectives:</td><td colspan="5">Inform students about hydrological and climatological time series and basic terminology. Train students to use simple descriptive techniques and hydrological time series models.</td></tr>
<tr><td>Learning outcomes (general and specific competences):</td><td colspan="5">After successful completion of the course, the student will be able to:
• Write an analysis of time series using descriptive techniques.
• Propose appropriate time series models.
• Propose prognostic models.
• Present time series in the frequency domain.</td></tr>
<tr><td>Brief syllabus content:</td><td colspan="5">Introduction: hydrological and climatological time series and their characteristics, basic terminology, goals and approaches to hydrological time series analysis. Simple descriptive techniques: variation types, time series stationarity, graphical representation and comparison of time series, analysis of series with trends, analysis of series with seasonal variation, autocorrelation and correlogram, cross-correlation, partial correlation, regression, smoothing series. Hydrological time series models: stochastic processes and their characteristics, stationary processes, "white noise", characteristics and estimation of autocorrelation function, AR, MA, ARMA and ARIMA models, Box-Jenkins seasonal ARIMA model, adjustment and estimation of model parameters, residual value analysis. Prognostic models, overview of prognostic procedures and their comparison. Analysis of hydrological time series in the frequency domain: spectral analysis, periodogram, spectral density function, cross-spectral density function, transfer function.</td></tr>
<tr><td rowspan="3">Instruction method (mark in bold)</td><td colspan="2">lectures</td><td>exercises</td><td>seminars</td><td>individual assignments</td></tr>
<tr><td colspan="2">consultations/tutorials</td><td>mentoring</td><td>field instruction</td><td>other</td></tr>
<tr><td colspan="5">Remarks:</td></tr>
</table>

<table>
<tr><td>Student obligations</td><td colspan="4">Students are required to participate in at least 65% of the lectures and 70% of the exercises and should also successfully write and defend the seminar paper to access the examination</td></tr>
<tr><td rowspan="3">Student monitoring and evaluation (mark in bold)</td><td>Class attendance</td><td>Activities in classes</td><td>Seminar paper</td><td>Practical work</td></tr>
<tr><td>Oral exam</td><td>Written exam</td><td>Continuous assessment</td><td>Essay</td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="5">Detailed description of evaluation within the European Credit Transfer System</td></tr>
<tr><td>STUDENT OBLIGATIONS</td><td>HOURS (ESTIMATE)</td><td>SHARE IN ECTS</td><td colspan="2">SHARE IN GRADE</td></tr>
<tr><td>Class attendance</td><td>45*</td><td>1.5</td><td colspan="2">10 %</td></tr>
<tr><td>Seminar paper</td><td>45</td><td>1.5</td><td colspan="2">30%</td></tr>
<tr><td>Written exam</td><td></td><td></td><td colspan="2"></td></tr>
<tr><td>Preliminary exam 1</td><td>45</td><td>1.5</td><td colspan="2">30 %</td></tr>
<tr><td>Preliminary exam 2</td><td>45</td><td>1.5</td><td colspan="2">30 %</td></tr>
<tr><td>Oral exam</td><td>90</td><td>3.0</td><td colspan="2">60%</td></tr>
<tr><td>Mandatory reading:</td><td colspan="4">• Chris Chatfield: The Analysis of Time Series: An Introduction, Sixth Edition, Texts in Statistical Science, 2003.
• Jevđević, V., 1974., Stohastički procesi u hidrologiji, Water Resources Publication, Fort Collins, Colorado i Institut za hidrotehniku GF, Sarajevo; Hrelja, H., 2007., Inženjerska hidrologija, Građevinski fakultet Sarajevo; Parzen, E., 1962., Stochastic processes, Holden Day, San Francisco.</td></tr>
<tr><td>Supplementary reading:</td><td colspan="4">• George E. P. Box, Gwilym M. Jenkins, and Gregory C. Reinsel: Time Series Analysis: Forecasting and Control, Wiley Series in Probability and Statistics, 2008.
• A.R. Rao and E.-C. Hsu: Hilbert-Huang Transform Analysis of Hydrological and Environmental Time Series, Water Science and Technology Library, 2008.
• Shumway R.D., Stoffer D.S.: Time Series Analysis and Its Applications, Springer Verlag, 2000.
• Napler Addison: The Illustrated Wavelet Transform Handbook, 2002.</td></tr>
<tr><td>Additional course information</td><td colspan="4">*1 Class attendance=3/4 of hour</td></tr>
</table>

<table>
<tr><td>Course title</td><td colspan="3">SELECTED CHAPTERS FROM HYDROLOGY</td><td>Course code</td><td></td></tr>
<tr><td>Study programme Cycle</td><td colspan="3">Doctoral study</td><td>Study year</td><td>1st (first)</td></tr>
<tr><td>ECTS credit value:</td><td>6.0</td><td>Semester</td><td>2nd (second)</td><td>Hours per semester (l+e+s)</td><td>30+30</td></tr>
<tr><td>Course status:</td><td>Mandatory</td><td>Prerequisites:</td><td>-</td><td>Corequisites:</td><td>-</td></tr>
<tr><td>Access to the course:</td><td colspan="2"></td><td colspan="2">Class schedule:</td><td></td></tr>
<tr><td colspan="2">Course holder/teacher:</td><td colspan="4">Associate prof. Gordan Prskalo, Ph.D.</td></tr>
<tr><td colspan="2">Contact hours/consultations:</td><td colspan="4"></td></tr>
<tr><td colspan="2">E-mail address and phone number:</td><td colspan="4">gordan.prskalo@gf.sum.ba</td></tr>
<tr><td colspan="2">Assistant</td><td colspan="4"></td></tr>
<tr><td colspan="2">Contact hours/consultations:</td><td colspan="4"></td></tr>
<tr><td colspan="2">E-mail address and phone number:</td><td colspan="4"></td></tr>
<tr><td>Course objectives:</td><td colspan="5">to acquire theoretical and practical knowledge in the field of hydrology, which covers the analysis of data on precipitation, hydrological processes on land, analysis of underground flow, flow to wells and groundwater protection</td></tr>
<tr><td>Learning outcomes (general and specific competences):</td><td colspan="5">After successfully completing the course, the student will be able to:
• explain the concepts and apply procedures of basic meteorological data analysis
• conduct basic hydrological analysis
• perform more complex statistical and probabilistic hydrological analyses
• conduct the analysis of low, medium and high water</td></tr>
<tr><td>Brief syllabus content:</td><td colspan="5">Groundwater and underground flow. Connection of groundwater and surface water, infiltration, capillarity, evaporation, factors of the vertical balance of groundwater. Measurement methods and measurement technique in the area of groundwater. Creating a natural watershed hydrograph. Separation of base and surface runoff. The concept of effective precipitation. Parametric hydrology, meaning, methods and application. SCS method, unit hydrograph, Rational method, Isochrone method. Mathematical modelling of hydrological processes. Runoff regulation types. Reservoirs and natural retarding basins. Sediment accumulation. Flow of bed load and suspended sediment in rivers. Sediment flow measurement methods and instruments. Empirical data processing and application.</td></tr>
<tr><td rowspan="3">Instruction method (mark in bold)</td><td colspan="2">lectures</td><td>exercises</td><td>seminars</td><td>individual assignments</td></tr>
<tr><td colspan="2">consultations/tutorials</td><td>mentoring</td><td>field instruction</td><td>other</td></tr>
<tr><td colspan="5">Remarks:</td></tr>
<tr><td>Student obligations</td><td colspan="5">Students are required to participate in at least 65% of the lectures and 70% of the exercises and should also successfully write and defend the seminar paper to access the examination</td></tr>
</table>

Student monitoring and evaluation (mark in bold)	**Class attendance**	**Activities in classes**	**Seminar paper**	Practical work
	Oral exam	**Written exam**	Continuous assessment	Essay

Detailed description of evaluation within the European Credit Transfer System			
STUDENT OBLIGATIONS	HOURS (ESTIMATE)	SHARE IN ECTS	SHARE IN GRADE
Class attendance	45*	1.5	10 %
Seminar paper	45	1.5	30%
Written exam			
Preliminary exam 1	45	1.5	30 %
Preliminary exam 2	45	1.5	30 %
Oral exam	90	3.0	60%

Mandatory reading:	H. Hrelja: Inženjerska hidrologija, Građevinski fakultet, Sarajevo, 2007. O. Bonacci: Oborine-glavna ulazna veličina u hidrološki ciklus, Geing, Split, 1994
Supplementary reading:	P.B. Bedient; W.C. Huber; B.E. Vieux: Hydrology and Floodplain Analysis, Prentice Hall 2008. O. Bonacci: Karst Hydrology, Springer Verlag, Heidelberg, 1987. O. Bonacci: Ekohidrologija, Građevinski fakultet Split, 2003.
Additional course information	**1 class attendance=3/4 of hour* *A student who passes the first and second preliminary exams is exempt from the oral exam.*

<table>
<tr><td>Course title</td><td colspan="3">HYDROLOGICAL MODELLING IN KARST</td><td>Course code</td><td></td></tr>
<tr><td>Study programme Cycle</td><td colspan="3">Doctoral study</td><td>Study year</td><td>1st (first)</td></tr>
<tr><td>ECTS credit value:</td><td>6.0</td><td>Semester</td><td>2nd (second)</td><td>Hours per semester (l+e+s)</td><td>30+25+5</td></tr>
<tr><td>Course status:</td><td>Mandatory</td><td>Prerequisites:</td><td>-</td><td>Corequisites:</td><td>-</td></tr>
<tr><td>Access to the course:</td><td colspan="2"></td><td colspan="2">Class schedule:</td><td></td></tr>
<tr><td colspan="2">Course holder/teacher:</td><td colspan="4">Associate prof. Gordan Prskalo, Ph.D.</td></tr>
<tr><td colspan="2">Contact hours/consultations:</td><td colspan="4"></td></tr>
<tr><td colspan="2">E-mail address and phone number:</td><td colspan="4">gordan.prskalo@gf.sum.ba</td></tr>
<tr><td colspan="2">Assistant</td><td colspan="4"></td></tr>
<tr><td colspan="2">Contact hours/consultations:</td><td colspan="4"></td></tr>
<tr><td colspan="2">E-mail address and phone number:</td><td colspan="4"></td></tr>
<tr><td>Course objectives:</td><td colspan="5">To introduce students into the methods, approaches and hydrological studies in karst, to train them to create, verify and calibrate hydrological models in karst, and to use water balance in defining relations in a karst area</td></tr>
<tr><td>Learning outcomes (general and specific competences):</td><td colspan="5">After successful completion of the course, students will be able to:
• Set up and create hydrological models in karst.
• Synthesize developed models to a new research area.
• Integrate water balance concepts from the viewpoint of basins in karst.
• Formulate and implement model verification and calibration procedures.</td></tr>
<tr><td>Brief syllabus content:</td><td colspan="5">Systematic approach: definitions and concepts. Problems and models in hydrology. Linear, non-stationary and nonlinear models. Black box and conceptual models. Modelling runoff in the basin. Characteristics of the system unit response. Models for unstudied basins. Analysis of the recession part of hydrograph. Modelling parameters. Water balance in soil. Conceptual models of water balance in karst. Characteristics of the recharge-discharge relationship in karst aquifers. Determination of the basin area and runoff coefficient in karst. Model calibration and verification. Coefficient of efficiency.</td></tr>
<tr><td rowspan="3">Instruction method (mark in bold)</td><td>lectures</td><td>exercises</td><td>seminars</td><td colspan="2">individual assignments</td></tr>
<tr><td>consultations/tutorials</td><td>mentoring</td><td>field instruction</td><td colspan="2">other</td></tr>
<tr><td colspan="5">Remarks:</td></tr>
<tr><td>Student obligations</td><td colspan="5">Students are required to participate in at least 65% of the lectures and 70% of the exercises and should also successfully write and defend the seminar paper to access the examination</td></tr>
<tr><td rowspan="2">Student monitoring and evaluation (mark in bold)</td><td>Class attendance</td><td>Activities in classes</td><td>Seminar paper</td><td colspan="2">Practical work</td></tr>
<tr><td>Oral exam</td><td>Written exam</td><td>Continuous assessment</td><td colspan="2">Essay</td></tr>
</table>

Detailed description of evaluation within the European Credit Transfer System				
STUDENT OBLIGATIONS	HOURS (ESTIMATE)		SHARE IN ECTS	SHARE IN GRADE
Class attendance	45*		1.5	10 %
Preliminary exam 1	45		1.5	30 %
Preliminary exam 2	45		1.5	30 %
Seminar paper	15		0.5	10%
Oral exam	30		1.0	20%
Mandatory reading:	• O. Bonacci, Karst Hydrology, Springer Verlag, Heidelberg, 1987.; • V.P. Singh, Hydrologic Systems, Rainfall-Runoff Modeling, Prentice Hall, 1988.; • Metka Petrič: Characteristics of recharge–discharge relations in karst aquifer, Inštitut za raziskovanje krasa ZRC SAZU, Založba ZRC, Postojna-Ljubljana, 2002.			
Supplementary reading:	• Mc Cuen: Hydrologic analysis and design, Prentice Hall, 1989.; • M.P. Wanielista, Hydrology and water quantity control, John Wiley & Sons, 1990.			
Additional course information	**1 class attendance=3/4 of hour*			

<table>
<tr><td>Course title</td><td colspan="3">SYSTEMATIC ENGINEERING IN THE PLANNING AND MANAGEMENT OF WATER RESERVOIRS</td><td>Course code</td><td>DHID21</td></tr>
<tr><td>Study programme Cycle</td><td colspan="3">University doctoral study, field Civil Engineering, branch Hydraulic Engineering - 3rd cycle</td><td>Study year</td><td>First or second</td></tr>
<tr><td>ECTS credit value:</td><td>6</td><td>Semester</td><td>First or second</td><td>Hours per semester (l+e+s)</td><td>30+30</td></tr>
<tr><td>Course status:</td><td>elective</td><td>Prerequisites:</td><td>1st and 2nd cycle</td><td>Corequisites:</td><td></td></tr>
<tr><td>Access to the course:</td><td colspan="3">Students of the first year of the postgraduate doctoral study, field Civil Engineering, branch Hydraulic Engineering</td><td>Class schedule:</td><td>According to schedule</td></tr>
<tr><td colspan="2">Course holder/teacher:</td><td colspan="4">Associate prof. Željko Rozić, Ph.D.</td></tr>
<tr><td colspan="2">Contact hours/consultations:</td><td colspan="4">As agreed</td></tr>
<tr><td colspan="2">E-mail address and phone number:</td><td colspan="4">zeljko.rozic@gf.sum.ba</td></tr>
<tr><td colspan="2">Assistant</td><td colspan="4"></td></tr>
<tr><td colspan="2">Contact hours/consultations:</td><td colspan="4"></td></tr>
<tr><td colspan="2">E-mail address and phone number:</td><td colspan="4"></td></tr>
<tr><td>Course objectives:</td><td colspan="5">To present to students the processes of systematic engineering,
To introduce students into real needs for water,
To familiarize students with research methods and new technologies - tools for functional management and planning of water reservoirs,
To point out to students the importance of surface water and groundwater quality, with a focus on the sustainable management of hydrological water cycle,
To analyse and calculate with students the possible estimates and dimensioning of water reservoirs for the functional and safe management of water needs.</td></tr>
<tr><td>Learning outcomes (general and specific competences):</td><td colspan="5">After successful completion of the course, the student will be able to:
Apply a systematic approach and systematic analysis in solving engineering problems related to the design and operation of water reservoirs
Plan and design water reservoirs in solving water-management problems of water use, protection from damaging effects of water and water protection
Formulate mathematical stochastic and deterministic models of water reservoirs and apply systematic analysis tools in solving water reservoir design and management problems
Set up a model for simulation of water reservoir operation for the purpose of solving various water management problems
Formulate optimisation models for solving engineering problems in planning, design and management of water reservoirs
Prepare the data necessary for planning and design of water reservoirs</td></tr>
</table>

<table>
<tr><td></td><td colspan="4">· Predict the environmental impact of water reservoirs and define protection measures</td></tr>
<tr><td>Brief syllabus content:</td><td colspan="4">· Water reservoirs and their role in water management and in the realisation of sustainable water supply, food and energy production, flood and drought protection and water environment protection.
· Basic theories of water reservoir volume design: planning of water resources and water reservoirs, basic characteristics of water reservoirs with respect to capacity, volume equations.
· Systematic approach to planning and design of water reservoir capacity.
· Methods for determining the capacity of water reservoirs: calculation using balance equation, critical period methods, low water method, probability matrix method, generated data based method, simulation and optimisation methods.
· Systematic engineering - basic definitions. Formulation of optimisation problems. Introduction to linear programming. Basics of linear programming. Application of linear programming in design and management of reservoirs and in solving other water management problems.
· The concept of dynamic programming.
· One-dimensional dynamic programming. Multidimensional dynamic programming.
· Special forms of dynamic programming.
· Application of dynamic programming in design and management of reservoirs and in solving other water management problems.</td></tr>
<tr><td rowspan="3">Instruction method (mark in bold)</td><td>Lectures</td><td>exercises</td><td>seminars</td><td>individual assignments</td></tr>
<tr><td>consultations/tutorials</td><td>mentoring</td><td>field instruction</td><td>Other: seminar paper</td></tr>
<tr><td colspan="4">Remarks:</td></tr>
<tr><td>Student obligations</td><td colspan="4">- to attend classes or other way of participation in the teaching process
- to write a seminar paper and present it
- to take preliminary exams
- oral exam (make-up exam in regular examination periods)</td></tr>
<tr><td rowspan="3">Student monitoring and evaluation (mark in bold)</td><td>Attending classes or other forms of teaching process</td><td>Activities in classes</td><td>Seminar paper (research)</td><td>Practical work</td></tr>
<tr><td>Oral exam</td><td>Written exam</td><td>Preliminary exams (continuous assessment)</td><td>Essay</td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="5">Detailed description of evaluation within the European Credit Transfer System</td></tr>
</table>

STUDENT OBLIGATIONS	HOURS (ESTIMATE)	SHARE IN ECTS	SHARE IN GRADE
Attending classes or other form of teaching process	45*	1.5	10%
Seminar paper	60	2.0	30%
Preliminary exams: 1st prelim. exam 2nd prelim. exam	 30 45	 1.0 1.5	 30% 30%
Oral exam	75	2.5	60%

**1 class attendance=3/4 of hour*

1 ECTS=30 hours
Additional explanations:
Lectures 30 hours -15 weeks uniformly distributed, or blocks of lectures using blackboard, PP presentations and computer classrooms Research seminar work 60 hours
Seminars: One seminar is required, which is developed on the basis of a literature review and scientific papers from the selected topic. Oral presentation of the seminar paper. Times As agreed

Mandatory reading:	(1) Margeta, J.: Osnove gospodarenja vodama; (2) H. Hrelja: Vodoprivredni sistemi; (3) Margeta, J.: Osnove sistemskog inženjerstva vodnih resursa, Građevinski fakultet, Split, 1993.; (4) Margeta, J., Uvod u sistemsko inženjerstvo u projektiranju i upravljanju akumulacijama, Split, 1988.
Supplementary reading:	(1) Smith A.A., E. Hinton, R.W. Lewis: Civil Engineering Systems Analysis and Design, John Willey amd Sons, New York, 1983.; (2) Gillet, B.E.: Introduction to Operation Research, McGraw Hill, New York, 1976.; (3) J. Margeta: Projektiranje i upravljanje volumenima vodospremišta, Građevinski fakultet, Split, 1994.; (4) McMahan, T.A.: Reseroir Capacity and Yield. Elsevier Scientific Publishing Company, Amsterdam, 1978.; (5) Moran, P.A.P.: The Theory of Storage, Methuen, London, 1959.; (6) Margeta, J.; Azzopardi, E.; Iacovides, I.: Smjernice za integralni pristup razvoju, gospodarenju i korištenju vodnih resursa.; (7) Ž. Rozić i ostali: Uvod u okolišno – održivi razvoj.
Additional course information	

Course title	**SUSTAINABLE URBAN WATER RESOURCES**			*Course code*	
Study programme Cycle	*University doctoral study, field Civil Engineering, branch Hydraulic Engineering - 3rd cycle*			*Study year*	*first*
ECTS credit value:	*6*	*Semester*	*second*	*Hours per semester (l+e+s)*	*30+30*
Course status:	*elective*	*Prerequisites:*	*1st and 2nd cycle*	*Corequisites:*	
Access to the course:	*Students of the first year of the postgraduate doctoral study, field Civil Engineering, branch Hydraulic Engineering*			*Class schedule:*	*According to schedule*
Course holder/teacher:	*Associate prof. Željko Rozić, Ph.D.*				
Contact hours/consultations:	*As agreed*				
E-mail address and phone number:	*zeljko.rozic@gf.sum.ba*				
Assistant					
Contact hours/consultations:					
E-mail address and phone number:					
Course objectives:	· *To present to students the processes of urban hydraulic engineering and hydrology,* · *To introduce students into real urban needs for water and sustainable urban water systems,* · *To present to students the impact of wastewater on the recipient, city and environment,* · *To familiarize students with research methods and new technologies - tools for functional management of urban water systems,* · *To point out to students the importance of quality of urban surface water and groundwater with emphasis on sustainable urban water cycle management,* · *To inform students about climate changes and effects on the urban water cycle,* · *To introduce students into the legal framework for functional management of water supply and drainage,* · *To analyse with students the social and economic sector and connection with the urban water system.*				
Learning outcomes (general and specific competences):	*After successful completion of the course, the student will be able to:* · *Formulate an assessment of sustainability of the urban water system* · *Apply systematic approach and systematic analysis in solving urban water system sustainability problems* · *Synthesize interpolation measures into existing urban water systems in accordance with the principles of sustainable development and sustainable living in urban areas* · *Predict the impact of climate changes on the operation of urban water systems including the operation of wastewater treatment plants, environmental impact and formulate measures to raise the level of*				

	sustainability and adaptability of the same in the future · *Predict the impact of climate changes on the operation of coastal urban water systems and formulate measures to raise the level of sustainability and adaptability of the same to expected average sea level rise* · *Combine the existing and develop new social and technological measures to raise the level of sustainability of urban water systems.*			
Brief syllabus content:	*Sustainable development and climate changes. Urban environments, sustainability of life in urban areas, sustainable urban water system. Integrated urban water system; Thermodynamic concept of urban water system; Water balance of urban water system, vertical water balance in the green rainwater drainage system; Renewable energy sources and urban water system; Tasks related to the management of sustainable urban water systems; Integration with other management processes; Planning an integrated urban water system in accordance with the concept of sustainable development; Techniques and tools to support decision-making; Managing needs; Urban water cycle techniques; Design of water-sensitive urban environments; Risk management.*			
Instruction method (mark in bold)	**lectures**	exercises	seminars	individual assignments
	consultations/tutorials	mentoring	field instruction	**seminar paper**
	Remarks:			
Student obligations	- to attend classes or other way of participation in the teaching process - to write a seminar paper and present it - to take preliminary exams - oral exam (make-up exam in regular examination periods)			
Student monitoring and evaluation (mark in bold)	**Attending classes or other forms of teaching process**	Activities in classes	**Seminar paper**	Practical work
	Oral exam	**Written exam**	**Preliminary exams (continuous assessment)**	Essay

Detailed description of evaluation within the European Credit Transfer System			
STUDENT OBLIGATIONS	HOURS (ESTIMATE)	SHARE IN ECTS	SHARE IN GRADE
Attending classes or other form of teaching process	45*	1.5	10%
Seminar paper	60	2.0	30%
Preliminary exams: 1st prelimi. exam 2nd prelim. exam	 30 45	 1.0 1.5	 25% 35%
Oral exam	75	2.5	60%
**1 class attendance=3/4 of hour*			

1 ECTS=30 hours Additional explanations: Lectures 30 hours -15 weeks uniformly distributed, or blocks of lectures using blackboard, PP presentations and computer classrooms Research seminar work 60 hours Seminars One seminar is required, which is developed on the basis of a literature review and scientific papers from the selected topic. Oral presentation of the seminar paper. Times As agreed	
Mandatory reading:	(1) Margeta, J.: Osnove sistemskog inženjerstva vodnih resursa, Građevinski fakultet, Split, 1993. (2) UNEP: Integrated Coastal Urban water System Planning in Coastal Areas of the Mediterranean, 2007. (3) Margeta J.:Smjernice za integralni pristup razvoju, gospodarenju i korištenju vodnih resursa, 1999. (4) Larry W Mays: Urban Water Supply Handbook (5) ROZIĆ Ž., Upravljanje urbanim vodnim sustavom primjenom objektno orijentiranog modeliranja, Magistarski rad, Građevinsko – Arhitektonski Fakultet Sveučilište u Splitu, ožujak 2006. (6) ROZIĆ Ž., Optimalizacija rada urbanog vodnog sustava, Doktorska disertacija, Građevinski fakultet Sveučilišta u Mostaru, Mostar, 2009.
Supplementary reading:	*(1) CIRIA; C523 Sustainable Urban Drainage Systems – Best Practice Manual, 2001.* *(2)Haugton, G. and Hunter, C. Sustainable Cities, Jassica Kingsley, London, 2001.* *(3) Ž. Rozić i ostali: Uvod u okolišno – održivi razvoj*
Additional course information	

Course title	**HYDRAULICS OF HYDRAULIC STRUCTURES**				Course code	
Study programme Cycle	University doctoral study, field Civil Engineering, branch Hydraulic Engineering - 3rd cycle				Study year	
ECTS credit value:	6	Semester			Hours per semester (l+e+s)	30+30
Course status:	mandatory	Prerequisites:	1st and 2nd cycle	Corequisites:		
Access to the course:	Students of the first year of the postgraduate doctoral study, field Civil Engineering, branch Hydraulic Engineering			Class schedule:		According to schedule

Course holder/teacher:	Prof. Zoran Milašinović, Ph.D.
Contact hours/consultations:	as agreed
E-mail address and phone number:	zoran_milasinovic@gf.unsa.ba
Assistant	Assistant prof. Mirna Raič, Ph.D.
Contact hours/consultations:	as agreed
E-mail address and phone number:	mirna.raic@gf.sum.ba
Course objectives:	· To present to students the role of individual structures within a water control system. · To introduce students into selection of relevant flows (calculation flows) for the hydraulic calculation of individual structures. · To present to students basic types and dispositions of outlet works. · To familiarize students with types of gates and valves and basics of hydraulic calculation. · To inform students about the principles and methods of water evacuation during construction. · To introduce students into water transport facilities, structures on conduits, and hydraulic calculations of individual structures.
Learning outcomes (general and specific competences):	After successful completion of the course, the student will be able to: · Propose dispositions of individual structures within complex water control systems. · Conduct appropriate hydraulic calculations of individual structures depending on the specifics of individual hydraulic structures. · Program and select the necessary gates/valves, and conduct appropriate hydraulic calculations. - Design water transport facilities, and appropriate structures on conduits with appropriate hydraulic calculations.
Brief syllabus content:	**Evacuation of high water and outlet works.** Selection of relevant flow (calculation flow). Determination of tailwater flow curves. Basic types and dispositions of outlet works. Overflow dams: a) Inlet part-overflow, barrage overflows, downstream effects, submerged overflow, b) gate controlled overflows, c) influence of bridge piers on overflow, d) conduit - dam spillway slope, e) stilling - energy dissipation, f)

<table>
<tr><td></td><td colspan="4">stilling basin - stilling pool: hydraulic calculation of stilling basin, hydraulic dimensioning of stilling basin, dynamic loads in stilling basin, two-stage stilling basin, g) bed protection downstream of the basin, h) ski-jump, i) submerged jump.
Arch dam outlet works.
Chute spillways: a) front spillway, b) chute.
Side spillway: intercepting channel
Shaft spillway: a) overflow funnel and transition section, b) vertical shaft, deflector and aeration.
Gates and valves.
Surface gates: plate gates, beam gates, segment gate, roller, sector, flaps.
Flow under surface gates.
Deep-seated gates and valves: lifting forces, cavitation and vibration, aeration behind gates, butterfly valve, ball valve.
Water evacuation during construction.
Intake structures.
Water transport facilities - conduits. Channels: a) selection of cross section and channel route, b) unlined channels: estimation of seepage losses, erosion stability of unlined channels, c) lined channels.
Closed conduits with free surface.
Water transfer tunnels.
Supply structures. Intersecting structures: a) aqueducts, b) siphons, c) culverts, d) bridge piers. Structures for overcoming excess head: cascades. Fish ladders.</td></tr>
<tr><td rowspan="3">Instruction method (mark in bold)</td><td>lectures</td><td>exercises</td><td>seminars</td><td>individual assignments</td></tr>
<tr><td>consultations/tutorials</td><td>mentoring</td><td>field instruction</td><td>Other: seminar paper</td></tr>
<tr><td colspan="4">Remarks: After completing the theoretical and practical part of the course, the student prepares a seminar paper, and after successfully defending it, he or she can take the written and oral parts of the exam.</td></tr>
<tr><td>Student obligations</td><td colspan="4">- to attend classes or other way of participation in the teaching process
- participation in field/laboratory research as part of instruction
- to write and present the seminar paper
- oral exam (make-up exam in regular examination periods)</td></tr>
<tr><td rowspan="3">Student monitoring and evaluation (mark in bold)</td><td>Attending classes or other forms of teaching process</td><td>Activities in classes</td><td>Seminar paper</td><td>Practical work</td></tr>
<tr><td>Oral exam</td><td>Written exam</td><td>Preliminary exams (continuous assessment)</td><td>Essay</td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="5">Detailed description of evaluation within the European Credit Transfer System</td></tr>
</table>

STUDENT OBLIGATIONS	HOURS (ESTIMATE)	SHARE IN ECTS	SHARE IN GRADE
Attending classes or other form of teaching process	45*	1.5	10%
Seminar paper	60	2.0	40%
Oral exam	75	2.5	50%
**1 class attendance=3/4 of hour* 1 ECTS=30 hours			
Mandatory reading:	(1) H. Breusers, A. Raudkivi: Hidraulic structures design manual, A.A. Balkema, 1991. (2) D.C. Smith, Hidraulics Structures, Univerzitet of Saskatchewan, 1995. (3) LJ.M. Savić, Uvod u hidrotehničke građevine, Građevinski fakultet Beograd 2009. (4) Petar Stojić, Iskorištavanje vodnih snaga, GAF Split, 1994.		
Supplementary reading:	Stojić, P., Hidrotehničke građevine (I., II. i III. dio), Građevinski fakultet u Splitu, 1997.		
Additional course information			

Course title	**EXPERIMENTAL HYDRAULICS**				Course code	
Study programme Cycle	University doctoral study, field Civil Engineering, branch Hydraulic Engineering - 3rd cycle				Study year	
ECTS credit value:	6	Semester			Hours per semester (l+e+s)	30+30
Course status:	mandatory	Prerequisites:	1st and 2nd cycle	Corequisites:		
Access to the course:	Students of the first year of the postgraduate doctoral study, field Civil Engineering, branch Hydraulic Engineering			Class schedule:		According to schedule
Course holder/teacher:	Prof. Zoran Milašinović, Ph.D.					
Contact hours/consultations:	as agreed					
E-mail address and phone number:	zoran_milasinovic@gf.unsa.ba					
Assistant	Assistant prof. Mirna Raič, Ph.D.					
Contact hours/consultations:	as agreed					
E-mail address and phone number:	mirna.raic@gf.sum.ba					

Course objectives:	· To present the role and significance of experimental hydraulics to students. · To inform students about real needs of experimental work both in laboratories and on structures, or *in situ*. · To present to students the possibilities and limitations of experimental methods for solving hydraulic problems. · To familiarize students with physical process modelling methods and model selection. · To introduce students into measurement principles and methods, both on physical hydraulic models and on structures. · To familiarize students with the application of computers for transfer, collection and processing of data obtained by measurements.
Learning outcomes (general and specific competences):	After successful completion of the course, the student will be able to: · Program the need and scope of experimental work aimed at checking the hydraulic stability of structures in complex water control systems. · Propose and implement appropriate methods of experimental hydraulic investigations depending on the specifics of individual hydraulic structures. · Program and select the appropriate measurement equipment for the purposes of conducting the proposed experimental activities. · Actively participate in: a) realisation of physical hydraulic models, b) implementation of the programmed experimental activities and procedures, c) measuring the planned physical quantities, d) systematisation and analysis of the collected measurement data, e) re-interpretation of the measured values on full-size open-air structures, f) preparation of reports on the conducted experimental studies.
Brief syllabus content:	**Dimensional analysis and similarity of flow.** Methods for solving hydraulic problems. Dimensional analysis and the purpose of its application. The basic concept and definitions in the theory of similarity. Dominant forces. Boundary layer development theory. Turbulence and its development in the boundary layer with consequences on the base flow. **Methods for modelling physical processes and selection of models.** Physical models. Models of open watercourses: a) immobile bed, b) mobile bed. Short structures: a) plane models, b) models with lateral contraction, c) spatial models of stilling pools. Modelling of systems under pressure: a) steady flow conditions, b) unsteady flow conditions: gradually changing flow, suddenly changing flow, transitional regimes. Groundwater flow modelling: a) in-plane filtration models; (b) axisymmetric models of flow to wells in steady and unsteady conditions. **Measurement principles and methods.** General principles of conversion of mechanical values into electrical ones. Characteristics of measurement systems. Flow measurement in systems under pressure. Devices for measuring the local velocity value. Electromagnetic meters. Ultrasonic flow meters. Turbine flow meters. Factors influencing flow meter selection. Flow measuring in systems with free water surface. Flow measuring on weirs, constrictions and outlets. Application of computers for collection, transfer and processing of data obtained by measurements. Conditions determining measurement accuracy and error analysis. Quantification of errors. Acquisition of measurement data.

Instruction method (mark in bold)	**lectures**	**exercises**	seminars	**individual assignments**
	consultations/tutorials	**mentoring**	**field instruction**	**Other: seminar paper**
	Remarks: After completing the theoretical and practical part of the course, the student prepares a seminar paper, and after successfully defending it, he or she can take the written and oral parts of the exam.			
Student obligations	- to attend classes or other way of participation in the teaching process - participation in field/laboratory research as part of instruction - to write and present the seminar paper - oral exam (make-up exam in regular examination periods)			
Student monitoring and evaluation (mark in bold)	**Attending classes or other forms of teaching process**	**Activities in classes**	**Seminar paper**	Practical work
	Oral exam	Written exam	Preliminary exams (continuous assessment)	Essay

Detailed description of evaluation within the European Credit Transfer System

STUDENT OBLIGATIONS	HOURS (ESTIMATE)	SHARE IN ECTS	SHARE IN GRADE
Attending classes or other form of teaching process	45*	1.5	10%
Seminar paper	60	2.0	40%
Oral exam	75	2.5	50%

**1 class attendance=3/4 of hour*

1 ECTS=30 hours

Mandatory reading:	(5) Novak, Čabelka: Models in Hydraulic Engineering, Pitman Publishing 1981. (6) Č. Maksimović: Mjerenja u hidrotehnici, Građevinski fakultet Univerziteta u Beogradu 1993. (7) D. Obradović, M. Radojković, Č. Maksimović: Primjena računara u komunalnoj hidrotehnici, Naučna knjiga, Beograd, 1989. (8) Z. Milašinović: Eksperimentalna hidraulika, Građevinski fakultet Univerziteta u Sarajevu, 1999.
Supplementary reading:	(1) P. Novak, A.I.B. Moffat, C. Nalluri, R. Narayanan, Hydraulic structures, Unwin Hyman, London 1990.
Additional course information	

Course title	**THEORY OF TRAFFIC FLOW**			*Course code*	
Study programme Cycle	*University doctoral study, field Civil Engineering, branch Transport Engineering - 3rd cycle*			*Study year*	
ECTS credit value:	*6*	*Semester*		*Hours per semester (l+e+s)*	*30*
Course status:	*elective*	*Prerequisites:*	*1st and 2nd cycle*	*Corequisites:*	
Access to the course:	*Students of the first year of the postgraduate doctoral study, field Civil Engineering, branch Transport Engineering*			*Class schedule:*	*According to schedule*
Course holder/teacher:	*Prof. Dražen Cvitanić, Ph.D.*				
Contact hours/consultations:	*As agreed*				
E-mail address and phone number:					
Assistant					
Contact hours/consultations:					
E-mail address and phone number:					
Course objectives:	· *Understanding the parameters of traffic flow* · *Adoption and application of the required knowledge for understanding of analytical traffic flow models of unsignalized, signalized and roundabout intersections* · *Adoption and application of the required knowledge for understanding of analytical traffic flow models of rural road sections*				
Learning outcomes (general and specific competences):	· *The student will know how to:* · *determine the traffic flow parameters required for analyses (headway, critical headway, free-flow speed)* · *apply and calibrate analytical traffic flow models of unsignalized intersections* · *apply and calibrate analytical traffic flow models of signalized intersections* · *apply and calibrate analytical traffic flow models of roundabouts* · *apply and calibrate analytical traffic flow models of rural road sections* · *apply and calibrate simulation models of traffic flow*				
Brief syllabus content:	*Characteristics of traffic flow. Flow, density, speed, spatial and temporal distances. Measurements of characteristic values at a point, measurements in sections. Two-dimensional and three-dimensional speed-flow-density relationship models. Driver characteristics (reaction time, limit values of acceleration, deceleration, impact). The effect of age, gender, and purpose of travel on flow. Car following models. Models of continuous flow - shock wave analysis. Macroscopic traffic flow models. Unsignalized and signalized intersection operation analysis models. Analytical models and application of queuing theory. The theory of time gap acceptance. Critical headways. Saturated flow.*				

	General information on traffic flow simulation models.			
Instruction method (mark in bold)	**lectures**	exercises	seminars	individual assignments
	consultations/tutorials	**mentoring**	field instruction	**Other: seminar paper**
	Notes: Lectures or mentoring work are dependent			
Student obligations	- to attend classes or other way of participation in the teaching process - to write a seminar paper and present it - oral exam			
Student monitoring and evaluation (mark in bold)	**Attending classes or other forms of teaching process**	Activities in classes	**Seminar paper**	Practical work
	Oral exam	**Written exam**	Preliminary exams (continuous assessment)	Essay

Detailed description of evaluation within the European Credit Transfer System

STUDENT OBLIGATIONS	HOURS (ESTIMATE)	SHARE IN ECTS	SHARE IN GRADE
Attending classes or other form of teaching process	24*	0.8	0%
Seminar paper	66	2.2	40%
Individual work and Oral exam	90	3.0	60%

**1 class attendance=3/4 of hour*
1 ECTS=30 hours

Mandatory reading:	**(1)** *D.R. Drew: Traffic Flow Theory and Control, McGraw-Hill, New York 1968.* **(2)** *Traffic flow theory, Transportation Research Board 1998.* **(3)** *F.A. Haight: Mathematical Theories of Traffic Flow, Academic press, London 1963* **(4)** *Cvitanić, D; Lovrić I:Teorija prometnog toka, Split 2008, interna skripta.* **(5)** *Traffic Engineering by Roger P. Roess, Elena S. Prassas, William R. McShane.*
Supplementary reading:	***(1)*** *Cvitanić, D.: Modeliranje kapaciteta i razine usluge nesemaforiziranih raskrižja, Građevinski fakultet Sveučilišta u Splitu, Magistarski rad, Split 2000* ***(2)*** *Lovrić, I.: Modeli brzine prometnog toka izvangradskih dvotračnih cesta. Građevinski fakultet Sveučilišta u Splitu, Doktorski rad, Split 2007.* ***(3)*** *Breški, D.: Usporedba analitičkih i simulacijskih modela za analizu funkcioniranja semaforiziranih raskrižja, Magistarski rad, Split 2000.*
Additional course information	

Course title	**SUSTAINABLE SAFETY IN ROAD INFRASTRUCTURE DESIGN**				*Course code*	
Study programme Cycle	*University doctoral study, field Civil Engineering, branch Transport Engineering - 3rd cycle*				*Study year*	
ECTS credit value:	*6*	*Semester*			*Hours per semester (l+e+s)*	*30*
Course status:	*elective*	*Prerequisites:*	*1st and 2nd cycle*	*Corequisites:*		
Access to the course:	*Students of the first year of the postgraduate doctoral study, field Civil Engineering, branch Transport Engineering*			*Class schedule:*		*According to schedule*
Course holder/teacher:	*Associate prof. Marko Renčelj, Ph.D.*					
Contact hours/consultations:	*As agreed*					
E-mail address and phone number:						
Assistant						
Contact hours/consultations:						
E-mail address and phone number:						
Course objectives:	· *Understanding of the most important elements and principles of road infrastructure safety sustainability;* · *Adopting complex principles of road infrastructure safety sustainability;* · *Adoption and application of the required knowledge for understanding of the methods and procedures in road infrastructure design in terms of sustainable safety;* · *Adopting the principles and knowledge related to self-explaining and error-forgiving road infrastructure*					
Learning outcomes (general and specific competences):	*Knowledge and understanding:* *- to understand all aspects of sustainable safety in road infrastructure design;* *- acquiring the skills necessary for cooperation in the process of safety sustainable design and construction of road infrastructure.* *Key skills:* *- knowledge and skills applicable in further processes of improving sustainable road infrastructure safety*					
Brief syllabus content:	*Vision and strategies of traffic safety* *History / theory / principles of safety sustainability of road infrastructure;* *Sustainable safety in the design of road infrastructure:* *- horizontal and vertical alignment* *- cross sections* *- access points and intersections* *- traffic areas in urban environment* *- non-motorized traffic participants* *- cost-benefit analysis* *- Self-explaining road infrastructure*					

	- Error forgiving road infrastructure.			
Instruction method (mark in bold)	**lectures**	exercises	seminars	individual assignments
	consultations/tutorials	**mentoring**	field instruction	**Other: seminar paper**
	Notes: Lectures or mentoring work are dependent			
Student obligations	- to attend classes or other way of participation in the teaching process - to write a seminar paper and present it - oral exam			
Student monitoring and evaluation (mark in bold)	**Attending classes or other forms of teaching process**	Activities in classes	**Seminar paper**	Practical work
	Oral exam	**Written exam**	Preliminary exams (continuous assessment)	Essay

Detailed description of evaluation within the European Credit Transfer System

STUDENT OBLIGATIONS	HOURS (ESTIMATE)	SHARE IN ECTS	SHARE IN GRADE
Attending classes or other form of teaching process	24*	0.8	0%
Seminar paper	66	2.2	40%
Individual work + Oral exam	90	3.0	60%

**1 class attendance=3/4 of hour*

1 ECTS=30 hours

Mandatory reading:	***(1)*** *Advancing Sustainable Safety, SWOV Institute for Road Safety Research, 2006.* ***(2)*** *Sustainable safe road design, World Bank, 2005.* **(3)** *Safety Handbook for Secondary Roads, Ripcord-Iserest, 2007.*
Supplementary reading:	
Additional course information	

Course title	Infrastructure planning and management					*Course code*	
Study programme Cycle	Postgraduate university doctoral study of civil engineering					*Study year*	1st (first)
ECTS credit value:	6	*Semester*				*Hours per semester (l+e+s)*	15+5+10
Course status:	Elective	*Prerequisites:*	None	*Corequisites:*	None		
Access to the course:				*Class schedule:*			
Course holder/teacher:	Associate prof. Ivana Domljan, Ph.D.						
Contact hours/consultations:	as agreed						
E-mail address and phone number:	ivana.domljan@gf.sum.ba, +387.36.355.019						
Assistant							
Contact hours/consultations:							
E-mail address and phone number:							
Course objectives:	The student will be able to plan infrastructure and recommend an appropriate plan for management especially of transport infrastructure.						
Learning outcomes (general and specific competences):	To understand the concept of infrastructure, infrastructure planning and management. To identify and analyse problems related to infrastructure projects, especially transport ones, and to plan infrastructure. To assess economic, financial, social, environmental aspects of infrastructure projects To develop an appropriate infrastructure management plan.						
Brief syllabus content:	Introductory considerations: defining investment projects, categories of infrastructure projects, common steps in infrastructure planning and management Transport systems Infrastructure planning Evaluation of infrastructure projects and comparison of alternatives Economic and financial analysis Environmental and social analysis Methods of operations research in planning and management of infrastructure projects						
Instruction method (mark in bold)	**lectures**	**exercises**	**seminars**	**individual assignments**			
	consultations/tutorials	**mentoring**	field instruction	other			
	Remarks:						

Student obligations	Regular attendance of classes, preparation of individual assignments, seminar paper, final oral exam.			
Student monitoring and evaluation (mark in bold)	**Class attendance**	**Activities in classes**	**Seminar paper**	Practical work
	Oral exam	Written exam	Continuous assessment	Essay

Detailed description of evaluation within the European Credit Transfer System

STUDENT OBLIGATIONS	HOURS (ESTIMATE)	SHARE IN ECTS	SHARE IN GRADE
Class attendance	24*	0.8	10 %
Individual assignments	42	1.4	20 %
Seminar paper	75	2.5	45 %
Oral exam	39	1.3	25 %

**1 class attendance=3/4 of hour*

1 ECTS=30 hours
According to study rules, the final grade is obtained as follows:
0 – 55 % insufficient (1)
55 – 66 % sufficient (2)
67 – 78 % good (3)
79 – 90 % very good (4)
91 – 100 % excellent (5)

Mandatory reading:	(1) Goodman, A. S., and Hastak, M., Infrastructure Planning, Engineering, and Economics, McGraw-Hill, New York, 2015. (2) Goodman, A. S., and Hastak, M., Infrastructure Planning Handbook: Planning, Engineering, and Economics, McGraw-Hill, New York, 2006. (3) Tan W., Principles of Project and Infrastructure Finance, Taylor and Francis, New York, 2007.
Supplementary reading:	(1) Grigg, Neil S., Infrastructure Finance : The Business of Infrastructure for a Sustainable Future, John Wiley & Sons, Inc., Hoboken, New Jersey, 2010. (2) Martland, C. D., Toward More Sustainable Infrastructure: Project Evaluation for Planners and Engineers, John Wiley & Sons, Inc., Hoboken, New Jersey, 2012.
Additional course information	

Course title	**TRANSPORT PLANNING**			*Course code*	
Study programme Cycle	*University doctoral study, field Civil Engineering, branch Transport Engineering - 3rd cycle*			*Study year*	
ECTS credit value:	*6*	*Semester*		*Hours per semester (l+e+s)*	*30*
Course status:	*elective*	*Prerequisites:*	*1st and 2nd cycle*	*Corequisites:*	
Access to the course:	*Students of the first year of the postgraduate doctoral study, field Civil Engineering, branch Transport Engineering*			*Class schedule:*	*According to schedule*
Course holder/teacher:	*Associate prof. Ivan Lovrić, Ph.D., Assistant prof. Boris Čutura, Ph.D.*				
Contact hours/consultations:	*As agreed*				
E-mail address and phone number:					
Assistant					
Contact hours/consultations:					
E-mail address and phone number:					
Course objectives:	· *Understanding the elements and principles of traffic planning* · *Adoption and application of the required knowledge for understanding of network and zone modelling;* · *Adoption and application of the required knowledge for understanding of the four-stage transport demand prediction model.*				
Learning outcomes (general and specific competences):	*Knowledge and understanding:* *- all aspects of application of traffic planning;* *- acquiring the skills necessary for cooperation in the traffic planning process.* *Key skills:* *- knowledge and skills applicable in further processes of improving traffic planning models*				
Brief syllabus content:	- *Development of traffic planning. Relationship between traffic and other activities. The procedure of forecasting transport demand.* - *Modelling network of roads with intersections. Zoning, centroid setting, zone properties.* - *Trip generation models; application of multidimensional regression analysis, categorical analyses, logistic analyses.* - *Transport means selection models. Utility functions. Models of trip distribution between zones; gravity model; preference models.* - *Trip assignment models; capacity constraint models, multiple route assignment models. Model calibration* - *Preparation of a research seminar paper.*				
Instruction method (mark in bold)	**lectures**	exercises	Seminars	individual assignments	

	consultations/tutorials	**mentoring**	field instruction	**Other: seminar paper**
	Notes: Lectures or mentoring work are dependent			
Student obligations	- to attend classes or other way of participation in the teaching process - to write a seminar paper and present it - oral exam			
Student monitoring and evaluation (mark in bold)	**Attending classes or other forms of teaching process**	Activities in classes	**Seminar paper**	Practical work
	Oral exam	**Written exam**	Preliminary exams (continuous assessment)	Essay

Detailed description of evaluation within the European Credit Transfer System			
STUDENT OBLIGATIONS	HOURS (ESTIMATE)	SHARE IN ECTS	SHARE IN GRADE
Attending classes or other form of teaching process	24*	0.8	0%
Seminar paper	66	2.2	40%
Individual work and Oral exam	90	3.0	60%
**1 class attendance=3/4 of hour* 1 ECTS=30 hours			
Mandatory reading:	***(1)*** *B.Y. Hutchinson: Principles of Urban Transport Systems Planning, Book Company, 1974.* ***(2)*** *J. Pađen: Osnove prometnog planiranja, Informator, Zagreb, 1986., Transportation planning handbook, ITE 2005.*		
Supplementary reading:	*R. Lane, Powel, T.J.: Analytical transport planning, Redword Burn Limited 1974.*		
Additional course information			

Course title	**TRANSPORT ENGINEERING - SELECTED CHAPTERS**				*Course code*	
Study programme Cycle	*University doctoral study, field Civil Engineering, branch Transport Engineering - 3rd cycle*				*Study year*	
ECTS credit value:	*6*	*Semester*			*Hours per semester (l+e+s)*	*30*
Course status:	*elective*	*Prerequisites:*	*1st and 2nd cycle*	*Corequisites:*		
Access to the course:	*Students of the first year of the postgraduate doctoral study, field Civil Engineering, branch Transport Engineering*			*Class schedule:*	*According to schedule*	
Course holder/teacher:	*Associate prof. Ivan Lovrić, Ph.D., Assistant prof. Boris Čutura, Ph.D.*					
Contact hours/consultations:	*As agreed*					
E-mail address and phone number:						
Assistant						
Contact hours/consultations:						
E-mail address and phone number:						
Course objectives:	· *Understanding the vehicle movement theory* · *Adoption and application of the required knowledge for understanding of the design of more complex elements of urban, suburban and rural roads;* · *Adoption and application of the required knowledge for understanding of the road management and maintenance principles.*					
Learning outcomes (general and specific competences):	*Knowledge and understanding:* *- theories of vehicle movement;* *- acquiring the skills necessary in the road design, construction, management and maintenance processes.* *Key skills:* *- knowledge and skills applicable in further processes of improving efficiency of the road network system.*					
Brief syllabus content:	- *The role of traffic in planning. Basics of the vehicle movement theory.* - *Classification of urban and suburban roads. Development and implementation of the urban and suburban road design concept.* - *More complex elements of rural road design. Separation of traffic flows. Spatial alignment.* - *General information on modern design methods. Application of electronic computers in design.* - *Management and maintenance of roads.* - *Preparation of a research seminar paper.*					
Instruction method (mark in bold)	**lectures**	exercises	seminars	individual assignments		

	consultations/tutorials	**mentoring**	field instruction	**Other: seminar paper**
	Notes: Lectures or mentoring work are dependent			
Student obligations	- to attend classes or other way of participation in the teaching process - to write a seminar paper and present it - oral exam			
Student monitoring and evaluation (mark in bold)	**Attending classes or other forms of teaching process**	Activities in classes	**Seminar paper**	Practical work
	Oral exam	**Written exam**	Preliminary exams (continuous assessment)	Essay

Detailed description of evaluation within the European Credit Transfer System

STUDENT OBLIGATIONS	HOURS (ESTIMATE)	SHARE IN ECTS	SHARE IN GRADE
Attending classes or other form of teaching process	24*	0.8	0%
Seminar paper	66	2.2	40%
Individual work and Oral exam	90	3.0	60%

**1 class attendance=3/4 of hour*
1ECTS=30 hours
Additional explanations:

Mandatory reading:	**(1)** *A Policy on geometric design of Highways and streets, AASHTO 2001.* **(2)** *McShane,W.R. Roess, R.P., Prassas,E.S.: Traffic engineering, Prentice Hall, 2004.* **(3)** *Maletin, M.: Planiranje i projektovanje saobraćajnica u gradovima, Orion art, 2009.*
Supplementary reading:	***(1)*** *Transportation Impact Analyses for Site Development, Institute of Transportation Engineers (ITE), 2005* ***(2)*** *Lorenc, H.: Projektovanje i trasiranje puteva i autoputeva, prijevod, Građevinska knjiga, Beograd,1980.*
Additional course information	