STUDY PLAN OF THE POSTGRADUATE UNIVERSITY STUDY PROGRAMME CIVIL ENGINEERING

starting from the academic year 2020/2021

Osijek, May of 2020

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GENERAL INFORMATION

The Study Programme adheres to the:

- Scientific Activity and Higher Education Act (Official Gazette 123/03, 198/03, 105/04, 174/04, 02/07, 46/07, 45/09, 63/11, 94/13, 139/13, 101/14, 60/15, 131/17)

- Statute of the J.J. Strossmayer University of Osijek, 2019
http://www.unios.hr/wp-content/uploads/2019/07/Statut-pro%C4%8Di%C5%A1%C4%87eni-tekst-20190711.pdf

- Ordinance on Postgraduate Study Programmes at the J.J. Strossmayer University of Osijek, 2015
http://www.unios.hr/wp-content/uploads/2015/07/SJJS_Pravilnik_o_poslijediplomskim_studijima_srpanj_2015.pdf

- Ordinance on Study Programmes and Studying at the J.J. Strossmayer University of Osijek, 2015
http://www.unios.hr/wp-content/uploads/2015/07/SJJS_Pravilnik_o_studijima_i_studiranju_srpanj_2015.pdf

- Strategy of the J.J. Strossmayer University of Osijek in the Period 2011-2020
http://www.unios.hr/wp-content/uploads/2015/07/SJJS_Strategija_Sveucilista_HR.pdf

- Statute of the Faculty of Civil Engineering and Architecture Osijek – consolidated text, 2020
http://www.gfos.unios.hr/fakultet/akti-fakulteta

- Development Strategy of the Faculty of Civil Engineering Osijek 2016-2020
http://www.gfos.unios.hr/portal/index.php/osiguravanje-kvalitete/dokumenti/515-dokumenti.html

- Ordinance on the Conditions for Election to Scientific Titles (Official Gazette 28/17)
https://narodne-novine.nn.hr/clanci/sluzbeni/2017_03_28_652.html

Title of the study programme: Postgraduate University Study Programme Civil Engineering

Institute holding and implementing the study programme: Josip Juraj Strossmayer University of Osijek, Faculty of Civil Engineering and Architecture Osijek

Study programme type: postgraduate university study programme

Level (1-professional/2-specialist graduate professional or 1-undergraduate university/2- graduate university/3-postgraduate specialist or postgraduate university): level 3, postgraduate university

Scientific or artistic area of the study programme: Technical Sciences

Scientific field of the study programme: Civil Engineering
Fundamental Technical Sciences

Scientific branches of the study programme:
2.05.01 Geotechnical Engineering
2.05.02 Load-Bearing Structures
2.05.03 Hydraulic Engineering
2.05.04 Thoroughfares
2.05.05 Organisation and Technology of Construction
2.15.03 Materials
2.15.05 Organisation of Labour and Production
2.15.06 Technical Mechanics (mechanics of rigid and deformable bodies)

Optimal enrolment quota: 15 students per year

Study Plan of the Postgraduate University Study Programme Civil Engineering

Scholarship costs of the Postgraduate University Study Programme for EU citizens: HRK 30,000.00

Scholarship costs of the Postgraduate University Study Programme for non-EU citizens: HRK 90,000.00

Location of the implementation of the Study Programme: The building of the Faculty of Civil Engineering Osijek is located at the Josip Juraj Strossmayer University in Osijek Campus, Vladimira Preloga 3. The floor plan area of the building is 3239 m². It has six levels (basement + semi basement + ground floor + 3) and its height is 19.3 m, and its total developed area is 10,600 m2. It consists of several programming-functional units, seven institutes (70 purpose-equipped classrooms and four laboratories), as well as teaching spaces (lecture halls, drawing rooms, and classrooms equipped for practical work), administration areas (dean's office, accounting, and students' office with accompanying rooms), and the faculty library, including student-related and common areas (atriums, stands, open classroom, cafeteria, hallways) and auxiliary and technical areas. At full capacity, the building can house 1348 students and 179 faculty employees.

Duration of the study programme: The duration of the Postgraduate University Study Programme Civil Engineering is three years (six semesters), during which the candidate may gather the maximum of 180 ECTS credits.

Maximum duration of the study process:

> **Duration of the study programme for full-time students:** A student may not spend longer than two years for the first year and no more than two years for the second year as well. Pursuant to Article 18 of the Ordinance on Postgraduate Study Programmes, the duration of a full-time postgraduate study programme is three years, and it can be extended up to five years due to justified reasons and with an explanation.

> **Duration of the study programme for part-time students:** A student may not spend longer than two years for the first year and no more than two years for the second year as well. Pursuant to Article 18 of the Ordinance on Postgraduate Study Programmes, the duration of a part-time postgraduate study programme is five years, and it can be extended up to seven years due to justified reasons and with an explanation.

Contractual relationships between the students and the holders of the doctoral study programme: A contract on studying is concluded with every postgraduate university study programme student. That contract regulates the mutual rights and obligations for the duration of the study process, the method for financing the study programme, as well as other significant issues for the contracting parties.

Beginning and end of the academic periods: The beginning and end of every academic year are defined by the Senate Decision on the Academic Calendar.

Structure and organisation of the postgraduate university study programme: Pursuant to Article 27 of the Ordinance on the Postgraduate University Study Programmes of the University, on enrolment or, as a rule, during the first semester, a postgraduate university study programme student will be assigned a study advisor from the List of Study Advisors, by the Committee for Postgraduate Study Programmes. The list of study advisors is composed of teachers employed at scientific-academic positions at the institution which is the holder of the study programme, and it is enacted by the Council of the holder institution. Per proposal of the Committee for Postgraduate Study Programmes, the teachers who already have more than three students whom they are mentoring may be excluded from the list.

The study advisor is usually chosen by the student, with approval from the study advisor, using the statement on the selection of the study advisor on the regulated form (OB-7-1-10), and the final decision is made by the Committee for Postgraduate Study Programmes. The study advisor helps the student during the study programme and monitors their work and accomplishments until a mentor is appointed. During the first semester of every year of studies, a student must create the annual activity plan, according to the regulated form (OB-8-4-6), which is signed by both the student and the study advisor / mentor. The study advisor/mentor has the obligation of submitting a report on the activities and progress of the student to the Committee for Postgraduate Study Programmes once per year, on the regulated form (OB-8-4-7). The study advisor may also be the student's mentor for the creation of the doctoral thesis. A student at the postgraduate university study programme has the right to change their study advisor / mentor or their topic once, by sending a written request to the Committee for the Postgraduate University Study Programme on the regulated form and with a written statement by the previous study advisor / mentor.

Pursuant to Article 28 of the Ordinance on the Postgraduate University Study Programme of the University, the student will be assisted with the creation of the doctoral thesis by a mentor, who is appointed by the council of the institution which is the holder of the postgraduate study programme according to the study plan, per proposal of the student and with

approval from the Committee for the Postgraduate University Study Programme. The council of the institution which is the holder of the postgraduate university study programme will appoint the mentor after obtaining their written consent on accepting the mentorship. The following persons may be appointed as mentors at postgraduate university study programmes: a teacher employed in a scientific-academic title or an art-academic title (docent, associate and full professor, tenured professor) or a scientist elected to a scientific title (research associate, senior research associate, research advisor, research advisor – tenure) or an equivalent title if they are a mentor who acquired their academic title abroad; a person elected to a scientific or a scientific-academic title and who is actively participating in scientific research from the same area of research as the doctoral thesis; a person with scientific achievements during the previous five years who has published relevant scientific papers or presented works of art related to the research topic of the doctoral thesis; a professor emeritus who is participating in the academic activities at the postgraduate university study programme of the holder institution; a person who is a respected international scientist and who is not employed at the institution which is the holder of the postgraduate university study programme but is participating in the academic process at the postgraduate university study programme pursuant to a special contract or is a manager or an associate at a scientific-research project which includes the relevant research and the doctoral thesis; two mentors must be appointed if the interdisciplinary research, the implementation of the research, or the artistic creation is conducted in more than one institution.

Along with the mentor, a co-mentor from the holder institution or from another domestic or international institution may be appointed for postgraduate university study programmes. The co-mentor may be a teacher or a scientist employed in a scientific-academic or a scientific title.

The Postgraduate University Study Programme is designed in modules, therefore, the student, along with their study advisor and according to the scope of research relevant for the doctoral thesis, apart from the **mandatory course**, Theoretical Postulates and Principles of Scientific Research, will choose the other 5 courses depending on the module to which they enrolled and according to the following models:

- **Module Load-Bearing Structures**
    - Of the required 5 courses, the student must choose at least three courses within the module, while other courses may be chosen from the module Engineering Mechanics or from among general elective courses.

- **Module Organisation, Technology, and Management**
    - Of the required 5 courses, the student must choose 4 elective courses within the module and 1 general elective course, with the note that the chosen courses must include courses from the area of Technical Sciences that carry at least 18 ECTS credits; or
    - Of the required 5 courses, the student must choose 3 elective courses within the module, 1 general elective course, and 1 course from the other modules, with the note that the chosen courses must include courses from the area of Technical Sciences that carry at least 18 ECTS credits.

- **Module Hydraulic Engineering**
    - Of the required 5 courses, the student must choose 4 elective courses within the module and 1 general elective course.

- **Module Engineering Mechanics**
    - Of the required 5 courses, the student must choose 3 elective courses within the module, 1 general elective course, and 1 course from the other modules; or
    - Of the required 5 courses, the student must choose 3 elective courses within the module and 2 courses from the other modules.

- **Module Transportation engineering and geotechnics**
    - Of the required 5 courses, the student must choose all 5 elective courses within the module, and in that case, the distribution of courses at the module is 3+2, depending on the chosen major, Thoroughfares or Geotechnical Engineering, favouring the major; or
    - Of the required 5 courses, the student must choose 4 within the module and 1 course may be a general elective course or an elective course at the other modules of the Study Programme. By selecting this model for the selection of courses, the distribution of courses at the module will be 3+1, depending on the chosen major, Transportation engineering and geotechnics, favouring the major.

Pursuant to Article 35 of the Ordinance on the Postgraduate University Study Programme of the University, a student may choose at most one course from the other postgraduate study programmes at the University and at the universities locally

and abroad, but approval must be obtained from the study advisor / mentor and the Committee for Postgraduate Study Programmes beforehand.

The Committee for Postgraduate Study Programmes recognises exams and other completed obligations pursuant to specific contracts between the institutions which are holders of postgraduate study programmes locally and abroad, pursuant to a Mobility Contract as part of the ERASMUS+ or CEEPUS programme. Otherwise, the applicants must submit a decision by the authorised University body on the academic recognition of the completed study obligation or ECTS credits, obtained at their own expense.

1. ACADEMIC DEGREE ACQUIRED AFTER THE COMPLETION OF THE STUDY PROGRAMME

The academic degree acquired after the completion of the study programme:

I. After completing the Postgraduate University Study Programme Civil Engineering, module Load-Bearing Structures, module Organisation, Technology, and Management, Module Hydraulic Engineering, and module Transportation engineering and geotechnics, the students will acquire the following academic title: Doctor of Science, scientific area Technical Sciences, scientific field Civil Engineering.

II. After completing the Postgraduate University Study Programme Civil Engineering, module Engineering Mechanics, the students will acquire the following academic title: Doctor of Science, scientific area Technical Sciences, scientific field Fundamental Technical Sciences.

2. ACADEMIC CONDITIONS FOR ENROLMENT AT THE BEGINNING OF THE STUDY PROGRAMME, CONDITIONS FOR THE ENROLMENT OF STUDENTS TO THE FOLLOWING SEMESTER OR TRIMESTER, OR THE FOLLOWING YEAR OF THE STUDY PROGRAMME, WITH THE PRELIMINARY CONDITIONS FOR THE COMPLETION OF STUDY OBLIGATIONS

Enrolment to the postgraduate university study programme is implemented on the basis of a public announcement announced by the Faculty Council. The public announcement for the enrolment to the postgraduate university study programme will be announced at least 30 days before classes begin at the postgraduate university study programme and it will be published in daily newspapers and the website of the Faculty of Civil Engineering and Architecture Osijek (GRAFOS).

The announcement for the enrolment of applicants to the postgraduate study programmes will contain:
- the title of the postgraduate university study programme and the holder of the study programme,
- enrolment conditions,
- number of available enrolment slots,
- scholarship amount,
- list of documents and other attachments required with the application,
- period during which the applications may be submitted,
- criteria for the selection of the applicants, and
- enrolment periods for the Postgraduate University Study Programme.

Academic conditions for enrolment to the Study Programme at the beginning of the Study Programme

The following persons my enrol to the Postgraduate Study Programme Civil Engineering:

- Persons who have completed the undergraduate and graduate study programme in civil engineering and who have acquired at least 300 ECTS credits during the process (professional master) with the minimum grade point average of 3.00, which is determined as the arithmetic mean of the average grades from exams at the undergraduate university study programme and the average grades from the graduate university study programme, in the scientific field of civil engineering. Persons who have completed the university undergraduate study programme as it was implemented before 2005 (dipl. ing.), who have the minimum combined grade point average of 3.0 (lectures and exercises) from the study programme, and persons who have completed the

university postgraduate study programme after which students acquired the academic degree of master of science (mr.sc.) from the scientific area of Technical Sciences, scientific field of Civil Engineering.

- Persons who have completed the undergraduate and graduate university study programmes from other scientific fields of the scientific area of Technical Sciences and the scientific area of Natural Sciences and who have acquired at least 300 ECTS credits in the process (professional master) with the minimum grade point average of 3.00, which is determined as the arithmetic mean of the average grades from exams at the undergraduate university study programme and the average grades from the graduate university study programme. Persons who have completed the university undergraduate study programme as it was implemented before 2005 (dipl. ing.), who have the minimum combined grade point average of 3.0 (lectures and exercises) from the study programme, and persons who have completed the university postgraduate study programme after which students acquired the academic degree of master of science (mr.sc.) from other scientific fields of the scientific area of Technical Sciences and the scientific area of Natural Sciences, and who have also acquired at least 60 ECTS credits from courses from the scientific field of Civil Engineering and the scientific field of Fundamental Technical Sciences. The persons who have not acquired the required amount of ECTS credits must pass bridging exams determined by the Committee for Postgraduate Study Programmes. A student must apply for the bridging exams after enrolling to the Study Programme. The students are required to pass their bridging exams before they enrol into the 2nd year. The bridging exams do not count toward the academic load of the Postgraduate University Study Programme.

Criteria for the evaluation of the students

When applying for enrolment, the candidate must also apply for the selection of one of at most three offered study advisors for whom the area of research and/or a potential topic of the doctoral thesis have been announced, as well as the number of students for whom they may act as study advisors in the relevant enrolment cycle. For every selected study advisor, the student must indicate the sequence of their preferred choices, from the first (first preference – highest priority) to the third at the most (third preference – lowest priority). The rankings will be created separately for every study advisor (potential mentor).

The criteria for the selection of the candidates are the following:
- Success at the previous study programme level   A (30)
- Passed exams and published papers   B (25)
- Student awards   C (10)
- Evaluation of the candidate's interview with the study advisor   D (25)
- Knowledge test from the scientific area of interest of the candidate and the English language   E (10)

The total number of points is determined on the basis of the sum of categories A through E. The candidates with **at least 50 gathered points** (under the condition that they have also met the conditions listed under the individual criteria for the selection) will be included in the rankings for the study advisor, where they will be ranked from the ones with the most points to those with the least points. Every study advisor will have their own list of candidates and enrolment will be granted to the candidates who match the enrolment quota of the relevant study advisor. If the candidate matching the enrolment quota is placed in the rankings for more than one study advisor, they will be granted enrolment from the rankings of the study advisor whom they have placed higher in the priority order, and they will be removed from the rankings of the other study advisors, who will then have that spot available, i.e., the candidates below that spot in the rankings will be moved one spot up.

In case there is an equal number of points, full-time students will have the advantage, and if two or more candidates are equal according to that criterion, the points will be counted according to the following priority order: D, A, B, E, C.

The method for determining points within categories A through E has been defined in the following manner:

$A = 8*a_1 + 2*a_2 - 20$

a_1 – grade point average from all passed exams during the studies at the university undergraduate and graduate study programmes or at the university undergraduate study programme. The grade point average a_1 **may not be lower than 3.0**. Applications of candidates with the grade point average a_1 lower than 3.00 will not be considered.

a_2 – diploma paper grade.

According to criterion A, the number of points may not exceed 30.

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$B = b_1 + b_2 \cdot 10$

b_1 – number of exams passed at the university postgraduate masters study programme which are relevant for the doctoral study programme.

b_2 – evaluation of the scientific-research paper authored in the last five years, from the area of the selected study programme module:

- Article in the proceedings of a domestic conference	0.10
- Article in the proceedings of an international conference	0.25
- Article in an unindexed professional journal	0.25
- Article in a journal indexed in other databases	0.50
- Article in a journal indeed in CC, SCI, and SCI Expanded	1.00

The published professional articles will be scored equally as a corresponding scientific article.

The share of the contributions by specific authors in the published scientific and professional papers will be determined in the manner defined by Article 15 of the Ordinance on the Conditions for the Election to Scientific Titles (Official Gazette 28/2017).

According to criteria B, the number of points may not exceed 25.

$C = c_1 + c_2 + c_3 + c_4$

c_1 – university award or a national award	10
c_2 – faculty award	5
c_3 – n is the number of courses where the candidate worked as a demonstrator during their studies	$2 \cdot n$
c_4 – if the candidate participated in teaching classes at an institute of higher education	2

According to criterion C, the number of points may not exceed 10.

D = Evaluation of the candidate's interview with the study advisor

The candidate's motivation and their interest in the study programme will be evaluated during the interview with the study advisor (potential mentor), along with their general attitude toward scientific-research work.

D – evaluation of the candidate's motivation and interest for the Study Programme: 0 – 25.

The candidate must acquire at least 10 points according to criterion D and the maximum number of points may not exceed 25.

E = evaluation of the English language knowledge test

E – evaluation of the written English language knowledge test:

Insufficient	0
Sufficient	5
Excellent	10.

The Committee for Postgraduate Study Programmes will conduct a written knowledge test which will consist of a translation of text from Croatian to English, from the relevant area for which the candidate applied. **According to Criterion E, the number of points may not exceed 10 or be lower than 5.** The minimum knowledge level which will be evaluated as sufficient is the level that matches the minimum level A2 according to the Common European Framework of Reference for Languages.

If all the criteria have been met, the Committee for the Postgraduate University Study Programme will determine the list of selected applicants for enrolment to the study programme and post it at the notice board and the website of the institution which is the holder of the study programme. The appeal period and the period for the response to the appeal will be posted. The faculty council of the holder institution will issue the Enrolment Decision per proposal of the Committee for the Postgraduate University Study Programme.

The rankings of applicants will be determined on the basis of the grade point average from the undergraduate and graduate study programmes or from the undergraduate study programme and the masters of science programme, published scientific and professional papers, and the other scientific and professional accomplishments in the previous five years, before the enrolment announcement for the postgraduate university study programme. The interview with the applicants

is a mandatory part of the application procedure. Within 8 days after the rankings are posted, those applicants who are not satisfied with the results of the application procedure should submit a written appeal with an explanation to the Students' Service. The appeal will be considered by the Committee for Postgraduate Study Programmes and it will send its response to the appeal to the applicant within 15 days after the appeal submission period.

The decision on the enrolment of students to the postgraduate university study programme will be issued by the Faculty Council, and it will appoint a study advisor from among the teachers employed in scientific-academic or scientific titles at GRAFOS for each of the students.

Conditions for enrolment to the following year of the study programme

Conditions for enrolment to the following year of the study programme for full-time students

When enrolling to the following year of the study programme, every student must be verified to have met the conditions for the following year of the study programme, according to the criteria listed in tables 1 and 2, as well as have their annual activity plan approved and have a positive evaluation of work and progress from the study advisor / mentor for the year of the study programme. As a rule, the work evaluation will be negative if the student has failed to meet the obligations that match the conditions for enrolment to the following year of the study programme.

In order to enrol to the second year of the study programme, a student must acquire 36 ECTS credits in total. During the first year of the study programme, they must pass three elective courses (18 ECTS), and they will acquire the rest of the credits by completing the elective curricular activities according to Table 2 and by engaging in scientific-research work, which will be scored according to the criteria presented in Table 2.

In order to enrol to the third year of the study programme, a student must acquire 120 ECTS credits in total. They can acquire the credits for enrolment to the third year by passing the remaining exams from the second year of the study programme, by engaging in elective curricular activities and scientific-research work, which is evaluated according to the criteria presented in Table 2, as well as through the mandatory application and public defence of the doctoral thesis topic during the second year of the study programme.

Before defending the doctoral thesis, the student must publish at least one scientific paper as part of the research related to the topic of the doctoral thesis, in a journal indexed in Current Contents, Science Citation Index, Science Citation Index Expanded, or in other bibliographic databases (the specification of the journal and the share of contributions of specific authors to the papers is determined according to the standing Ordinance on the Conditions for Election to Scientific Titles), which is related to the topic of the research presented in the doctoral thesis. The doctoral thesis is worth 60 ECTS credits and the students will obtain 180 ECTS credits in total after they complete the study programme.

In case the student's work and progress have been evaluated as negative in two consecutive annual evaluation procedures conducted by the Committee for Postgraduate Study Programmes, it can issue a decision on revoking the student's rights to continue with the study programme.

A student may enrol to the first and second year of the study programme no more than twice.

Conditions for enrolment to the following year of the study programme for part-time students

When enrolling to the following year of the study programme, every student must be verified to have met the conditions for the following year of the study programme, according to the criteria listed in tables 1 and 2, as well as have their annual activity plan approved and have a positive evaluation of work and progress from the study advisor / mentor for the year of the study programme. As a rule, the work evaluation will be negative if the student has failed to meet the obligations that match the conditions for enrolment to the following year of the study programme.

In order to enrol to the second year of the study programme, a student must acquire 20 ECTS credits in total. During the first year of the study programme, they must pass at least two elective courses (12 ECTS) and acquire 8 ECTS credits by engaging in elective curricular activities according to Table 2 and in scientific-research work, which will be scored according to the criteria presented in Table 2.

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In order to enrol to the third year of the study programme, a student must acquire 60 ECTS credits in total during the first and second year. During the first and second year, they may acquire the credits by engaging in elective curricular activities and in scientific-research work, the results of which will be scored according to the criteria presented in Table 2.

During the third year, as a rule, they should pass the remaining exams from the first and second year, acquire 18 ECTS credits through elective curricular activities which have been cumulatively added for all three years of the study programme, and apply for and publicly defend the doctoral thesis topic, which together counts for 30 ECTS credits according to Table 2.

In case the student's work and progress have been evaluated as negative in two consecutive annual evaluation procedures conducted by the Committee for Postgraduate Study Programmes, it can issue a decision on revoking the student's rights to continue with the study programme. A student may enrol to the first and second year of the study programme no more than twice.

Table 1. The structure of curricular and extracurricular activities

a) For full-time students			
YEAR	**FORM OF ACTIVITIES**	**DESCRIPTION OF ACTIVITIES**	**ECTS**
I year of studies	Curricular	Passing exams	Elective courses (min. of 3 courses)	min.18
		Other direct forms of classes	Elective academic activities	According to Table 2 max. 18
	Extracurricular	Scientific-research work	Scientific research	According to Table 2
Condition for enrolment to the II year of studies			**36**
II year of studies	Curricular	Passing exams	Elective courses (the remaining courses that were not passed during the I year of studies)	36 reduced for the number of ECTS credits from courses passed during the I year
		Other direct forms of classes	Elective academic activities	18 reduced for the number of ECTS credits from curricular activities achieved in the I year, according to Table 2
	Extracurricular	Scientific-research work	Scientific research	According to Table 2
		Appling for the topic of the doctoral thesis		10
		Public defence of the doctoral thesis topic		20
Condition for enrolment to the III year of studies			**120**
III year of studies	Extracurricular	Scientific-research work	Doctoral paper	60
Total acquired at the end of the study programme			**180**
b) For part-time students			
YEAR	**FORM OF ACTIVITIES**	**DESCRIPTION OF ACTIVITIES**	**ECTS**
I year of studies	Curricular	Passing exams	Elective courses (min. of 2 courses)	min. of 12
		Other direct forms of classes	Elective academic activities	According to Table 2 max. 18
	Extracurricular	Scientific-research work	Scientific research	According to Table 2
Condition for enrolment to the II year of studies			**20**
II year of studies	Curricular	Passing exams	Elective courses (min. of 2 courses)	min. 12
		Other direct forms of classes	Elective academic activities	18 reduced for the number of ECTS credits from curricular activities achieved in the I year, according to Table 2
	Extracurricular	Scientific-research work	Scientific research	According to Table 2
Condition for enrolment to the III year of studies			**60**

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III year of studies	Curricular	Passing exams	Elective courses (the remaining courses that were not passed during the I and II year of studies)	36 reduced for the number of ECTS credits from courses passed during years I and II
		Other direct forms of classes	Elective academic activities	18 reduced for the number of ECTS credits from curricular activities achieved years I and II, according to Table 2
	Extracurricular	Scientific-research work	Scientific research	According to Table 2
		Appling for the topic of the doctoral thesis		10
		Public defence of the doctoral thesis topic		20
	Extracurricular	Scientific-research work	Doctoral paper	60
Total acquired at the end of the study programme				180

Table 2. ECTS credits for curricular and extracurricular activities

No	DESCRIPTION	ECTS
	CURRICULAR ACTIVITIES	
	Mandatory curricular activities	
1	Six passed exams at the Postgraduate University Study Programme	**36**[1]
	Elective curricular activities which include teaching and the transfer of knowledge:	
1	Holding professional or scientific workshops organised by the Faculty of Civil Engineering and Architecture Osijek as part of the annual plan of professional and scientific workshops (every presentation/holding of a workshop counts for 3 ECTS credits, to the maximum of 12 ECTS credits, the duration of every workshop is at least 4 academic classes) [2]	**3**
2	Pedagogy-psychological and didactics-teaching methods education	**6**
3	Assisting in teaching classes at the university undergraduate or graduate study programmes (seminars, exercises), which yields ECTS credits, according to the method that 1 ECTS credit equals to assisting during 20 classes, provided that the sum may not exceed 6 ECTS credits	**max. 6**
4	Authoring or co-authoring a university textbook or a book, and editing (head editor) or reviewed professional, academic, or scientific editions.	**6**
5	Authoring or co-authoring reviewed academic materials related to specific academic units. (every authorship or co-authorship counts for 2 ECTS credits). [3]	**max. 6**
6	Acting as a co-mentor for drafting a final paper or a specialist diploma paper or a diploma paper (each co-mentorship counts for 2 ECTS credits).	**max. 6**
7	Attending workshops with the topic of business and entrepreneurship development (every workshop attendance counts for 1 ECTS credit, the minimum duration of every workshop is 2 academic classes).	**max. 4**
8	Attending workshops with the topic of searching through sources of information – catalogues, databases, and other online sources (every workshop attendance counts for 1 ECTS credit, the minimum duration of every workshop is 2 academic classes).	**max. 4**
9	Attending workshops with the topic Academic English Language (every workshop attendance counts for 1 ECTS credit, the minimum duration of every workshop is 2 academic classes).	**max. 4**
10	Creating the annual activity plan of a postgraduate **university** study programme with the support and approval from the study advisor/mentor and submitting in on the form OB 8-4-6 (every plan counts for 1 ECTS credit per year)	**max. 3**
	EXTRACURRICULAR ACTIVITIES	
	Other extracurricular activities	
1	Scientific paper (published or accepted for publication) in journals which are indexed in Current Contents, Science Citation Index, or Science Citation Index Expanded, as defined by the Ordinance for the Election to Scientific Titles. [4]	**36**
2	Scientific paper (published or accepted for publication) in journals which are indexed in other significant databases defined by the Ordinance for the Election to Scientific Titles. [4]	**18**
3	Published and **presented** papers from international and domestic scientific conferences. [5]	**12**
4	Published papers which were presented as **posters** from international scientific conferences. [5]	**8**
5	Academic stay at other domestic or international universities or scientific institutions for at least 1 month (cumulatively) during the postgraduate **university** study programme.	**18**
6	Patented results of scientific research.	**36**
	Extracurricular activities related to the application and defence of the thesis	
7	Applying for the topic of the doctoral thesis.	**10**
8	Public defence of the doctoral thesis topic.	**20**
9	Doctoral thesis.	**60**

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[1] *each course counts for 6 ECTS credits; the student will acquire 36 ECTS credits for the minimum of six selected courses that they must pass during the study programme*

[2] *Holding a workshop must be announced beforehand, and after the workshop is held, a report on the workshop with the list of participants must be submitted to the Head of the Postgraduate University Study Programme Civil Engineering. The minimum number of workshop participants is ten*

[3] *The academic units are defined by the course teacher and the materials are reviewed by the Academic Committee.*

[4] *The specification of the journals and the share of each author's contributions are determined according to the standing Ordinance on the Conditions for the Election to Scientific Titles*

[5] *The published and presented papers from international conferences/posters must adhere to the Ordinance on the Conditions for the Election to Scientific Titles*

Note:

- *Papers under items 1, 2, 3, and 4 refer to the papers that the student has published during the postgraduate university study programme*
- *Full-time students may not acquire ECTS credits cumulatively for scientific papers under 2, 3, and 4.*

Conditions and the method for acquiring the doctorate of science by enrolling to the Postgraduate University Study Programme and creating the doctoral thesis without attending classes and passing exams

Persons who have passed certain exams from the field of Civil Engineering and the field of Fundamental Technical Sciences at the postgraduate scientific study programme (to acquire the academic degree of a master of science) may have their passed exams recognised as being equivalent to the exams from this Study Programme, up to the maximum of 48 ECTS credits, and a created and defended master's paper will be recognised as a scientific paper with 22 ECTS credits. The student may acquire the remaining required credits to reach 90 ECTS credits by publishing scientific papers, which requires them to keep up with advancements in the profession and pass two bridging exams which will be determined by the Committee for Postgraduate Study Programmes. A completed postgraduate specialist study programme in civil engineering will be recognised as being equivalent to a paper published in other bibliographical databases, as defined in the Ordinance on the Conditions for the Election to Scientific Titles and it will count for 18 ECTS credits.

Pursuant to Article 36 of the Ordinance on the Postgraduate Study Programme of the University, as an exception, persons who have accomplished scientific achievements that are significant enough to match the conditions for the election to scientific titles, according to a decision by the Faculty Council or the Council of the Doctoral School or the University Council for Postgraduate Interdisciplinary University or Interuniversity (Doctoral) Study Programmes on meeting the regulated conditions and after drafting and publicly defending the doctoral thesis, with agreement from the Senate, may acquire the doctorate of science.

Scientific achievements are accomplished by meeting the conditions regulated by law and the other required regulations for selection to at least the title of a scientific associate in the scientific fields of Civil Engineering or Fundamental Technical Sciences.

Doctoral thesis as a scientific publication based on published articles

Pursuant to the Ordinance on Postgraduate Study Programmes (Article 41), along with the possibility of forming the doctoral thesis as a scientific publication – a monograph, it is also possible to form the doctoral thesis as a scientific publication based on published articles. This form of the paper is only possible as part of research work at the doctoral study programme to which the student enrolled at the Faculty of Civil Engineering and Architecture Osijek.

In cases where the doctoral thesis is in the form of a scientific publication based on published articles, those articles must be equivalent to a doctoral thesis in scope and significance, and they should represent the independence and creativity of the doctoral student, as well as the originality of the research. All the published papers (articles) which are equivalent to the doctorate must be an interconnected topical unit, which will be verified by the Committee for the Evaluation of the Doctoral Thesis appointed by the Faculty Council.

The student and the mentor should write and sign a statement together which lays out a detailed description of the contribution (qualitatively and quantitatively with the shares displayed numerically, %) of each co-author of a specific paper, where the share of the main student in the scientific paper should be at least 50%. The Committee for the Evaluation of the Doctoral Thesis or the Faculty Council may request a written statement on the contribution of every co-author according to the standing ordinances.

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In the process of initiating the procedure for the appointment of the Committee for the Evaluation of the Doctoral Thesis and the Committee for the Defence of the Doctoral Thesis by the Faculty Council, the students must decide, in agreement with their mentor, on the model according to which they will submit their doctoral thesis a scientific publication based on published articles.

Regardless of the selected model, the students must pass their exams at the Study Programme, at least 6 courses and the other obligations mandated by the plan of the Postgraduate University Study Programme Civil Engineering.

In order to select the doctoral thesis as a scientific publication based on published articles, the following requirements must be met:

1. The doctoral student must be the main author of all the papers;
2. The highest number of authors per published paper may be four (4);
3. The results of the scientific papers must not be a part of the previously defended qualification paper (final, diploma, or master's paper);
4. All the scientific papers must be published after the enrolment to the doctoral study programme;
5. The doctoral paper, as well as the attached papers which have been published during the study programme must be in English, apart from the sections of the papers which must be published both in Croatian and in English pursuant to the standing ordinances;
6. Every paper will count as qualification for only one doctoral student;
7. The doctoral thesis must contain the following chapters:
    I. **TITLE PAGES** regulated by the University and the Faculty.
    II. **ABSTRACT AND KEYWORDS** in Croatian and in English.
    III. **ACKNOWLEDGMENTS** or dedications as the doctoral student chooses – not necessary.
    IV. **INTRODUCTION** – an exhaustive overview of knowledge covered by the specific area of study, which must be the result of a thorough inspection of the literature pertaining to the area, and which has been published in an international journal in English, according to the information provided in **Table 3**. This section may also contain an unpublished overview of knowledge from the specific area of research, but in that case, an additional published paper is required in the category of scientific papers. Along with the results of the literature inspection, the introduction should also contain working hypotheses, research goals, research methodology descriptions, and the expected scientific contributions.
    V. **SCIENTIFIC PAPERS** – offprints of scientific papers are attached instead of the experimental part and the results, their content must match the applied topic and they must be published in an international journal/journals in English, according to the information provided in **Table 3**. If the published papers are not in open access journals, the entire doctoral thesis must be published with the mentioned citation/citations, so the mentioned paper/papers may be read according to the conditions of the journal publisher.
    VI. **DISCUSSION** – must apply commonly for all the published papers and it must provide arguments and an explanation for the reason why the compiled papers provide a new contribution to science in reference to the individual papers, and it will eventually lead toward the conclusion.
    VII. **CONCLUSION** – a summarised recapitulation of the most important knowledge resulting from the conducted research, which explains the new contribution to science in reference to all the individual papers
    VIII. **RESUME OF THE DOCTORAL STUDENT**
    IX. **LIST OF PUBLICATIONS**
    X. **ATTACHMENTS** – methodological information and results which are relevant for the doctoral thesis but are not a part of the attached published papers.

Table 3. The required number and type of papers for the doctoral thesis as a scientific publication based on published articles

Chapter of the doctoral thesis	Required number of published papers	Required type of paper	Citation database of the journal in which the paper was published	Quartile of the journal*
IV INTRODUCTION	1**	Full paper	Web of science Core Collection (WoSCC)	Q1 to Q4
V NUMBER OF SCIENTIFIC PAPERS	min. 2	Full paper	WoSCC - Science Citation Index Expanded (SCIE) or Current Contents Connect (CC)	Q1 or Q2
	min. 1		Web of science Core Collection (WoSCC)	Q1 to Q4***

* The quartile is determined within the appropriate categories of the JCR (Journal Citation Report) based on the database Web of Science Core Collection. The quartile is determined according to the year the paper was published or the latest year for which the journal quartile information is available.
** If a paper from chapter IV has not been published, then the number of required published scientific papers in chapter V will be increased for 1 and is 4. If the journal in which the paper was published is indexed in the WoSCC, but its quartile and/or impact factor has not been determined yet, it will be considered as placed in the fourth quartile (Q4).
*** If the journal in which the paper was published is indexed in the WoSCC, but its impact factor has not been determined yet, it will not be considered as placed in the fourth quartile (Q4).

3. PREDICTED LEARNING OUTCOMES ACQUIRED BY COMPLETING INDIVIDUAL STUDY OBLIGATIONS, STUDY MODULES, AND THE ENTIRE STUDY PROGRAMME, AS WELL AS THE PREDICTED NUMBER OF HOURS FOR EVERY STUDY OBLIGATION WHICH ENSURES THE ACQUISITION OF THE PREDICTED LEARNING OUTCOMES

This study programme ensures the acquisition of the highest quality scientific education in the field of Civil Engineering based on scientific research, through the acquisition of the study programme and participation in organised scientific-research activities. After creating the doctoral thesis, in which the students make their scientific contribution, they will prove themselves as scientists in their area of research.

The declared employment qualifications of the students who have completed the study programme:

> **A doctor of technical sciences from the scientific field of Civil Engineering is qualified to independently head a high-quality scientific paper in the profession, they possess and may independently utilise highest quality knowledge in Civil Engineering and related technical sciences, and their inventive work may yield scientific contributions in the area of Civil Engineering.**

During the study programme, the students systematically develop the knowledge and skills in applying research methods, the ability to formulate research problems by evaluating and creating new facts from the area of research, where the students use their acquired highly specialised knowledge and skills. During the study programme, they are focused at developing new research methods.

The Study Programme enables the acquisition of skills related to planning and heading projects
> Apart from the acquisition of specialised knowledge, the students also develop competencies related to project management – organisation and implementation of scientific research under the conditions of limited time and limited material and financial resources. The students at the Study Programme are expected to create the Annual Research Plan which will determine the schedule of research activities, the determination of the necessary resources, and the formation of a research team, whereby the students will demonstrate their ability to design, plan, implement, and adapt the research problem. The Research Plan is used to define the scope of the research, the connections between the planned activities and the defined scope, the key research events, and the potential risks and measures to alleviate those risks. After successfully completing the Study Programme and acquiring the degree of a doctor of science, the students will confirm that they have acquired these skills and that they are aware that those skills should be expanded and developed. The students are also focused at the cooperation with other researchers and scientists domestically and abroad, and they are developing their organisational skills in that manner.

The Study Programme enables the familiarisation with research methodologies or deductive skills
> During the Study Programme and the implementation of research, in the process of drafting the doctoral thesis, the students are able to demonstrate the ability to identify the research problem, to determine and analyse the relevant literature from the area of research, to determine the data gathering method, to select appropriate and very specific theoretical and analytical methods, and to apply and deduce the conclusions of the research. They are able to consider their own conclusions and the successfulness of their own achievements.

The Study Programme enables the acquisition of writing and reporting skills
> The development of writing and reporting skills is implemented by the requirement to write the doctoral thesis according to the highest academic standards. During the Study Programme, the students will present their seminar papers in front of the teachers and colleagues, and at the end of the Study Programme, also in front of

the Committee for the Defence of the Doctoral Thesis. The students at the Postgraduate University Study Programme Civil Engineering of the Faculty of Civil Engineering and Architecture Osijek are regularly presenting their research topics at the meeting of young researchers from the area of Civil Engineering and related technical sciences – Common Foundations.

The Study Programme enables the development of teaching skills and the skills related to monitoring and evaluating students' activities

Pursuant to Article 114 of the Statute of the Faculty of Civil Engineering and Architecture Osijek (May of 2018), the students of the Postgraduate University Study Programme may participate in academic activities, specifically during seminars and exercises at the undergraduate professional or university study programmes, or the graduate university study programme, or the specialist graduate professional study programme, according to the study programme and the Statute. Junior scientists and assistants are included in the academic activities at the university undergraduate and university graduate study programme. Engagement in the academic activities has been scheduled to accommodate the time required for scientific-research activities. As part of the academic activities, they also participate in the process of monitoring and evaluating students' activities. The students' time management competencies, their focus toward the accomplishment of educational goals, and their self-discipline is developed in this manner.

The Study Programme enables the development of skills related to expressing personal and professional authority
The Study Programme enables taking ethical and social responsibility

Considering the expectations that the students will be able to accept the most complex tasks in their work environment after they complete the doctoral study programme – initiate, organise, and participate in various project that demand coordinated efforts and the combination of associates with different competencies during the Study Programme, the Study Programme is focused toward the development of capabilities or accepting and promoting technological, social, and cultural accomplishments. They are educated to engage in communication with the wider academic and social community in their professional area.

After completing the Postgraduate University Study Programme Civil Engineering at the Faculty of Civil Engineering and Architecture Osijek, the students will be able to:

- recognise, define, and formulate the research problem;
- critically analyse, evaluate, and synthesize new and complex research ideas;
- display systematic understanding of the area they are studying and a high degree of knowledge from the area in which they are specialised;
- independently conduct scientific research;
- independently construct an experimental model and a measuring instrument;
- apply specific knowledge in generating new knowledge and research projects;
- publish scientific papers;
- take responsibility for conducting research and for the social benefits of the research results;
- accept the most complex tasks in their work environment;
- apply ethical principles in research.

Acquiring highly specialised knowledge and the research potential of the Faculty have been emphasized in the areas of scientific branches of Load-Bearing Structures, Organisation and Technology of Construction, Hydraulic Engineering, Transportation engineering and geotechnics. The Faculty's strategic documents formalise and support this direction of the scientific activities, the investments in infrastructural development, and the creation of conditions for the concentration of research groups. As part of the Study Programme, the intention is to achieve a synergistic effect between learning, research, and innovations. The Study Programme enables and encourages work related to the construction of experimental models and measuring instruments.

The students at the Postgraduate University Study Programme Civil Engineering, depending on the selected courses and the area of research, will acquire the following competencies:

Module Load-Bearing Structures

The Postgraduate University Study Programme at the module Load-Bearing Structures will expand and develop the knowledge that the students acquired during their previous education at undergraduate and graduate study programmes related to structures made of concrete, masonry, steel, and wood, as well as to construction materials themselves. Through detailed research into the behaviour of materials and structures exposed to various effects and the methods for ensuring their useability and durability, the students will acquire the skills required to reproduce the existing scientific knowledge, but

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also to recognise and resolve any new scientific problems in the relevant area. The students are also provided with the opportunity to cooperate with other modules and the application of advanced modelling methods and calculations of the behaviour of structures and materials will provide them with the necessary knowledge and skills to work in the modern, competitive scientific-research and economic environment.

Module Organisation, Technology, and Management

The Postgraduate University Study Programme at the module Organisation, Technology, and Management will expand and develop the knowledge of master engineers of civil engineering related to organisation, planning, optimisation of technological-economic aspects, development of technology, sustainable development, management and control of construction projects, and business activities of companies. The Study Programme provides an exhaustive study of methods, techniques, and systems related to the stated issues, as well as the study of advanced planning, construction, analysis, management, protection, and maintenance methods for buildings.

Module Engineering Mechanics

The Postgraduate University Study Programme at the module Engineering Mechanics is the basis of fundamental technical sciences within the area of Civil Engineering, and after the students complete this Study Programme, they will possess the knowledge from the area of nonlinear dynamic calculation, estimation of the behaviour of historical buildings, inverse, numeric, and experimental models, and the application of new materials. The module provides an exhaustive study of the stated topics with advanced scientific methods of experimental and numeric modelling.

Module Hydraulic Engineering

The students at the Postgraduate University Study Programme Civil Engineering, module Hydraulic Engineering will expand the knowledge they acquired as master engineers of civil engineering and depending on the selected courses and the area of research, they will acquire competencies related to a wider conceptualisation of hydraulic engineering problems and the research work in the area of Hydraulic Engineering. During the process of studying, the emphasis is on competencies related to the application of modern scientific methods and the interconnectivity between hydraulic engineering and the protection of the environment.

Module Transportation engineering and geotechnics

The Postgraduate University Study Programme at the module Transportation engineering and geotechnics provides the students with the competencies in the area of critical analysis, evaluation and synthesis of new and complex concepts, application of modern methodological procedures in the scientific branches Transportation engineering and geotechnics, as well as developing new ones, by testing materials and structures, and professional and scientific application of relevant knowledge in conceptualising and analysing them. The students will also be competent to engage in independent advanced scientific-research work regarding testing, modelling, calculating, analysing, and designing systems and interventions from those scientific branches.

The list of mandatory and elective courses and/or modules with the number of active classes required to implement them and the number of ECTS credits for the Postgraduate University Study Programme Civil Engineering have been presented in Table 4, and Attachment 1 provides the description and the general information on all the courses.

Table 4. The list of mandatory and elective courses and/or modules with the number of active classes required to implement them and the number of ECTS credits

LIST OF MODULES/COURSES						
Study programme year: 1						
Semester: 1						
MODULE	COURSE	HOLDER	L	E	S	ECTS	STATUS1
MANDATORY COURSE	Theoretical Postulates and Principles of Scientific Research	Izv.prof.dr.sc. Davorin Penava	30	0	30	6	M
GENERAL ELECTIVE COURSES	Numerical Mathematics	Prof.dr.sc. Ninoslav Truhar	30	0	30	6	E
	Application of Expert Systems	Izv.prof.dr.sc. Marija Šperac	30	0	30	6	E
	Applied Multivariate Statistics	Prof.dr.sc. Mirta Benšić	30	0	30	6	E
	Small and Medium Entrepreneurship	Doc.dr.sc. Ivana Šandrk Nukić	30	0	30	6	E

LIST OF MODULES/COURSES
Study programme year: 1
Semester: I, II

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MODULE	COURSE	HOLDER	L	E	S	ECTS	STATUS1
LOAD-BEARING STRUCTURES	Reliability Engineering	Doc.dr.sc. Tihomir Dokšanović, Prof.dr.sc. Damir Markulak	30	0	30	6	E
	Serviceability Limit States of Reinforced Concrete Structures	Doc.dr.sc. Ivan Kraus	30	0	30	6	E
	Earthquake Engineering II	Izv.prof.dr.sc. Marijana Hadzima-Nyarko	30	20	10	6	E
	Wood Structures III	Izv.prof.dr.sc. Jurko Zovkić	30	10	20	6	E
	Steel and Composite Structure Modelling	Prof.dr.sc. Damir Markulak	30	0	30	6	E
	Theory of Structure Durability	Prof.dr.sc. Ivanka Netinger Grubeša; Doc.dr.sc. Ivana Miličević	30	0	30	6	E
	Fatigue of Steel Structures	Izv.prof.dr.sc. Ivan Radić	30	0	30	6	E
	Blast Load Effects on Structures	Doc.dr.sc. Hrvoje Draganić	30	0	30	6	E
	Special Chapters of Concrete and Masonry Structures	Prof.dr.sc. Damir Varevac	30	30	0	6	E

LIST OF MODULES/COURSES							
Study programme year: 1							
Semester: I, II							
MODULE	COURSE	HOLDER	L	E	S	ECTS	STATUS1
ORGANISATION, TECHNOLOGY, AND MANAGEMENT	Economic Aspects of Investment Projects	Prof.dr.sc. Ksenija Čulo	30	0	30	6	E
	Maintenance Management of Buildings	Prof.dr.sc. Saša Marenjak	30	20	10	6	E
	Planning, Modelling, and Simulating the Construction Process	Doc.dr.sc. Mario Galić	30	0	30	6	E
	Optimisation of Construction Processes	Izv.prof.dr.sc. Uroš Klanšek	30	0	30	6	E
	Sustainable Construction Technologies	Izv.prof.dr.sc. Hrvoje Krstić	30	0	30	6	E
	Strategic Management	Doc.dr.sc. Ivana Šandrk Nukić, Dr.sc. Barbara Medanić, prof. emer.	30	0	30	6	E
	Quality Management in Construction Projects	Izv.prof.dr.sc. Zlata Dolaček-Alduk	30	0	30	6	E
	Comprehensive Energy Modelling of Buildings	Izv.prof.dr.sc. Hrvoje Krstić	30	0	30	6	E
	Technologies for the Automation of Construction, Monitoring, and Control Processes	Izv.prof.dr.sc. Zlata Dolaček-Alduk, Doc.dr.sc. Mario Galić	30	0	30	6	E

LIST OF MODULES/COURSES							
Study programme year: 1							
Semester: I, II							
MODULE	COURSE	HOLDER	L	E	S	ECTS	STATUS1
HYDRAULIC ENGINEERING	Wastewater Treatment Methods	Izv.prof.dr.sc. Zoltán Melicz	30	20	10	6	E
	River Basin Management	Prof.dr.sc. Lidija Tadić	30	20	10	6	E
	Evaluation and Management of Environmental Risks	Prof.dr.sc. Roko Andričević	30	0	30	6	E
	Selected Chapters of Hydrology	Izv.prof.dr.sc. Marija Šperac	30	0	30	6	E
	Systematic Analysis in Hydraulic Engineering	Prof.dr.sc. Barbara Karleuša	30	0	30	6	E
	Groundwater Flow and Transport Process	Doc.dr.sc. Tamara Brleković	30	0	30	6	E
	Geoinformation Technologies and Environmental Management	Prof. dr. sc. Mladen Jurišić, Izv. prof. dr. sc. Ivan Plaščak	30	10	20	6	E
	Ecohydrology	Dr.sc. Ognjen Bonacci, prof. emer.	30	15	15	6	E
	Basis of Physical Modelling of Open Watercourses	Izv.prof.dr.sc. Enikő Anna Tamás	30	30	0	6	E

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		River Hydraulics	Izv. prof. dr. sc. Marijan Babić	30	0	30	6	E

LIST OF MODULES/COURSES								
Study programme year: 1								
Semester: I, II								
MODULE	COURSE	HOLDER	L	E	S	ECTS	STATUS1
ENGINEERING MECHANICS	Nonlinear Behaviour Models of Materials and Structures	Prof.dr.sc. Ivica Guljaš	30	20	10	6	E
	Advanced Structural Dynamics	Prof.dr.sc. Ivica Guljaš	30	15	15	6	E
	Mechanics of Wood Composites	Izv.prof.dr.sc. Silva Lozančić	30	20	10	6	E
	Theory and Principles of Assessment and Retrofit of Historical Buildings	Izv.prof.sc. Davorin Penava, Dr. Vasilis Sarhosis	30	0	30	6	E
	Inverse Modelling and Parameter Identification	Prof. dr. sc. Ivica Kožar	30	0	30	6	E
	Numerical Models for the Behaviour of Elements, Systems, and Loads	Izv.prof.dr.sc. Tanja Kalman Šipoš	30	0	30	6	E
	Experimental Models of Loads and Structures	Doc.dr.sc. Goran Gazić	30	0	30	6	E
	Stability of Historical Religious Buildings	Izv.prof.dr.sc. Mirjana Bošnjak-Klečina	30	10	20	6	E
	New Materials in Civil Engineering	Doc.dr.sc. Ivana Miličević and Prof.dr.sc. Ivanka Netinger Grubeša	30	0	30	6	E

LIST OF MODULES/COURSES								
Study programme year: 1								
Semester: I, II								
MODULE	COURSE	HOLDER	L	E	S	ECTS	STATUS1
TRANSPORTATION ENGINEERING AND GEOTECHNICS	Flexible Pavement Structures	Prof.dr.sc. Sanja Dimter	30	0	30	6	I
	Analysis of Asphalt Mixtures	Prof.dr.sc. Aleksandra Deluka-Tibljaš	30	30	0	6	I
	Rigid Pavements	Izv.prof.dr.sc. Ivana Barišić	30	20	10	6	I
	Management of Modern Roadways	Doc.dr.sc. Miroslav Šimun	30	0	30	6	I
	Transport Modelling	Izv.prof.dr.sc. Irena Ištoka Otković	30	10	20	6	I
	Computer Modelling in Geotechnics	Prof.dr.sc. Mensur Mulabdić, izv.prof.dr.sc. Krunoslav Minažek	30	0	30	6	I
	Earth Structures and Dynamic Soil Compaction	Prof.dr.sc.Dietmar Adam	30	0	30	6	I
	Efficiency Mechanisms of Geosynthetics	Prof.dr.sc. Mensur Mulabdić, doc.dr.sc. Stanislav Lenart	30	0	30	6	I
	Laboratory and In-Situ Soil Tests	Izv.prof.dr.sc. Krunoslav Minažek	30	0	30	6	I
	Soil Dynamics and Foundations	Prof.dr.sc. Mensur Mulabdić	30	0	30	6	I

L-lectures, E-exercises, S-seminars
1 IMPORTANT: Regarding course status, M is entered if a course is mandatory and E if it is elective.

4. THE ASSIGNED NUMBER OF ECTS CREDITS FOR EVERY STUDY OBLIGATION IS BASED ON THE AVERAGE TOTAL OF INVESTED EFFORT BY A STUDENT IN ORDER TO ACQUIRE THE PREDICTED LEARNING OUTCOMES AS PART OF THAT OBLIGATION

Along with the information on ECTS credits stated in tables 1, 2, 4, and 4, this chapter presents the schematic of ECTS credits at the Postgraduate University Study Programme Civil Engineering.

Curricular activities are implemented through elective courses and through direct forms of academic activities composed of lectures, research seminars, exercises, workshops, and similar. Direct forms of curricular activities include mandatory and elective curricular activities. The stated has been presented in Figure 1.
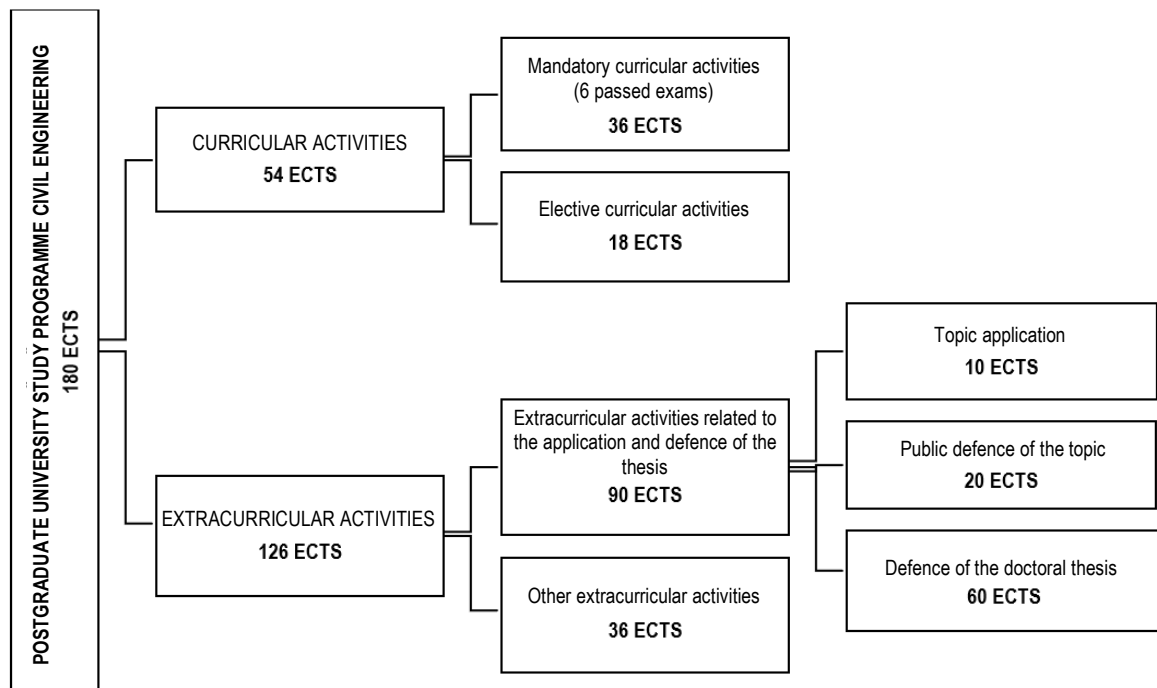
Figure 1. Schematic of ECTS credits at the Postgraduate University Study Programme Civil Engineering

By passing mandatory and elective courses (mandatory curricular activities), the students will acquire the minimum of 36 ECTS credits. The students will acquire 18 ECTS credits through elective curricular activities. Direct forms of curricular activities count for 30 % of the total obligations predicted by the Study Programme, i.e., 54 ECTS credits.

Extracurricular activities include the implementation of scientific research with guidance and supervision from the study advisor or mentor, as well as the creation of scientific papers, presentations, laboratory work, or other forms of practical work, with the ultimate goal of drafting the doctoral thesis. The extracurricular activities count for 70% of the total obligations predicted by the study programme, i.e., 126 ECTS credits. After acquiring the minimum of 90 ECTS credits through curricular and extracurricular activities, the student may initiate the process of acquisition of the doctorate of science by submitting a proposal for the topic of the doctoral thesis to the Faculty Council.

The Committee for the Acquisition of the Doctorate of Science will verify whether the conditions for the initiation of the procedure for the recognition of the doctoral thesis topic have been met. The application used to initiate the procedure must be submitted on a special form for the application of the topic which must be signed by the holder of the Study Programme. The defence of the doctoral thesis topic is public, before the Committee for the Recognition of the Doctoral Thesis Topic, other doctoral students, and other interested persons. The Committee for the Recognition of the Doctoral Thesis Topic must include at least three members, one of whom must be from another university. The date and location of the public defence of the doctoral thesis topic will be posted at the notice board and the website of the University or the institution which is the holder of the study programme. The application of the doctoral thesis topic yields 10 ECTS credits and the public presentation and defence of the doctoral thesis topic before the Committee for the Recognition of the Doctoral Thesis Topic yields 20 ECTS credits. The public presentation of the doctoral thesis topic is an integral part of the Report and Proposal of the Committee for the Recognition of the Doctoral Thesis Topic. The members of the Committee will write the Report and issue the final proposal.

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The procedure for the application, evaluation, and defence of the doctoral thesis has been regulated by Articles 131 through 143 of the Statute of the J.J. Strossmayer University of Osijek, and by the procedure of the holder institution of the study programme PO-7-8, Application, Evaluation, and Defence of the Doctoral Thesis. The students will acquire additional 60 ECTS credits after the successful defence of the doctoral thesis and they will complete the Study Programme with the total of 180 ECTS credits.

5. THE METHOD OF TEACHING COURSES AND THE METHODS FOR EVALUATING THE ACQUIRED LEARNING OUTCOMES FOR EVERY STUDY OBLIGATION

The form of implementing the academic activities and the verification of the acquired learning outcomes for every study obligation and the list of mandatory and elective courses and/or modules with the number of active classes required for their implementation and the number of ECTS credits for the Postgraduate University Study Programme Civil Engineering has been presented in detail in Attachment 1.

6. LIST OF OTHER STUDY PROGRAMMES IN WHICH ECTS CREDITS MAY BE ACQUIRED

Instead of a scientific-guidance course from the module, the students may select a course from another doctoral study programme in the country or from abroad, depending on the study programme schematic of the specific module. The decision on taking a course from another study programme will be made by the Committee for Postgraduate Study Programmes. The enrolment to courses and the rights and obligations of students will be regulated according to an agreement between the GRAFOS and the institution implementing the doctoral study programme which includes the relevant course. The ECTS credits acquired in this manner are counted toward the 180 ECTS credits necessary to complete the Study Programme.

The Study Plan of the Postgraduate University Study Programme Civil Engineering allows for the possibility of taking one course from a doctoral study programme implemented by another institute of higher education in the country or from abroad instead of a scientific-guidance course from the module – depending on the course schematic of the module course. As part of that process, the Committee for Postgraduate Study Programmes will determine the suitability of the institution and the course, as well as the number of ECTS credits which will be accredited to the student after they successfully pass the course at the guest institution. Attending classes at the other institution and the other rights and obligations of the student will be regulated by a bilateral agreement between the GRAFOS and the host institution.

Research stays at other domestic or international universities or scientific institutions lasting at least 1 month (cumulatively) during the Postgraduate Study Programme may allow students to acquire up to 18 ECTS credits (the students must submit a certificate from the institution where they stayed and a report on their stay and research). The credits will be granted proportionally to the number of days that the students stayed at the relevant institutions. The ECTS credits will be approved by the Committee for Postgraduate Study Programmes on the basis of a certificate from the institution where the student was staying and the report on the results achieved during the mobility, which will be certified by the mentor.

In case a student transfers from another postgraduate university study programme, the Committee for Postgraduate Study Programmes will determine the number of ECTS credits which will be recognised and the obligations that the student must complete at the postgraduate university study programme implemented by the GRAFOS before the completion of the Study Programme.

7. THE METHOD FOR THE COMPLETION OF THE STUDY PROGRAMME

The Study Programme will be completed after six exams have been successfully passed, all the other obligations required for the Postgraduate University Study Programme have been met, and the doctoral thesis has been successfully written and publicly defended before the Committee, which is worth 180 ECTS credits in total. The procedure for the application, evaluation, and defence of the doctoral thesis, the rights and obligations of the student, mentor, and the Committee for the Acquisition of the Doctorate of Science has been regulated in detail by Articles 131 through 143 of the Statute of the J.J. Strossmayer University of Osijek and the procedure of the institution which is the holder of the study programme PO-7-8, Application, Evaluation, and Defence of the Doctoral Thesis, as well as Articles 41 through 51 of the Ordinance on Postgraduate Study Programmes of the J.J. Strossmayer University of Osijek. This procedure must be applied by all teachers-mentors, the Committee for the Acquisition of the Doctorate of Science, the Committee for the Recognition of the

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Doctoral Thesis Topic, the Committee for the Evaluation of the Doctoral Thesis, and the Committee for the Defence of the Doctoral Thesis.

The procedure for the application, evaluation, and defence of the doctoral thesis

The procedure for the application, evaluation, and defence of the doctoral thesis has been regulated by the Statute of the University, the Statute of the Faculty of Civil Engineering and Architecture Osijek, and the Ordinance on the Postgraduate Study Programmes at the Josip Juraj Strossmayer University of Osijek.

After acquiring at least 90 ECTS credits according to the conditions of the Study Programme, the student may initiate the process for the acquisition of the doctorate of science by submitting the proposal of the doctoral thesis topic (OB 7-8-1) to the Faculty Council, which must contain the general information on the postgraduate university study programme student, the title of the proposed topic, the explanation of the topic, the information on the proposed mentor or mentor and co-mentor and their competencies, the explanation of the topic, the overview of previous research, the goal and hypotheses of the research, the research methods, the expected scientific contributions, the proposed literature list, the statement of the postgraduate university study programme student that they have not applied another doctoral thesis with the identical topic at another study programme of the University or at another university, and the statement or statements of the mentor on the consent and acceptance of mentorship for the student (OB 7-8-2).

The conditions for the initiation of the procedure for the recognition of the doctoral thesis topic will be verified by the determination of the Committee for Postgraduate Study Programmes.

Per proposal of the Committee for Postgraduate Study Programmes, the Faculty Council will appoint the Committee for the Recognition of the Doctoral Thesis Topic with at least three members, one of whom must be the employee of another institution, which must submit a report within 90 days after the appointment, which will contain the proposal for either accepting or rejecting the doctoral thesis topic and determine the date and location of the public defence of the doctoral thesis topic.

The defence of the doctoral thesis topic will be public. The date and location of the defence of the doctoral thesis topic will be posted on the notice board and the website of the University and the Faculty, at least 8 days before the public defence of the doctoral thesis topic will take place. The decision and the notice will be delivered to the postgraduate university study programme student and all the members of the Committee and the members of the Science Committee.

The student must prepare for the public defence of the doctoral thesis topic according to the regulated instructions for drafting the presentation of the public defence of the doctoral thesis topic and the proposed topic of the doctoral thesis.

The purpose of the public defence of the doctoral thesis topic is the following:
- enabling the Committee for the Recognition of the Doctoral Thesis Topic to make sure that the research that represents the basis for the proposal of the doctoral thesis topis is an independent and original effort by the applicant;
- offering an opportunity to the postgraduate university study student to publicly defend the doctoral thesis topic and clarify any uncertainties from the proposal;
- enabling the Committee for the Recognition of the Doctoral Thesis Topic to evaluate the knowledge of the postgraduate university study student regarding the area of research of the thesis topic.

The applicant must defend the doctoral thesis topic before the Committee for the Recognition of the Doctoral Thesis Topic, the Science Committee, the other students of the postgraduate university study programme, and any interested persons, according to the Protocol for the Public Defence of the Doctoral Thesis Topic.
The Minutes from the Public Defence of the Doctoral Thesis Topic (OB 7-8-3) are an integral part of the Report and Proposal of the Committee for the Recognition of the Doctoral Thesis Topic (OB 7-8-4).

The Science Committee will consider the report from the Committee for the Recognition of the Doctoral Thesis Topic and issue a written opinion on the report, after which it will inform the Faculty Council on its opinion.

On the basis of the explained report and proposal of the Committee for the Recognition of the Doctoral Thesis Topic and the mentor selection form, as well as the opinion of the Science Committee, the Faculty Council will issue the final decision on the recognition, amendment, or rejection of the proposed doctoral thesis topic, inform the applicant, and appoint the mentor or the first and second mentor.

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The amendment decision will instruct the applicant to amend the proposed doctoral thesis topic within 30 days and reinitiate the application procedure, which does not require another public defence of the doctoral thesis topic.
The rejection decision will instruct the applicant to draft a new doctoral thesis topic proposal within 90 days and reinitiate the application procedure.

When initiating the procedure for the appointment of the Committee for the Evaluation of the Doctoral Thesis and the Committee for the Defence of the Doctoral Thesis by the Faculty Council, the students will decide, in agreement with their mentors, on the model they will use to submit their doctoral thesis as a scientific publication – monograph or as a scientific publication based on published articles.

Before the final submission, the candidate must submit the doctoral thesis in electronic form (word or pdf format) to the mentor. The mentor will review the thesis using the information system for the verification of originality Turnitin. After completing the originality verification of the doctoral thesis, the mentor will fill in the written report according to the form OB 7-8-9. If the thesis meets the originality requirements according to the mentor's opinion, the opinion will be issued as positive. If the thesis does not meet the originality requirements according to the mentor's opinion, the mentor may return the thesis to the candidate to be revised until it meets the requirements or they may take other legal actions according to the acts of the Faculty of Civil Engineering and the University of Osijek.

The mentor will fill in the Certificate on the Completion and Submission of the Doctoral Thesis (OB 7-8-5) and the Certificate on the Completed Verification of the Doctoral Thesis in the Plagiarism Detection Software Turnitin (OB 7-8-9), and submit them to the Faculty Council which will appoint the Committee for the Evaluation of the Doctoral Thesis.

The Committee for the Evaluation of the Doctoral Thesis will send a report (OB 7-8-6) to the Faculty Council.

Pursuant to the explained report and the proposal of the Committee for the Evaluation of the Doctoral Thesis, the Faculty Council will issue the final decision on the evaluation of the doctoral thesis. After accepting the positive evaluation of the doctoral thesis, usually at the same meeting, the Faculty Council will appoint the Committee for the Defence of the Doctoral Thesis of at least three members and two alternates, and specify the date and location of the defence. The members of the Committee for the Evaluation of the Doctoral Thesis may also be members of the Committee for the Defence of the Doctoral Thesis.

The Statute of the Faculty of Civil Engineering and Architecture Osijek, Articles 60 through 63, regulate the procedure in case of recognition, amendment, or rejection of the doctoral thesis in detail.

The doctoral thesis must include the following items:
1. external and internal page of the front cover;
2. empty page or, if required, a dedication page;
3. title page in Croatian;
4. title page in English or German;
5. title page in another world language, if required;
6. evaluation committees and bibliographical data;
7. author's declarations;
8. empty page;
9. foreword;
10. abstract and keywords in Croatian;
11. abstract and keywords in English or German;
12. abstract and keywords in another world language (not mandatory);
13. empty page;
14. table of contents;
15. empty page;
16. list of illustrations;
17. list of tables;
18. list of abbreviations and symbols;
19. empty page;
20. main text: appropriately distributed into chapters, subchapters, etc.;
21. annexes (attachments);
22. bibliography;
23. empty page;
24. short resume of the author with a photograph;
25. empty page;
26. external and internal page of the back cover.

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The instructions for drafting the doctoral thesis have been made according to the standard HRN ISO 7144:2004 Documentation – Presentation of theses and similar documents (ISO 7144:1986) and HRN ISO 6357:2001 Documentation – Spine titles on books and other publications (ISO 6357:1985).

Defence of the doctoral thesis according to the Protocol for the Defence of the Doctoral Thesis.

Minutes of the defence of the doctoral thesis will be kept (OB 7-8-7), which will be signed by the Committee members and the minutes keeper. The decision of the Committee for the Defence of the Doctoral Thesis will be noted in the minutes, and it may be the following:
- Defended by a unanimous decision of the Committee
- Defended by the majority of the votes of the Committee members
- Not defended.

The doctoral thesis may only be defended once.

After the doctoral thesis has been successfully defended, within one month after the defence, the applicant will submit a bound doctoral thesis to the secretariat, along with the electronic version in at least 5 copies, and they will sign a statement on archiving the doctoral thesis in the institutional, university, and national digital repository (OB 7-8-8), regardless of the chosen form of the doctoral thesis (scientific publication – monograph or a doctoral thesis as a scientific publication based on published articles).

The doctoral thesis must be drafted in the Croatian language, but with approval from the professional committee of the institution implementing the study programme, it may be in one of the world languages. The title, abstract, and the keywords of the doctoral thesis must be written in Croatian and in English. The abstract should enable the understanding of the goal of the doctoral thesis, the research methods, the results, and the conclusions.

The doctoral thesis must be submitted in electronic form and in written form. The form and content of the doctoral thesis has been regulated on a special form for drafting the doctoral thesis, which has been regulated by the Faculty of Civil Engineering and Architecture Osijek.

After the defence of the doctoral thesis, the Dean of the Faculty will submit a report to the Rector of the University about completing the doctorate and attach the decision of the Committee for the Defence of the Doctoral Thesis and one copy of the thesis to the report.

After completing the Postgraduate University Study Programme Civil Engineering, module Load-Bearing Structures, module Organisation, Technology, and Management, module Hydraulic Engineering, and module Transportation engineering and geotechnics, the students will acquire the academic title:

**Doctor of Science, scientific area Technical Sciences,
scientific field Civil Engineering.**

After completing the Postgraduate University Study Programme Civil Engineering, module Engineering Mechanics, the students will acquire the academic title:

**Doctor of Science, scientific area Technical Sciences,
scientific field Fundamental Technical Sciences.**

The diploma will be issued by the Josip Juraj Strossmayer University of Osijek. The diplomas will be handed by the Rector at the formal graduation ceremony.

8. **PROVISIONS REGULATING THE POSSIBILITY AND THE CONDITIONS UNDER WHICH STUDENTS WHO HAVE STOPPED ATTENDING THE STUDY PROGRAMME OR LOST THE RIGHT TO STUDY MAY OR MAY NOT CONTINUE WITH THEIR STUDIES**

Conditions under which students who have stopped attending the Study Programme or lost the right to study at one of the study programmes may continue with their studies have been defined by the Ordinance on Postgraduate Study Programmes at the Josip Juraj Strossmayer University of Osijek (July 2015).

The students who have stopped attending a postgraduate university study programme at this Faculty or who have lost the right to study at another postgraduate university study programme at another faculty of civil engineering may continue a postgraduate university study programme at this Faculty under the condition of passing bridging exams, if the study programmes are different at the moment the studies are continued. The bridging exams will be determined by the Committee for Postgraduate Study Programmes.

Students who have enrolled to a full-time postgraduate university study programme will lose their student status if they do not defend their doctoral thesis within five years after the date on which they enrolled to the study programme.

Students will lose their postgraduate university study programme student status if the Faculty Council issues a decision on stopping the procedure for the acquisition of the doctorate pursuant to the Statute of the University. A student whose postgraduate university study programme student status has ended due to termination of studies may continue with their studies, under the condition that no more than three years have passed after the date on which they terminated their studies and that the study programme has not been significantly altered (more than 20%) from the form it had when the student enrolled.

The request for the approval to continue with a terminated study programme must be submitted to the Committee for Postgraduate Study Programmes. The decision on the approval to continue with a terminated study programme will be issued by the Committee for Postgraduate Study Programmes and it will contain the approval for the continuation of the study programme, the recognition of the exams with grades and the acquired ECTS credits during the study programme, and the amount of scholarship which will be determined according to the amount determined for the class of students with whom the student is continuing with the study programme.

A student will acquire the right to a certificate after attending and passing exams from every semester or to a group certificate on the completed postgraduate university study programme, without creating and defending the doctoral thesis, as part of lifelong education.

ATTACHMENTS

ATTACHMENT 1. Description and general information for every course

MANDATORY COURSE

General information

Course teacher	**Izv. prof. dr. sc. Davorin Penava, dipl. ing. građ.**
Course title	**Theoretical Postulates and Principles of Scientific Research**
Study programme	**Postgraduate University Study Programme Civil Engineering**
Course status	Mandatory course
Year	I

Acquired credits and the form of implementing academic activities	ECTS coefficient of the student academic load	6.0
	Number of classes (lectures (L)+exercises (E)+seminars (S))	30+0+30

1. COURSE DESCRIPTION

1.1. Course goals

The basic goal of the course is teaching the students about theoretical postulates and principles of scientific research for the purpose of designing, selecting, and developing a research problem. The goal of the course is also to familiarise the students with the basics of academic literacy and writing a scientific publication, correcting and forming the publication by applying the principles of academic integrity, and then with searching and managing bibliographical sources and mastering the presentation and communication skills in science.

1.2. Preconditions for taking the course

There are no preconditions.

1.3. Expected learning outcomes for the course

After completing their study obligations at the course, the students will be able to:
1) **Assign value to the comprehensive knowledge and understanding of the scientific principles and methodologies required to support their education in their engineering discipline, as well as the understanding and knowledge about the scientific principles of related disciplines, in order to enable the appreciation of the scientific and engineering context, and in order to support their understanding of relevant historical, present, and future developments and technologies;**
2) **Evaluate, apply, and integrate knowledge and understanding from other engineering disciplines in order to support the study in their own engineering discipline, as well as the ability to evaluate them critically and apply them efficiently in planning and monitoring their own research programme;**
3) **Compare the scientific methods required to support their education in their engineering discipline and they will be trained to apply a series of scientific methods, tools, and notations, conscientiously and critically, in the analysis and resolution of engineering problems, including the management of bibliographical sources and the application of IT tools, and to plan their self-learning as the basis of lifelong education;**
4) **Build the need for a high level of professional and ethical behaviour in engineering, familiarity with professional codes of conduct and the ways in which ethical dilemmas arise;**
5) **Select the appropriate method of presentation and communication of scientific research in the scientific and engineering context.**

1.4. Course content

Introduction to the course; Basics of academic literacy; Designing, selecting, and developing a research problem; Setting research goals and establishing the sequence of implementation; Searching for bibliographical sources and using electronic bibliographic databases; The concept and understanding of plagiarism and avoiding plagiarism; Overview and evaluation of bibliographical sources; Use of software for the purpose of management of bibliographical sources; Developing a plan for a scientific

publication and gathering notes; Writing a scientific publication; Critical presentation, correction, and forming the template for a scientific publication; Presentation and communication skills in science; Various.

1.5. Types of academic activities	☒ lectures ☒ seminars and workshops ☐ exercises ☒ remote education ☐ field classes	☒ independent tasks ☒ multimedia and web ☐ laboratory ☐ mentorship ☒ other ————————————

1.6. Comments	No.

1.7. Students' obligations

Attending classes; Creating a research plan (in cooperation with the study advisor); Research progress report (in cooperation with the study advisor); Seminar paper; Continuous knowledge tests; Oral knowledge tests; Plagiarism tests.

1.8. Monitoring the students' work

Attending classes	2.0	Activity during classes		Seminar paper	1.0	Experimental work	
Written exam		Oral exam	0.5	Essay		Research	2.0
Project		Continuous knowledge testing	0.5	Paper		Practical work	
Portfolio							

1.9. Grading and evaluating the student's activities during classes and at the final exam

STUDENT ACTIVITY *	ECTS	LEARNING OUTCOME **	ACADEMIC ACTIVITY	EVALUATION METHOD	CREDITS	
					min	max
Attending classes	2.0	1-9	Lectures and seminars	Attendance check	0	0
Creating a seminar paper	1.0	1-6	Seminar paper	Grading	0	40
Written answers to asked questions	0.5	1-6	Continuous knowledge testing	Grading	0	15
Oral answers to asked questions	0.5	1-6	Oral exam	Grading	0	15
Creating a research plan (in cooperation with the study advisor)	1.0	1-9	Scientific-research work	Verification of requirements	0	15
Creating a research progress report (in cooperation with the study advisor)	1.0	1-9	Scientific-research work	Verification of requirements	0	15

1.10. Mandatory reading (at the moment of application of the study programme proposal)

1) Alley, M. (2013) The craft of scientific presentations: critical steps to succeed and critical errors to

avoid. New York: Springer-Verlag New York.
2) **Barrass, R. (2002) Scientists must write: a guide to better writing for scientists, engineers and students. Springer US.**
3) **Fogiel, M. (Max) and Recreation and Education Association. (1997) REA's quick & easy guide to writing & publishing your A+ scientific/technical paper. REA.**
4) **Lester, J. D. and Lester, J. D. (2015) Writing research papers: a complete guide. Pearson Education Limited.**
5) **Reynolds, G. (2011) The naked presenter: delivering powerful presentations with, or without, slides. New Riders.**

1.11. Additional reading (at the moment of application of the study programme proposal)

1) Eco, U. (2015) How to write a thesis. The MIT Press.
2) Silobrčić, V. (1998) Kako sastaviti, objaviti i ocijeniti znanstveno djelo (How to Draft, Publish, and Evaluate a Scientific Publication). 4th edn. Medicinska naklada.
3) Zelenika, R. (1998) Metodologija i tehnologija izrade znanstvenog in stručnog djela (Methodology and Technology of Drafting a Scientific and Professional Publication). 3rd edn. Faculty of Economy of the University of Rijeka.

1.12. Number of copies of the required reading in relation to the number of students currently attending classes at the course

Title	Number of copies	Number of students
Alley, M. (2013) The craft of scientific presentations: critical steps to succeed and critical errors to avoid. New York: Springer-Verlag New York.	0	10
Barrass, R. (2002) Scientists must write: a guide to better writing for scientists, engineers and students. Springer US.	0	10
Fogiel, M. (Max) and Recreation and Education Association. (1997) REA's quick & easy guide to writing & publishing your A+ scientific/technical paper. REA.	0	10
Lester, J. D. and Lester, J. D. (2015) Writing research papers: a complete guide. Pearson Education Limited.	0	10
Reynolds, G. (2011) The naked presenter: delivering powerful presentations with, or without, slides. New Riders.	0	10

1.13. Methods for monitoring quality which ensure the acquisition of the resulting knowledge, skills, and competencies

Evaluation of the learning outcomes implemented by regularly gathering feedback from students on whether certain learning outcomes are being achieved and whether all the outcomes have been covered (analysis of the student survey on the quality of teachers, attendance and communication at lectures, as well as the analysis of individual/group seminar papers).
Verification of the implementation of the study programme according to the learning outcomes which is carried out by analysing the relationship between learning outcomes, teaching methods, and knowledge tests among students at the study programme level. It also includes the evaluation of the impact that he assigned learning outcomes have on the student's academic load.

* Every student activity/academic activity should be assigned with the appropriate share of ECTS credits for individual activities, so that the total number of ECTS credits match the credit value of the course.

** This column should contain the learning outcomes from item 1.3 which have been included in this student/teacher activity.

GENERAL ELECTIVE COURSES

General information	
Course teacher	**Prof.dr.sc. Ninoslav Truhar**
Course title	**Numerical Mathematics**
Study programme	**Postgraduate University Study Programme Civil Engineering**
Course status	General elective course
Year	I
Acquired credits and the form of implementing academic activities	ECTS coefficient of the student academic load
	Number of classes (lectures (L)+exercises (E)+seminars (S))

Acquired credits and the form of implementing academic activities	ECTS coefficient of the student academic load	6.0
	Number of classes (lectures (L)+exercises (E)+seminars (S))	30+0+30

1. COURSE DESCRIPTION

1.1. Course goals

Familiarising the students with the fundamental ideas and methods of numerical linear algebra used to solve linear systems, least squares problems, eigenvalues and singular values problems, and enabling the student to solve specific problems through the use of existing software packages or their own programs.

1.2. Preconditions for taking the course

There are no preconditions.

1.3. Expected learning outcomes for the course

1. Understanding the source and the types of errors in numerical calculations;
2. Applying the Gauss algorithm, LU-decomposition, the Cholesky algorithm, QR and SVD decomposition;
3. Understanding the generalised and symmetric eigenvalue problem and using iterative methods for their computation;
4. Using the computer and the appropriate software packages for the purpose of creating corresponding programs.

1.4. Course content

Introduction. Types of errors. Significant digits. Errors in calculating function values. Interpolation. Spline interpolation. Solving nonlinear equations. Least squares problems. Defining problems and examples. Matrix analysis. Vector and matrix norm. Orthogonality and SVD. Matrix condition and the sensitivity of quadratic linear systems. Solving linear equation systems. Triangular systems, LU-decomposition, The Gauss algorithm. Linear least squares problem. Householder and Givens matrices, QR-decomposition. Eigenvalue problem. Generalised eigenvalue problems, properties, and decomposition, symmetric problem of eigenvalues, properties, and decomposition. Iterative methods for computing eigenvalues.

1.5. Types of academic activities	☒ lectures ☐ seminars and workshops ☒ exercises ☐ remote education ☐ field classes	☒ independent tasks ☐ multimedia and web ☐ laboratory ☒ mentorship ☐ other _____
1.6. Comments	No.	
1.7. Students' obligations		

Attending classes; creating and presenting seminar papers.

1.8. Monitoring the students' work

Attending classes	2	Activity during classes		Seminar paper	1	Experimental work	
Written exam		Oral exam		Essay		Research	
Project		Continuous knowledge testing	3	Paper		Practical work	
Portfolio							

1.9. Grading and evaluating the student's activities during classes and at the final exam

STUDENT ACTIVITY *	ECTS	LEARNING OUTCOME **	ACADEMIC ACTIVITY	EVALUATION METHOD	CREDITS	
					min	max
Attending classes	1	1-10	Lectures and exercises	Keeping attendance records	0	10
Continuous knowledge testing	2	1-10	Independent tasks	Reviewing research progress reports	0	30
Seminar paper	3	1-10	Seminars and workshops	Reviewing and grading seminar papers	0	60

1.10. Mandatory reading (at the moment of application of the study programme proposal)

• **R. Scitovski, Numerička matematika, izmijenjeno i dopunjeno izdanje (Numerical Mathematics, Amended Edition), Department of Mathematics, Osijek, 2015,** http://www.mathos.unios.hr/images/homepages/scitowsk/Num-2015.pdf
• **N. Truhar, Numerička linearna algebra (Numerical Linear Algebra), J. J. Strossmayer University, Department of Mathematics, 2010,** http://www.mathos.unios.hr/images/uploads/302.pdf

1.11. Additional reading (at the moment of application of the study programme proposal)

•R. Scitovski, Z. Tomljanović i N. Truhar, Metode optimizacije (Optimisation Methods), J. J. Strossmayer University, Department of Mathematics, 2014, http://www.mathos.unios.hr/images/uploads/301.pdf
•Aganović i K. Veselić K., Matematički modeli i metode (Mathematical Models and Methods), J. J. Strossmayer University, Department of Mathematics
, http://www.mathos.unios.hr/images/uploads/715.pdf
•S. Suljagić, Matematika III (Mathematics III), Faculty of Civil Engineering, Zagreb, online materials
http://www.grad.hr/nastava/matematika/mat3/index.htm

1.12. Number of copies of the required reading in relation to the number of students currently attending classes at the course

Title	Number of copies	Number of students
Numerical Mathematics, Amended Edition	5	5
Numerical Linear Algebra	5	5

1.13. Methods for monitoring quality which ensure the acquisition of the resulting knowledge, skills, and competencies

The students' work is monitored by keeping attendance records and noting their engagement in the process of creating the seminar paper.

General information

Course teacher	**Izv.prof.dr.sc. Marija Šperac**
Course title	**Application of Expert Systems**
Study programme	**Postgraduate University Study Programme Civil Engineering**
Course status	General elective course
Year	I
Acquired credits and the form of implementing academic activities	ECTS coefficient of the student academic load — 6.0
	Number of classes (lectures (L)+exercises (E)+seminars (S)) — 30+0+30

1. COURSE DESCRIPTION

1.1. Course goals

The basic goals are the development of the ability to recognise the decision-making problem as a qualitative problem, where the goals are multicriterial and ill structured, and the limitations are complex and ill structured, and which are solved by using heuristic methods; establishing rules and developing predictive mechanisms which will be used to evaluate the future conditions of the system.

1.2. Preconditions for taking the course

There are no preconditions.

1.3. Expected learning outcomes for the course

1. Developing an expert system for a specific problem;
2. Analysing the conditions and changes in an actual (real) system by applying an expert system;
3. Predicting future conditions of the system on the basis of expert systems;
4. Recognising the advantages and disadvantages of the application of expert systems.

1.4. Course content

Artificial intelligence (expert systems and neural networks) as tools for qualitative analyses and decision-making: [Cognitive processes and information processing; Expert systems and conventional programs – synergy; Databases and knowledge bases]. // Theoretical foundations of expert systems: [The structure of expert systems; Representation of knowledge in expert systems; Logic based representation of knowledge; Representation of knowledge and object methods (semantic networks, frameworks, and objects); Deductive and inductive reasoning and knowledge processing]. // Practical aspects of the application of expert systems. // Development of an expert system and the acquisition of knowledge: [Systematic analysis; Knowledge acquisition and logic design; Physical design – selecting programming languages and tools; expert system shells; selecting and adapting the user interface; Coding, testing, and implementing the expert system; Implementation]. // Object oriented representation and hybrid methods: [Object oriented representation; Hybrid methods, systems, and tools for expert systems]. // Uncertainty in expert systems: [Uncertainty in the real world; Probabilistic methods; Fuzzy sets and fuzzy logic; Probability theory; Theory of evidence]. // Evaluation of expert systems.

1.5. Types of academic activities	☒ lectures ☒ seminars and workshops ☐ exercises ☐ remote education ☐ field classes	☒ independent tasks ☐ multimedia and web ☐ laboratory ☐ mentorship ☐ other _____

1.6.	Comments					No.		

1.7. Students' obligations

Attending classes; creating and presenting seminar papers.

1.8. Monitoring the students' work

Attending classes	1	Activity during classes		Seminar paper	2	Experimental work	
Written exam		Oral exam		Essay		Research	
Project		Continuous knowledge testing	3	Paper		Practical work	
Portfolio							

1.9. Grading and evaluating the student's activities during classes and at the final exam

STUDENT ACTIVITY *	ECTS	LEARNING OUTCOME **	ACADEMIC ACTIVITY	EVALUATION METHOD	CREDITS	
					min	max
Attending classes	1	1,2,3	Lectures	Keeping attendance records	0	10
Continuous knowledge testing	3	1,2,3	Independent tasks	Reviewing research progress reports	0	40
Seminar paper	2	1,2,3	Seminars and workshops	Reviewing and grading seminar papers	0	50

1.10. Mandatory reading (at the moment of application of the study programme proposal)

• **D.Mc Neil; P. Freiberger: Fuzzy Logic, Simon and Schuster; New York, London 1993.**
• **T.Toreno; K. Asai; M. Sugeno: Fuzzy Systems Theory and its Applications; Academic Press Limited, London 1991.**
• **Novaković, B.; Majetić,D.; Široki, M. : Umjetne neuronske mreže (Artificial Neural Networks), Zagreb : Faculty of Mechanical Engineering and Naval Architecture, 1998**
• **Ali R. Khataee, Masoud B. Kasiri: Artificial neural network modeling of water and wastewater treatment processes, New York : Nova Science Publishers, 2011**

1.11. Additional reading (at the moment of application of the study programme proposal)

•Darrel, R. : Expert Systems: Design, Applications and Technology, Computer Science, Technology and Applications, Nova 2017.

1.12. Number of copies of the required reading in relation to the number of students currently attending classes at the course

Title	Number of copies	Number of students
D.Mc Neil; P. Freiberger: Fuzzy Logic,	1	
T.Toreno; K. Asai; M. Sugeno: Fuzzy Systems Theory and its Applications	1	
Novaković, B.; Majetić,D.; Široki, M. : Umjetne neuronske mreže (Artificial Neural Networks)	3	

1.13. Methods for monitoring quality which ensure the acquisition of the resulting knowledge, skills, and competencies

Presentations of seminar papers, level of active participation by students, and class attendance.

General information	
Course teacher	**Prof.dr.sc. Mirta Benšić**
Course title	**Applied Multivariate Statistics**
Study programme	**Postgraduate University Study Programme Civil Engineering**
Course status	General elective course
Year	I

Acquired credits and the form of implementing academic activities	ECTS coefficient of the student academic load	6.0
	Number of classes (lectures (L)+exercises (E)+seminars (S))	30+0+30

1. COURSE DESCRIPTION

1.1. Course goals

Familiarising the students with statistical inference in multivariate models and enabling them to understand and apply multivariate analysis to data analysis in the application of statistics to modelling.

1.2. Preconditions for taking the course

There are no preconditions.

1.3. Expected learning outcomes for the course

Applying the statistical models covered by the course content for making conclusions regarding the posed problems;
Using computers and an appropriate software as tools in data analysis;
Assigning value to conclusions reached by statistical analysis;
Present the possibility of their application to non-experts and experts.

1.4. Course content

Data matrices and scales of measurement. Overview of the methods for making statistical inference for univariate data. Bivariate analysis of discrete random variables, contingency tables. Regression and correlation. Multivariate linear regression, ANOVA. Generalised linear models. Principal component analysis and factor analysis. Data grouping (cluster analysis).

1.5. Types of academic activities	☒ lectures ☒ seminars and workshops ☐ exercises ☐ remote education ☐ field classes	☒ independent tasks ☒ multimedia and web ☐ laboratory ☐ mentorship ☐ other
1.6. Comments	No.	

1.7. Students' obligations

Lectures, seminars, and course-specific classroom classes are mandatory for the students, and they are required to conduct research, gather data, and create and present a seminar paper.

1.8. Monitoring the students' work

Attending classes	2	Activity during classes		Seminar paper	2	Experimental work	

Written exam		Oral exam		Essay		Research		
Project		Continuous knowledge testing	2	Paper		Practical work		
Portfolio								

1.9. Grading and evaluating the student's activities during classes and at the final exam

STUDENT ACTIVITY *	ECTS	LEARNING OUTCOME **	ACADEMIC ACTIVITY	EVALUATION METHOD	CREDITS	
					min	max
Attending classes	1	1-10	Lectures and exercises	Keeping attendance records	0	10
Continuous knowledge testing	2	1-10	Independent tasks	Reviewing research progress reports	0	30
Seminar paper	3	1-10	Seminars and workshops	Reviewing and grading seminar papers	0	60

1.10. Mandatory reading (at the moment of application of the study programme proposal)

- **F.E. Harrell, Regression Modeling Strategies with Applications to Linear Models, Logistic Regression and Survival Analysis, Springer, New York, 2001.**
- **A. Basilevsky, Statistical Factor Analysis and Related Models: Theory and Applications, WileyInterscience, New York, 1994.**

1.11. Additional reading (at the moment of application of the study programme proposal)

- G.A.F. Seber, Linear Regression Analysis, J. Wiley & Sons., New York, 1977.
- M.J. Crawley, The R Book, J. Wiley & Sons, 2007.
- L. Fahrmeier, G. Tutz, Multivariate Statistical Modeling Based on Generalized Linear Models, Springer,
- New York, 2001.
- R.C. Mittelhammer, Mathematical statistics for economics and business, Springer, 1996.
- P. McCullagh, J.A: Nelder, Generalized Linear Models, CRC Press, 1989.
- R.L. Gorsuch, Factor Analysis, Lawrence Erlbaum Assoc. 1983
- K.A. Bollen, Structural equations with latent variables, Wiley-Interscience, 1989
- M. Benšić, N. Šuvak, Uvod u vjerojatnost i statistiku (Introduction to Probability and Statistics), Department of Mathematics, University of Osijek, 2014.
- M. Benšić, N. Šuvak, Primijenjena statistika (Applied Statistics), Department of Mathematics, University of Osijek, 2013.

1.12. Number of copies of the required reading in relation to the number of students currently attending classes at the course

Title	Number of copies	Number of students
Regression Modeling Strategies with Applications to Linear Models	-	
Statistical Factor Analysis and Related Models: Theory and Applications	-	

1.13. Methods for monitoring quality which ensure the acquisition of the resulting knowledge, skills, and competencies

Homework, practical work with professional data, conducting research and creating and presenting the seminar paper.

General information

Course teacher	**Doc.dr.sc. Ivana Šandrk Nukić**
Course title	**Small and Medium Entrepreneurship**
Study programme	**Postgraduate University Study Programme Civil Engineering**
Course status	General elective course
Year	I

Acquired credits and the form of implementing academic activities	ECTS coefficient of the student academic load	6.0
	Number of classes (lectures (L)+exercises (E)+seminars (S))	30+0+30

1. COURSE DESCRIPTION

1.1. Course goals

Familiarising the students with entrepreneurship as a way of thinking and acting based on recognising and taking advantage of business opportunities.

1.2. Preconditions for taking the course

There are no preconditions.

1.3. Expected learning outcomes for the course

After passing the course, the students will be able to:
1. **evaluate a business opportunity**
2. **draft a business plan**
3. **manage a business enterprise**
4. **design an entrepreneurial strategy**
5. **organise international positioning**

1.4. Course content

Entrepreneurial perspective: development of entrepreneurship through history. The concept of entrepreneurship and entrepreneurs. Entrepreneurial qualities, skills, behaviour. Entrepreneurship in various contexts – corporate entrepreneurship, social entrepreneurship, entrepreneurship in the SME sector. Establishing and initiating an enterprise: business idea and opportunity analysis. Legal form, intellectual property, and other legal issues. Business plan. Financing an enterprise – sources of capital. Entrepreneurial support institutions. Managing and developing an enterprise – Entrepreneurship strategy: exploiting an enterprise. Growth strategies and managing the implications of growth. International positioning. GEM – global entrepreneurship research.

1.5. Types of academic activities	☒ lectures ☒ seminars and workshops ☐ exercises ☒ remote education ☐ field classes	☒ independent tasks ☒ multimedia and web ☐ laboratory ☒ mentorship ☐ other x consultations
1.6. Comments	The classes may be taught in English.	

1.7. Students' obligations

Seminar paper. Essay. Oral exam.

1.8. Monitoring the students' work

Attending classes	0.1	Activity during classes		Seminar paper	1	Experimental work	
Written exam		Oral exam	1.5	Essay	1.5	Research	1.9
Project		Continuous knowledge testing		Paper		Practical work	
Portfolio							

1.9. Grading and evaluating the student's activities during classes and at the final exam

STUDENT ACTIVITY *	ECTS	LEARNING OUTCOME **	ACADEMIC ACTIVITY	EVALUATION METHOD	CREDITS	
					min	max
Attending classes	0.1	1,2,3,4,5	Lectures or consultations	Keeping attendance records	0	0
Creating a seminar paper	2.9	1,2,3,4,5	Mentored written expression	Reading and grading the paper	0	50
Writing an essay (3000 words)	1.5	1,2,3,4,5	Individual written expression	Reading and grading the essay	0	25
Answering questions	1.5	1,2,3,4,5	Oral exam	Grading the answers	0	25

1.10. Mandatory reading (at the moment of application of the study programme proposal)

Hisrich, R.D., Peters, M.P., Shepherd., D.A.: Poduzetništvo, sedmo izdanje (Entrepreneurship, seventh edition), MATE d.o.o., Zagreb, 2011.

1.11. Additional reading (at the moment of application of the study programme proposal)

Alpeza, Mirela; Delić, Anamarija; Oberman Peterka, Sunčica; Krstić, Darija; Marković, Nina
Osmislite i provjerite svoju poduzetničku ideju; Vodič za sve one koji razmišljaju o ulasku u poduzetničke vode (Design and Verify Your Entrepreneurship Idea; A Guide for all Those Considering Entrepreneurship)
Osijek: Josip Juraj Strossmayer University of Osijek, Faculty of Economics in Osijek, 2015
Delić, Anamarija; Oberman Peterka, Sunčica; Perić, Julia
Želim postati poduzetnik (I Want to Become an Entrepreneur)
Osijek: Josip Juraj Strossmayer University of Osijek, Faculty of Economics in Osijek, 2014

1.12. Number of copies of the required reading in relation to the number of students currently attending classes at the course

Title	Number of copies	Number of students
Entrepreneurship	2	1

1.13. Methods for monitoring quality which ensure the acquisition of the resulting knowledge, skills, and competencies

Student survey.

* Every student activity/academic activity should be assigned with the appropriate share of ECTS credits for individual activities, so that the total number of ECTS credits match the credit value of the course.

** This column should contain the learning outcomes from item 1.3 which have been included in this student/teacher activity.

ELECTIVE COURSES IN THE MODULE LOAD-BEARING STRUCTURES

General information		
Course teachers	**doc.dr.sc. Tihomir Dokšanović** **prof.dr.sc. Damir Markulak**	
Course title	**Reliability Engineering**	
Study programme	**Postgraduate University Study Programme Civil Engineering**	
Course status	Elective course in the module Load-Bearing Structures	
Year	I	
Acquired credits and the form of implementing academic activities	ECTS coefficient of the student academic load	6.0
	Number of classes (lectures (L)+exercises (E)+seminars (S))	30+0+30

1. COURSE DESCRIPTION

1.1. Course goals

Enabling students to recognise the causes of uncertainty and risks in construction, mathematically model those causes and interpret the concepts of structure reliability used as the basis for European standards. Relate the engineering structure calculation methods with the general concept of reliability and the mathematical modelling of the reliability of a structure.

1.2. Preconditions for taking the course

There are no preconditions.

1.3. Expected learning outcomes for the course

1. **Analysing the concept of reliability of civil engineering structures used as the basis for European standards**
2. **Formulating the basic variables regarding resistance and action of various probability distributions**
3. **Formulating the limit state equations for the probabilistic reliability analysis of specific structural members**
4. **Evaluating the reliability of a structural component and the entire structure**

1.4. Course content

Fundamental concepts in reliability engineering, i.e., the reliability principle. Basic concepts from the theory of probability and the related structure uncertainties. Selection of the required level of structure reliability – procedures for determining the reliability level, economic aspects, the influence of time, the reliability index as a measurement of structure reliability. First and second order methods for calculating structure reliability and their features. Reliability and European standards and the partial factor method. Gathering and processing data on structures – actions and resistance. Stochastic modelling of structural response, actions, and resistance. Basic variables and models and transformations of basic variables. Limit state equations and the proof of reliability using partial factors – ultimate and serviceability limit states. Determining reliability using software suites.

1.5. Types of academic activities	☒ lectures ☒ seminars and workshops ☐ exercises ☐ remote education ☐ field classes	☒ independent tasks ☐ multimedia and web ☐ laboratory ☐ mentorship ☐ other
1.6. Comments	No.	

1.7. Students' obligations								
Regular class attendance and creating a seminar paper.								

1.8. Monitoring the students' work								
Attending classes	1.0	Activity during classes		Seminar paper	2.0	Experimental work		
Written exam		Oral exam	1.0	Essay		Research		
Project		Continuous knowledge testing	2.0	Paper		Practical work		

1.9. Grading and evaluating the student's activities during classes and at the final exam

STUDENT ACTIVITY *	ECTS	LEARNING OUTCOME **	ACADEMIC ACTIVITY	EVALUATION METHOD	CREDITS	
					min	max
Attending classes	1.0	1, 2, 3	Lectures	Keeping attendance records	0	0
Homework	2.0	1, 2, 3, 4	Independent tasks	Reviewing and grading homework	0	35
Writing a seminar paper	2.0	1, 2, 3, 4	Seminar paper	Reviewing and grading the seminar paper	0	50
Answering oral questions	1.0	1, 2, 3	Oral exam	Grading answers	0	15

1.10. Mandatory reading (at the moment of application of the study programme proposal)

- **Milčić, V.; Peroš, B., *Uvod u teoriju sigurnosti nosivih konstrukcija* (Introduction to the Theory of Load-Bearing Structure Safety). Faculty of Civil Engineering Split: Split, Croatia, 2003.**
- **Holický, M., *Reliability analysis for structural design*. SUN MeDIA Stellenbosch: Stellenbosch, South Africa, 2009.**
- **The Joint Committee on Structural Safety (JCSS), Probabilistic Model Code. Technical University of Denmark: 2001.**
- ***HRN EN 1990:2011, Eurocode – Basis of Structural Design*.**

1.11. Additional reading (at the moment of application of the study programme proposal)

- International Organization for Standardization (ISO), *ISO 2394, General principles on reliability for structures*. ISO: Geneva, Switzerland, 2015.
- Ditlevsen, O.; Madsen, H. O., *Structural reliability methods*. Wiley New York: New York City, New York, USA, 1996.
- Ayyub, B. M.; McCuen, R. H., *Probability, Statistics, and Reliability for Engineers and Scientists*. 3rd Edition ed.; CRC Press, Boca Raton, Florida, USA, 2016.
- Androić, B.; Dujmović, D.; Džeba, I., *Inženjerstvo pouzdanosti 1* (Reliability Engineering 1). IA Projektiranje d.o.o.: Zagreb, Croatia, 2006.

1.12. Number of copies of the required reading in relation to the number of students currently attending classes at the course

Title	Number of copies	Number of students
Introduction to the Theory of Load-Bearing Structure Safety	6	1
Reliability analysis for structural design	0	1
Probabilistic Model Code	0	1

| HRN EN 1990:2011, Eurocode – Basis of Structural Design | 0 | 1 |

1.13. Methods for monitoring quality which ensure the acquisition of the resulting knowledge, skills, and competencies

The activity of the students is monitored by keeping lecture attendance records, reviewing and discussing independent tasks, and activity in the process of creating seminar papers.

General information

Course teacher	**Doc. dr. sc. Ivan Kraus, mag. ing. aedif.**	
Course title	**Serviceability Limit States of Reinforced Concrete Structures**	
Study programme	**Postgraduate University Study Programme Civil Engineering**	
Course status	Elective course in the module Load-Bearing Structures	
Year	I	
Acquired credits and the form of implementing academic activities	ECTS coefficient of the student academic load	6.0
	Number of classes (lectures (L)+exercises (E)+seminars (S))	30+0+30

1. COURSE DESCRIPTION

1.1. Course goals

Advancing the knowledge on the rules for reinforcing concrete elements which are susceptible to the development of cracks, with the goal of designing higher quality and more durable structures. Acquiring the skills and knowledge for the estimation of appearance, development, and control of cracks in reinforced concrete structural elements, under the effect of static and dynamic loads. Recognising critical locations in structures and structural elements with the purpose of programming the desired behaviour of structures. Evaluating and comparing various mathematical methods for the evaluation and control of the deflection and width of cracks.

1.2. Preconditions for taking the course

There are no preconditions.

1.3. Expected learning outcomes for the course

1. **Estimating and comparing short-term ~~instant~~ and long-term deflections of reinforced concrete elements by applying various analytical and numerical methods**
2. **Recommending the method for controlling the deflection of reinforced concrete elements**
3. **Evaluating and assigning value to the width of a crack in a reinforced concrete structural element**
4. **Comparing and re-examining the various methods for controlling and limiting cracks in reinforced concrete elements**
5. **Designing a solution for limiting the width of a crack in a reinforced concrete structural element**

1.4. Course content

Engineering estimate of non-linear behaviour of reinforced concrete: theories for the determination of forces, quantification of ductility, and models during non-linear tasks. Classification of serviceability limit states: stress, deformation, deflection, crack condition, vibrations, and fatigue. Limit deformation state: deflection line, theoretical calculation of the curvature of the cross section, constructing the bending moment-rotation diagram, evaluation of deflection increments with the increase in the amount of short-term load, creep deflection, approximate methods for the calculation of deflection. Limit state of cracks: theoretical and experimental research, elastoplastic theory of cracks in a bent beam, predicting the widths of cracks, changes in the curvature of beams and the distribution of cracks, distribution of cracks. During all this, the following effects are analysed: type of load, minimum

reinforcement, diameter, spacing, and types of reinforcement, concrete grade, the ratio of tensile and compressive reinforcement and the dimensions of the cross-section. Examples of calculations according to the following standards and ordinances: EN, DIN and ACI.

1.5. Types of academic activities	☒ lectures ☒ seminars and workshops ☐ exercises ☐ remote education ☐ field classes	☒ independent tasks ☐ multimedia and web ☐ laboratory ☐ mentorship ☐ other _____

| 1.6. Comments | No. | |

1.7. Students' obligations

Participation in the academic process is mandatory for the students, which includes attending classes regularly, where they are expected to display critical thinking and present their personal position with arguments as part of discussions about specific relevant topics, solve problems, and keep up with current literature regarding the topics being taught. The students must create, present, and defend a seminar paper.

1.8. Monitoring the students' work

Attending classes	1.0	Activity during classes		Seminar paper	4.0	Experimental work	
Written exam		Oral exam	1.0	Essay		Research	
Project		Continuous knowledge testing		Paper		Practical work	
Portfolio							

1.9. Grading and evaluating the student's activities during classes and at the final exam

STUDENT ACTIVITY *	ECTS	LEARNING OUTCOME **	ACADEMIC ACTIVITY	EVALUATION METHOD	CREDITS min	max
Attending classes	1	1, 2, 3	Oral presentation and conversation method	Keeping attendance records, discussions during classes	0	10
Creating a seminar paper	4	1, 2, 3, 4, 5	Documentation and demonstration method for the assigned task through independent work	Reviewing and grading the quality of the seminar paper	0	70
Defending the seminar paper and answering questions during the oral exam	1	2, 5	Oral presentation and conversation method	Evaluating the answers and critical thinking	0	20

1.10. Mandatory reading (at the moment of application of the study programme proposal)

Sorić, Z., Kišiček, T. (2018.) Betonske konstrukcije 2 (Concrete Structures 2), University of Zagreb, Faculty of Civil Engineering, Zagreb

| Radić, J. and associates (2006.) Betonske konstrukcije – priručnik (Concrete Structures – Handbook). Hrvatska sveučilišna naklada, University of Zagreb, Faculty of Civil Engineering, SECON HNDK, Andris, Zagreb |
| Mihanović, A., Marović, P., Dvornik, J. (1993.) Nelinearni proračuni armiranobetonskih konstrukcija (Non-Linear Calculations of Reinforced Concrete Structures). DHGK, Zagreb |
| Tomičić, I. (1996.) Betonske konstrukcije (Concrete Structures), DHGK, Zagreb |
| Tomičić, I. (1996.) Betonske konstrukcije - odabrana poglavlja (Concrete Structures – selected chapters), University of Zagreb, Faculty of Civil Engineering, Zagreb |

1.11. Additional reading (at the moment of application of the study programme proposal)

HRN EN 1992-1-1:2013. Eurocode 2. Design of concrete structures – Part 1-1: General rules and rules for buildings (EN 1992-1-1:2004+AC:2010) + national addendum.
Nilson, A. H. (1986.) Design of concrete structures, McGraw-Hill, Inc.
Radić, J. i suradnici (2006.) Betonske konstrukcije – riješeni primjeri (Concrete Structures – Solved Examples). Hrvatska sveučilišna naklada, University of Zagreb, Faculty of Civil Engineering, Andris, Zagreb

1.12. Number of copies of the required reading in relation to the number of students currently attending classes at the course

Title	Number of copies	Number of students
Sorić, Z., Kišiček, T. (2018.) Betonske konstrukcije 2 (Concrete Structures 2), University of Zagreb, Faculty of Civil Engineering, Zagreb	25	
Radić, J. and associates (2006.) Betonske konstrukcije – priručnik (Concrete Structures – Handbook). Hrvatska sveučilišna naklada, University of Zagreb, Faculty of Civil Engineering, SECON HNDK, Andris, Zagreb	6	
Mihanović, A., Marović, P., Dvornik, J. (1993.) Nelinearni proračuni armiranobetonskih konstrukcija (Non-Linear Calculations of Reinforced Concrete Structures). DHGK, Zagreb	11	
Tomičić, I. (1996.) Betonske konstrukcije (Concrete Structures), DHGK, Zagreb	17	
Tomičić, I. (1996.) Betonske konstrukcije - odabrana poglavlja (Concrete Structures – selected chapters), University of Zagreb, Faculty of Civil Engineering, Zagreb	9	

1.13. Methods for monitoring quality which ensure the acquisition of the resulting knowledge, skills, and competencies

The activity of the students is monitored by keeping lecture attendance records and by evaluating the students' efforts in the creation of the seminar paper.

General information

Course teacher	**Izv.prof.dr.sc. Marijana Hadzima-Nyarko**	
Course title	**Earthquake Engineering II**	
Study programme	**Postgraduate University Study Programme Civil Engineering**	
Course status	Elective course in the module Load-Bearing Structures	
Year	I	
	ECTS coefficient of the student academic load	6.0

Acquired credits and the form of implementing academic activities	Number of classes (lectures (L)+exercises (E)+seminars (S))	30+20+10

1. COURSE DESCRIPTION

1.1. Course goals

Advancing the knowledge related to complex issues of structural analysis and dynamics, behaviour of materials and sets at post-elastic deformations, analysis of limit load-bearing and usability states, and the specific design of structures for earthquake-prone areas. Training students for independent research activities in the area of seismic engineering, as well as for solving complex seismic calculations.

1.2. Preconditions for taking the course

There are no preconditions.

1.3. Expected learning outcomes for the course

1. **Interpreting the results of earthquake forces and structural calculations, as well as the status of deformations and stress under the effects of an earthquake, dynamic properties and effects of structures, and their interaction.**
2. **Estimating the level of earthquake vulnerability and earthquake risks.**
3. **Mastering the model testing and experimental research procedures related to the effects of earthquakes and applying the research results on actual structural sets.**
4. **Carrying out experimental and theoretical research in the area of earthquake engineering.**
5. **Interpreting and presenting the research results in the form of scientific-research papers.**

1.4. Course content

Calculations of buildings exposed to the effects of earthquakes. Analytical methods: the equivalent static forces method; the spectral method; direct dynamic calculations; calculations according to the load-bearing capacity; calculations using pushover analysis; seismic calculations based on behaviour. The importance of ductile behaviour. Interdependence of resistance, rigidity, displacement, damage, and earthquake risk. The response of buildings to earthquake and simulated effects: environmental vibrations, forced vibrations, impulse activity, earthquake platforms, quasi dynamic testing. Model testing used to research the effects of earthquakes. Resistance calculation and the structural design of complex reinforced concrete, masonry, and steel building structures. Determining earthquake risks. Estimating earthquake vulnerability using the empirical and the analytical approach. Methods for the reinforcement of load-bearing structures for the effects of earthquakes. Typical examples of building reinforcement. Modern trends in earthquake engineering.

1.5. Types of academic activities	☒ lectures ☒ seminars and workshops ☐ exercises ☐ remote education ☐ field classes	☐ independent tasks ☐ multimedia and web ☐ laboratory ☐ mentorship ☐ other _____
1.6. Comments	No comments	

1.7. Students' obligations

Regular class attendance and creating the seminar paper.

1.8. Monitoring the students' work

Attending classes	2.0	Activity during classes		Seminar paper	3.0	Experimental work	
Written exam		Oral exam		Essay		Research	
Project		Continuous knowledge testing	1.0	Paper		Practical work	
Portfolio							

1.9. Grading and evaluating the student's activities during classes and at the final exam

STUDENT ACTIVITY *	ECTS	LEARNING OUTCOME **	ACADEMIC ACTIVITY	EVALUATION METHOD	CREDITS	
					min	max
Attending classes	2.0	1,2,3,4,5	Lectures	Keeping attendance records	0	0
Writing a seminar paper	3.0	1,2,3,4	Seminar paper	Reviewing and grading seminar papers	0	75
Answering oral questions	1.0	1,2,3,4	Oral exam	Evaluating the provided answers	0	25

1.10. Mandatory reading (at the moment of application of the study programme proposal)

- **Aničić, D. i dr: Zemljotresno inženjerstvo – visokogradnja (Earthquake Engineering – Building Construction), Građevinska knjiga, Beograd, 1990.**
- **Coburn, A.; Spence, R. Earthquake protection, 2nd Edition, John Wiley & Sons, ltd, Chichester, 2002.**
- **Hadzima-Nyarko, M.; Nikić, D.; Morić, D. Potresno inženjerstvo - procjena oštetljivosti zgrada (Earthquake Engineering – Evaluation of Building Vulnerability), GrAFOS, Osijek, 2018.**

1.11. Additional reading (at the moment of application of the study programme proposal)

- Tomaževič, M., Earthquake-Resistant Design of Masonry Buildings, Imperial College Press, London, 1999.
- Elnashai, A.S.; Di Sarno, L. Fundamentals of Earthquake Engineering, John Wiley & Sons, ltd, Chichester, 2008.
- Fardis, M.N. Seismic Design, Assessment and Retrofitting of Concrete Buildings based on EN-Eurocode 8, Springer, 2009.

1.12. Number of copies of the required reading in relation to the number of students currently attending classes at the course

Title	Number of copies	Number of students
Earthquake Engineering – Building Construction		
Earthquake protection		
Earthquake Engineering – Evaluation of Building Vulnerability		

1.13. Methods for monitoring quality which ensure the acquisition of the resulting knowledge, skills, and competencies

The activity of the students is monitored by keeping lecture attendance records, by evaluating the students' efforts in the creation of the seminar paper, and by evaluating their knowledge at the oral exam.

General information

Course teacher	**Izv. prof. dr. sc. Jurko Zovkić**
Course title	**WOOD STRUCTURES III**
Study programme	**Postgraduate University Study Programme Civil Engineering**
Course status	Elective course in the module Load-Bearing Structures
Year	I

Acquired credits and the form of implementing academic activities	ECTS coefficient of the student academic load	6.0
	Number of classes (lectures (L)+exercises (E)+seminars (S))	30+0+30

1. COURSE DESCRIPTION

1.1. Course goals

Acquiring advanced knowledge on the behaviour of wooden beams/elements. Mastering the knowledge and skills required for active understanding of modern calculation methods. Training in the creation of advanced numerical models in order to describe the behaviour of wooden beams/elements.

1.2. Preconditions for taking the course

There are no preconditions.

1.3. Expected learning outcomes for the course

1. **Defining the deformation and stress status in a wooden beam.**
2. **Being able to explain the behaviour of laminated beams under horizontal and vertical effects.**
3. **Being able to apply advanced numerical modelling methods.**
4. **Being able to analyse the behaviour or wooden laminated structures under the effect of fire.**

1.4. Course content

Modern methods for the calculation of wooden structures. Non-linear behaviour of laminated composite wood. Specifics of modelling complex wooden structures. The interaction of laminated beams and the steel bearing and joining elements. The effect of cross-sectional prestressing. Cross-laminated timber (CLT). Complex calculation methods for determining the mechanical resistance of wooden structures exposed to fire. Testing wooden elements and structures.

1.5. Types of academic activities	☒ lectures ☒ seminars and workshops ☐ exercises ☐ remote education ☐ field classes	☐ independent tasks ☐ multimedia and web ☐ laboratory ☐ mentorship ☐ other _____

1.6. Comments No	No comments

1.7. Students' obligations

Regular class attendance and successfully created, defended, and submitted seminar paper.

1.8. Monitoring the students' work

Attending classes	2.0	Activity during classes		Seminar paper	3.0	Experimental work	
Written exam		Oral exam	1.0	Essay		Research	
Project		Continuous knowledge testing		Paper		Practical work	
Portfolio							

1.9. Grading and evaluating the student's activities during classes and at the final exam

STUDENT ACTIVITY *	ECTS	LEARNING OUTCOME **	ACADEMIC ACTIVITY	EVALUATION METHOD	CREDITS	
					min	max
Attending classes	2.0	1, 2, 3, 4	Lectures	Keeping attendance records	0	0
Writing a seminar paper	3.0	1, 2, 3, 4	Seminar paper	Reviewing and grading seminar papers	0	75
Answering oral questions	1.0	1, 2, 3, 4	Oral exam	Evaluating answers	0	25

1.10. Mandatory reading (at the moment of application of the study programme proposal)

- **Bjelanović, A., Rajčić, V.: Drvene konstrukcije prema europskim normama (Wooden Structures According to European Norms), Hrvatska sveučilišna naklada, Zagreb, 2005. (II edition 2007.)**
- **Francois Colling: HOLZBAU (Grundlagen und Bemessung nach EC 5), Springer Vieweg, 4. Auflage 2014**
- **Francois Colling: HOLZBAU - BEISPIELE (Musterlösungen und Bemessungstabellen nach EC 5), Springer Vieweg, 4. Auflage 2014**
- **Klausjürgen Becker, Karl Rautenstrauch: Ingenieurholzbau nac Eurocode 5 (Konstruktion, Berechnung, Ausführung), Ernst&Sohn, 2014.**

1.11. Additional reading (at the moment of application of the study programme proposal)

- HRN EN 1995
- HRN EN 1993
- HRN EN 1991
- HRN EN 1990

1.12. Number of copies of the required reading in relation to the number of students currently attending classes at the course

Title	Number of copies	Number of students
Bjelanović, A., Rajčić, V.: Drvene konstrukcije prema europskim normama (Wooden Structures According to European Norms), Hrvatska sveučilišna naklada, Zagreb, 2005. (II edition 2007.)	19	
Francois Colling: HOLZBAU (Grundlagen und Bemessung nach EC 5), Springer Vieweg, 4. Auflage 2014	1	
Francois Colling: HOLZBAU - BEISPIELE (Musterlösungen und Bemessungstabellen nach EC 5), Springer Vieweg, 4. Auflage 2014	1	
Klausjürgen Becker, Karl Rautenstrauch: Ingenieurholzbau nac Eurocode 5 (Konstruktion, Berechnung, Ausführung), Ernst&Sohn, 2014.	1	

1.13. Methods for monitoring quality which ensure the acquisition of the resulting knowledge, skills, and competencies	

The activity of the students is monitored by keeping lecture attendance records, by evaluating the students' activity during classes, and by evaluating their effort during the creation of the seminar paper.

General information

Course teacher	**prof.dr.sc. Damir Markulak**	
Course title	**Steel and Composite Structures Modelling**	
Study programme	**Postgraduate University Study Programme Civil Engineering**	
Course status	Elective course in the module Load-Bearing Structures	
Year	I	
Acquired credits and the form of implementing academic activities	ECTS coefficient of the student academic load	6.0
	Number of classes (lectures (L)+exercises (E)+seminars (S))	30+0+30

1. COURSE DESCRIPTION

1.1. Course goals

The goal of the course is training the students to analyse the significant characteristics of steel and composite structures which have a significant effect on their behaviour and regarding that, teaching them about the methods for considering those characteristics during experimental testing, modelling, and structural design ~~calculations~~. The students will then be able to use numerical models of varying complexity which are adapted to the main ~~ultimate~~ purpose of calculations from various aspects – structural modelling, the effects of global and local stability issues, behaviour of joints, nature of the effect of loads, and similar.

1.2. Preconditions for taking the course

There are no preconditions.

1.3. Expected learning outcomes for the course

1. **Analysing the significant characteristics of steel and composite structures which are relevant for defining numerical models**
2. **Modelling the behaviour of the structure, parts of the structure, or joints ~~attachments~~ in steel or composite structures numerically and/or experimentally**
3. **Evaluating the accuracy of specific design ~~calculation~~ models for describing the actual behaviour of steel and composite structures**
4. **Selecting the appropriate design method ~~of calculation~~ or the appropriate complexity of the numerical model, depending on the purpose of the design ~~calculation~~**

1.4. Course content

Significant characteristics of steel and composite structures which are relevant for design ~~calculating~~ and defining the appropriate numerical models. Material models for application in calculations of steel and composite structures. Classification and modelling of frame~~work~~ systems – the application of first and second order theory. Modelling the global and local imperfections of a structure and its elements. Selecting the appropriate method for design of ~~calculating~~ frame~~work~~ structures. Applying the elasticity and plasticity theory in calculations. Classification, modelling, and calculation of joints ~~attachments~~ in steel and composite structures. Modern software suites for the calculation of steel and composite structures. Numerical modelling of steel and composite structures exposed to various types of variable and accidental action effects. ~~related to their use and extraordinary effects~~.

1.5. Types of academic activities	☒ lectures	☒ independent tasks ☐ multimedia and web

		☒ seminars and workshops ☐ exercises ☐ remote education ☐ field classes	☐ laboratory ☐ mentorship ☐ other _____

1.6. Comments:	No comments

1.7. Students' obligations

Regular class and consultation attendance and completing specific tasks (independent tasks), and the seminar paper.

1.8. Monitoring the students' work

Attending classes	1	Activity during classes		Seminar paper	3.5	Experimental work	
Written exam		Oral exam	1.5	Essay		Research	
Project		Continuous knowledge testing		Paper		Practical work	
Portfolio							

1.9. Grading and evaluating the student's activities during classes and at the final exam

STUDENT ACTIVITY *	ECTS	LEARNING OUTCOME **	ACADEMIC ACTIVITY	EVALUATION METHOD	CREDITS	
					min	max
Attending classes and appearing for consultations	1	1,2,3	Lectures - consulting	Keeping attendance records or tracking consultation appearances		5
Independent solving of small-scale tasks	1	1,2,3,4	Tasks for independent work	Reviewing and grading homework		20
Creating a seminar paper	2.5	1,2,3,4	Seminar paper	Reviewing and grading seminar papers		50
Answering oral questions	1.5	1,2,3	Oral exam	Evaluating answers		25

1.10. Mandatory reading (at the moment of application of the study programme proposal)

- **D. Dujmović, B. Androić, I. Džeba: Modeliranje konstrukcija prema Eurocode 3 (Structure Modelling According to Eurocode 3), IA projektiranje, Zagreb, 2004.**
- **D. Dujmović, B. Androić, I. Lukačević: Primjeri proračuna spregnutih konstrukcija prema Eurocode 4 (Examples of Composite Structure Calculations According to Eurocode 4), IA Projektiranje, Zagreb, 2014.**
- **P. Vellasco and all: Modelling Steel and Composite Structures, Butterworth-Heinemann, 2017**

- **Groups of standards for the calculation of steel (HRN EN 1993) and composite structures (HRN EN 1994)**

1.11. Additional reading (at the moment of application of the study programme proposal)

- L. S. da Silva, R. Simoes, H. Gervasio: Design of Steel Structures, ECCS Eurocode Design Manuals, Ernst&Sohn, 2010
- D. Beg, U. Kuhlmann, L. Davaine, B. Braun: Design of plated structures, ECCS Eurocode Design Manuals, Ernst&Sohn, 2010
- Markulak, D.: Posebna poglavlja čeličnih konstrukcija (Special Chapters of Steel Structures), GF Osijek, Osijek 2010

1.12. Number of copies of the required reading in relation to the number of students currently attending classes at the course

Title	Number of copies	Number of students
D. Dujmović, B. Androić, I. Džeba: Modeliranje konstrukcija prema Eurocode 3 (Structure Modelling According to Eurocode 3), IA projektiranje, Zagreb, 2004.	7	
D. Dujmović, B. Androić, I. Lukačević: Primjeri proračuna spregnutih konstrukcija prema Eurocode 4 (Examples of Composite Structure Calculations According to Eurocode 4), IA Projektiranje, Zagreb, 2014.	5	
P. Vellasco and all: Modelling Steel and Composite Structures, Butterworth-Heinemann, 2017	2	
Skupine normi za proračun čeličnih (HRN EN 1993) i spregnutih konstrukcija (HRN EN 1994) (Groups of standards for the calculation of steel (HRN EN 1993) and composite structures (HRN EN 1994))	1	

1.13. Methods for monitoring quality which ensure the acquisition of the resulting knowledge, skills, and competencies

The students' activity is monitored by keeping lecture and consultation attendance records, quality and accuracy of the created independent tasks and the seminar paper, and the discussions when those papers are submitted.

General information

Course teacher	**Prof.dr.sc. Ivanka Netinger Grubeša** **Izv.prof.dr.sc. Ivana Miličević**	
Course title	**Theory of Structure Durability**	
Study programme	**Postgraduate University Study Programme Civil Engineering**	
Course status	Elective course in the module Load-Bearing Structures	
Year	I	
Acquired credits and the form of implementing academic activities	ECTS coefficient of the student academic load	6.0
	Number of classes (lectures (L)+exercises (E)+seminars (S))	30+0+30

1. COURSE DESCRIPTION

1.1. Course goals

Advancing the knowledge in the area od designing structures which are exposed to aggressive activities of the environment. Reducing the damage caused to buildings and to the entire economy by applying measures for the protection of structures.

1.2. Preconditions for taking the course

There are no preconditions.

1.3. Expected learning outcomes for the course

1. Estimating the effects of environmental factors (extreme temperatures, fire, moisture, chemical and electrochemical effects, biological effects, and accidental mechanical effects) on a structure;
2. Relating the structure and the properties of materials;
3. Creating the method for the numerical modelling of processes and the resistance of materials/structure;
4. Recommending the method for repairing the structure, depending on the level of degradation

1.4. Course content

Basic classification of structures according to their intended use, their structural system, and the material used in their construction. The level of environmental effects may cause damage to the material which can jeopardise the durability of the structure over time. By ensuring the durability of the structure, we are ensuring its usability, but we are also affecting its load-bearing capacity. The level of jeopardy for the durability of the structure caused by the created damage will depend on the material and on the type of activity. In order to perform the appropriate engineering estimate, it is necessary to be familiar with: 1) environmental effects on the structure: extreme temperatures, fire, moisture, chemical and electrochemical effects, biological effects, and accidental mechanical effects, 2) correlation of the structure and the properties of materials, 3) mechanisms of transitional processes, 4) testing methods regarding the durability properties of materials, 5) the effect of defects on the properties of the materials and the structure, 6) numerical modelling of processes and the resistance of the materials 7) protection systems depending on the structural materials 8) repairing structures.

1.5. Types of academic activities	☒ lectures ☒ seminars and workshops ☐ exercises ☐ remote education ☐ field classes	☐ independent tasks ☐ multimedia and web ☐ laboratory ☐ mentorship ☐ other _____

1.6. Comments	No comments

1.7. Students' obligations

Regular class attendance and creating the seminar paper.

1.8. Monitoring the students' work

Attending classes	0.5	Activity during classes		Seminar paper	3.5	Experimental work	
Written exam		Oral exam	2.0	Essay		Research	
Project		Continuous knowledge testing		Paper		Practical work	

Portfolio								

1.9. Grading and evaluating the student's activities during classes and at the final exam

STUDENT ACTIVITY *	ECTS	LEARNING OUTCOME **	ACADEMIC ACTIVITY	EVALUATION METHOD	CREDITS	
					min	max
Attending classes	0.5	1,2,3,4	Lectures	Keeping attendance records	0	0
Writing a seminar paper	3.5	1,2,3,4	Seminar paper	Reviewing and grading seminar papers	0	70
Answering oral questions	2.0	1,2,3,4	Oral exam	Evaluating the provided answers	0	30

1.10. Mandatory reading (at the moment of application of the study programme proposal)

- **Kefei Li, Durability: Design of Concrete Structures: Phenomena, Modeling, and Practice, Wiley, 2017.**
- **Vladimír Křístek, Pavel Manas and Alexander N. Kravcov: Safety and Durability of Buildings and Structures, Scientific.Net, 2015.**

1.11. Additional reading (at the moment of application of the study programme proposal)

- Zongjin Li: Advanced Concrete Technology, John Wiley & Sons, 2011.
- John Bull: Durability of Materials and Structures in Building and Civil Engineering, Whittles Publishing, 2006.
- Jan Bijen: Durability of Engineering Structures - Design, Repair and Maintenance, Woodhead Publishing, 2003.
- Roberge R. Pierre: Handbook of Corrosion Engineering, McGraw Hill Books, New York, 1999.
- David Doran, Bob Cather: Construction materials Reference Book, Butterworth-Heinemann Ltd, Oxford, 1995.
- Lyall Addleson, Colin Rice: Performance of Materials in Buildings, Butterworth-Heinemann Ltd, Oxford, 1995.
- S.N. Alekseev, F.M. Ivanov, S. Modry, P. Schiessel: Durability of Reinforced Concrete in Aggressive Media, A.A. Balkema-Rotterdam-Brookfield, USA, 1993.

1.12. Number of copies of the required reading in relation to the number of students currently attending classes at the course

Title	Number of copies	Number of students
Kefei Li, Durability: Design of Concrete Structures: Phenomena, Modeling, and Practice, Wiley, 2017.	1	1
Vladimír Křístek, Pavel Manas and Alexander N. Kravcov: Safety and Durability of Buildings and Structures, Scientific.Net, 2015.	1	1

1.13. Methods for monitoring quality which ensure the acquisition of the resulting knowledge, skills, and competencies

The activity of the students is monitored by keeping lecture attendance records and by evaluating their effort during the creation of the seminar paper.

General information	
Course teacher	**izv.prof.dr.sc. Ivan Radić**
Course title	**Fatigue of Steel Structures**

Study programme	**Postgraduate University Study Programme Civil Engineering**	
Course status	Elective course in the module Load-Bearing Structures	
Year	I	
Acquired credits and the form of implementing academic activities	ECTS coefficient of the student academic load	6.0
	Number of classes (lectures (L)+exercises (E)+seminars (S))	30+0+30

1. COURSE DESCRIPTION

1.1. Course goals
Acquiring the knowledge and skills for evaluating the service life of a structure from the aspect of material fatigue; recognising the potential critical location in a structure and measures for avoiding brittle fracture; improving the performances of a structure due to fatigue.

1.2. Preconditions for taking the course
There are no preconditions.

1.3. Expected learning outcomes for the course
1. Evaluating the necessity of fatigue analysis as the basis for structural design **2. Calculating the nominal stress differences in estimating fatigue** **3. Constructing the fatigue strength curve** **4. Estimating the service life of a structure from the aspect of material fatigue**

1.4. Course content
Basic concepts and definitions in the analysis of material fatigue. The appearance of fatigue and the existing analysis concepts. Methods for evaluating fatigue – allowed damage method, safe service life method. Stresses caused by the effects of fatigue. Stress calculation – nominal normal and shearing stress. Calculation values: differences in nominal stress, altered differences in nominal stress, differences in stress for welded attachments, differences in stress due to the geometric shape. Fatigue strength – fatigue strength curve, detail category. Determining the parameters of fatigue stress and verification methods – determining the cases of stress, detail stress history, counting cycles, the stress difference spectrum, methods for verifying stress on the basis of accumulated damage and on the basis of the difference in stress.

1.5. Types of academic activities	☒ lectures ☐ independent tasks ☒ seminars ☐ multimedia and and workshops web ☐ exercises ☐ laboratory ☐ remote ☐ mentorship education ☐ other ☐ field classes _____

1.6. Comments	No comments

1.7. Students' obligations
Regular class attendance and creating the seminar paper.

1.8. Monitoring the students' work

Attending classes	1.0	Activity during classes		Seminar paper	4.0	Experimental work	
Written exam		Oral exam	1.0	Essay		Research	

Project		Continuous knowledge testing		Paper		Practical work	
Portfolio							

1.9. Grading and evaluating the student's activities during classes and at the final exam

STUDENT ACTIVITY *	ECTS	LEARNING OUTCOME **	ACADEMIC ACTIVITY	EVALUATION METHOD	CREDITS	
					min	max
Attending classes	0.5	1, 2, 3, 4	Lectures	Keeping attendance records	0	0
Writing a seminar paper	4.0	1, 2, 3, 4	Seminar paper	Reviewing and grading seminar papers	0	70
Answering oral questions	1.5	1, 2, 3, 4	Oral exam	Evaluating answers	0	30

1.10. Mandatory reading (at the moment of application of the study programme proposal)

- **Alain Nussbaumer, Luis Borges, Laurence Davaine. Fatigue design of steel and composite structures: Eurocode 3: Design of steel structures, part 1-9 fatigue; Eurocode 4: Design of composite steel and concrete structures. John Wiley & Sons, 2012.**
- **HRN EN 1993-1-9:2014 - Eurocode 3: Design of steel structures -- Part 1-9: Fatigue**

1.11. Additional reading (at the moment of application of the study programme proposal)

- B. Androić, D. Dujmović, I. Džeba. Metalne konstrukcije 4 (Metal Structures 4), IA projektiranje, Zagreb, 2003.
- D. Markulak. Čelične konstrukcije (Steel Structures) – internal textbook – part 1, Faculty of Civil Engineering Osijek, 2004.

1.12. Number of copies of the required reading in relation to the number of students currently attending classes at the course

Title	Number of copies	Number of students
Alain Nussbaumer, Luis Borges, Laurence Davaine. Fatigue design of steel and composite structures: Eurocode 3: Design of steel structures, part 1-9 fatigue; Eurocode 4: Design of composite steel and concrete structures. John Wiley & Sons, 2012.	0	
HRN EN 1993-1-9:2014 - Eurocode 3: Design of steel structures -- Part 1-9: Fatigue	0	

1.13. Methods for monitoring quality which ensure the acquisition of the resulting knowledge, skills, and competencies

The activity of the students is monitored by keeping lecture attendance records, by evaluating the students' efforts in the creation of the seminar paper, and by evaluating their knowledge at the oral exam.

General information

Course teacher	**Izv. prof. dr. sc. Hrvoje Draganić, dipl. ing. građ.**
Course title	**Blast Load Effects on Structures**
Study programme	**Postgraduate University Study Programme Civil Engineering**
Course status	Elective course in the module Load-Bearing Structures
Year	I

Acquired credits and the form of implementing academic activities	ECTS coefficient of the student academic load	6.0
	Number of classes (lectures (L)+exercises (E)+seminars (S))	30+0+30

1. COURSE DESCRIPTION

1.1. Course goals

Familiarising the students with the problems, standards, and calculation methods in designing structures that are resilient to explosive effects. Mastering the available engineering methods for the calculation of stress caused by explosions and the dynamic response of the structure. Acquiring knowledge about the explosive resistance criteria of structures. Learning the methods for modelling the effects of an explosion and the damage caused to structural elements and the entire structure. Mastering the use of sensors for measuring basic blast load parameters to successfully conduct experimental testing.

1.2. Preconditions for taking the course

There are no preconditions.

1.3. Expected learning outcomes for the course

1) **Evaluating the stress levels due to the effects of an explosion.**
2) **Creating a numerical model to simulate blast load effects on a structure.**
3) **Planning an experiment involving the measurement of the basic blast load parameters.**
4) **Evaluating the damage (condition) of a structural element or the entire structure.**
5) **Verifying the results obtained from numerical simulations.**

1.4. Course content

Resistance criteria of structural elements to the effects of an explosion; Calculation of blast loaded structural elements; Numerical modelling of blast load; Numerical modelling of blast load responses and damage at the element and at the entire structure level; Dynamic increase factor of material characteristics; Experimental measurement of blast load parameters; The relation of earthquake and blast load resistance (the resistance of earthquake designed structures to blast load effects); Safety of structures: safety facade, safety distance, designing details, element strengthening.

1.5. Types of academic activities	☒ lectures ☒ seminars and workshops ☐ exercises ☐ remote education ☐ field classes	☐ independent tasks ☐ multimedia and web ☒ laboratory ☐ mentorship ☐ other _____
1.6. Comments	**No.**	

1.7. Students' obligations

The students must actively participate in the academic process (lectures, seminars, and laboratory exercises), which includes regular class attendance, and the students are expected to present their positions with arguments

during discussions related to specific topics taught, to solve problems posed at the laboratory exercises, and keep up with current literature. The students also must write and present a seminar paper.

1.8. Monitoring the students' work						
Attending classes	0.5	Activity during classes	0.0	Seminar paper	4.0	Experimental work	1.0
Written exam		Oral exam	0.5	Essay		Research	
Project		Continuous knowledge testing		Paper		Practical work	
Portfolio							

1.9. Grading and evaluating the student's activities during classes and at the final exam

STUDENT ACTIVITY *	ECTS	LEARNING OUTCOME **	ACADEMIC ACTIVITY	EVALUATION METHOD	CREDITS	
					min	max
Attending classes and activity during classes (lectures, seminars and laboratory exercises)	0.5	1), 2), 3)	Lectures and discussion with students regarding the lecture topic.	Attending classes and activity during classes – a written summary with key points of the discussion, notes from laboratory practice.	0	0
Answering oral questions	0.5	1), 2), 3)	Oral exam	Evaluating answers	0	10
Seminar paper	4.0	1), 2), 3), 4), 5)	Independently creating a written seminar paper, presentation, defence, and answering questions.	Matching the content to the title of the seminar paper, properly citing sources from literature.	0	70
Experimental work	1.0	1), 2), 3), 4), 5)	Laboratory work – demonstrating the function of the measuring devices and numerical analyses in computer programs.	A summary description of the practical task as part of the experimental testing report.	0	20
				Total:	0	100

1.10. Mandatory reading (at the moment of application of the study programme proposal)

- **Structures to Resist the Effects of Accidental Explosions, Technical Manual TM 5-1300. US Army, Navy and Air Force. Washington DC: US Government Printing Office; 1990.**
- **Mays, Geoffrey, Peter Desmond Smith, and Peter D. Smith, eds. Blast effects on buildings: Design of buildings to optimize resistance to blast loading. Thomas Telford, 1995.**
- **Dusenberry, Donald O., ed. Handbook for blast resistant design of buildings. John Wiley & Sons, 2010.**

1.11. Additional reading (at the moment of application of the study programme proposal)

- Syngellakis, S. Design Against Blast: Load Definition & Structural Response. Vol. 11. WIT Press, 2013.
- Hetherington, John, and Peter Smith. Blast and ballistic loading of structures. CRC Press, 2014.

- Su, Yu. Numerical simulation of strengthened unreinforced masonry (URM) walls by new retrofitting technologies for blast loading. Diss. 2009.
- National Research Council. Protecting buildings from bomb damage: Transfer of blast-effects mitigation technologies from military to civilian applications. National Academies Press, 1995.
- ANSYS, I. "ANSYS Autodyn user's manual (Release 15.0). ANSYS." (2013).

1.12. Number of copies of the required reading in relation to the number of students currently attending classes at the course

Title	Number of copies	Number of students
Dusenberry, Donald O., ed. Handbook for blast resistant design of buildings. John Wiley & Sons, 2010.	1	

1.13. Methods for monitoring quality which ensure the acquisition of the resulting knowledge, skills, and competencies

Quality is monitored in several stages. In the first stage, the preparation of academic materials is monitored by reviewing the list of current literature and the teaching materials based on the studied literature, which presents current knowledge from the relevant area. In the second stage of the academic process, the quality is ensured by continuous communication with the students and by verifying the realization of the planned learning outcomes. In the third stage, after the academic process is complete, the quality of the implemented classes and the activity of the students is controlled by conducting the student survey and reviewing the results of the students' papers. After receiving feedback from the students on the quality of the implemented classes, an analysis is conducted, which is followed by the proposal for improving certain elements of the academic process.

General information

Course teacher	**Izv. prof. dr. sc. Damir Varevac, dipl. ing. grad.**
Course title	**Special Chapters of Concrete and Masonry Structures**
Study programme	**Postgraduate University Study Programme Civil Engineering**
Course status	Elective course in the module Load-Bearing Structures
Year	I
Acquired credits and the form of implementing academic activities	ECTS coefficient of the student academic load	6.0
	Number of classes (lectures (L)+exercises (E)+seminars (S))	30+30+0

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1. COURSE DESCRIPTION

1.1. Course goals

The goal of the course is training students to be able to analyse non-typical reinforced concrete elements and masonry elements. The students will acquire the knowledge required to complete a detailed analysis of the load-bearing capacity and usability of a structure and its elements by gaining deeper insight into the behaviour of reinforced concrete as a material. By knowing about the material characteristics of reinforced concrete, the students will be able to apply advanced calculation methods, which include the plasticity theory and the non-linear behaviour of the composite concrete – reinforcement.

1.2. Preconditions for taking the course

There are no preconditions.

1.3. Expected learning outcomes for the course

1. Selecting the material model which is suitable for the specific circumstances
2. Analysing the stress state and evaluating the behaviour of the structural element

3. Comparing and evaluating common calculation methods and advanced non-linear calculations
4. Formulating a specific problem using accurate and approximate calculation methods and evaluating results

1.4. *Course content*	

Analysing hollow cross-sections under the conditions of complex stress states (bending with and without horizontal force and torsion), redistribution of internal forces on statically unspecified beams, behaviour, calculation, and reinforcement of variable height beams and beams with openings, calculation and reinforcement of the reinforced concrete wall beams, the strut-and-tie method of calculating internal forces, shear between the flange and girder, constituent models of concrete (uniaxial, biaxial, and triaxial), non-linear analysis of reinforced concrete elements, calculations according to the plasticity theory, high-strength concrete, calculation of the elements made of special fibre-reinforced concrete, polymer reinforcements, prestressed masonry – modelling and calculation.

1.5. *Types of academic activities*	☒ lectures ☒ seminars and workshops ☐ exercises ☐ remote education ☐ field classes	☒ independent tasks ☐ multimedia and web ☐ laboratory ☒ mentorship ☐ other _____

1.6. *Comments*	No comments

1.7. *Students' obligations*

Regular class and consultation attendance, and creating the seminar paper.

1.8. *Monitoring the students' work*

Attending classes	1	Activity during classes		Seminar paper	4	Experimental work	
Written exam		Oral exam	1	Essay		Research	
Project		Continuous knowledge testing		Paper		Practical work	
Portfolio							

1.9. *Grading and evaluating the student's activities during classes and at the final exam*

STUDENT ACTIVITY *	ECTS	LEARNING OUTCOME **	ACADEMIC ACTIVITY	EVALUATION METHOD	CREDITS	
					min	max
Attending classes and regular consultations	1	1, 2, 4	Ex cathedra lectures, individual work with students	Keeping attendance records		20
Creating a seminar paper	4	1, 2, 3, 4	Independent work with regular consultations	Grading the seminar paper with a comprehension test		60
Defending the seminar paper	1	1, 2, 3, 4	Oral exam	Evaluating comprehension and knowledge		20

1.10. Mandatory reading (at the moment of application of the study programme proposal)

- **M. P. Nielsen: Limit Analysis and Concrete Plasticity, CRC Press 1998.**
- **Z. Sorić, T. Kišiček: Betonske konstrukcije I (Concrete Structures I), University of Zagreb, Faculty of Civil Engineering, 2014**
- **Z. Sorić, T. Kišiček: Betonske konstrukcije II (Concrete Structures II), University of Zagreb, Faculty of Civil Engineering, 2018**
- **HRN EN 1992 Designing concrete structures**

1.11. Additional reading (at the moment of application of the study programme proposal)

- J. Meyboom: Limit Analysis of Reinforced Concrete Slabs, Institut fur Baustatik und Konstruktion ETH Zurich, 2002.
- P. C. Varghese: Advanced Reinforced Concrete Design, PHI Learning 2011.

1.12. Number of copies of the required reading in relation to the number of students currently attending classes at the course

Title	Number of copies	Number of students
Z. Sorić, T. Kišiček: Betonske konstrukcije I (Concrete Structures I)	26	
Z. Sorić, T. Kišiček: Betonske konstrukcije II (Concrete Structures II)	25	
M. P. Nielsen: Limit Analysis and Concrete Plasticity	1	
HRN EN 1992 Designing concrete structures	1	

1.13. Methods for monitoring quality which ensure the acquisition of the resulting knowledge, skills, and competencies

The activity of the students is monitored by evaluating their activity during classes, their understanding of the problems, and the quality of the created seminar paper which should result in publishing a scientific paper.

* Every student activity/academic activity should be assigned with the appropriate share of ECTS credits for individual activities, so that the total number of ECTS credits match the credit value of the course.

** This column should contain the learning outcomes from item 1.3 which have been included in this student/teacher activity.

ELECTIVE COURSES IN THE MODULE ORGANISATION, TECHNOLOGY AND MANAGEMENT

General information

Course teacher	**Prof.dr.sc. Ksenija Čulo, dipl.oec.**	
Course title	**Economic Aspects of Investment Projects**	
Study programme	**Postgraduate University Study Programme Civil Engineering**	
Course status	Elective course in the module Organisation, Technology and Management	
Year	I	
Acquired credits and the form of implementing academic activities	ECTS coefficient of the student academic load	6.0
	Number of classes (lectures (L)+exercises (E)+seminars (S))	30+0+30

1. COURSE DESCRIPTION

1.1. Course goals

Adopting interdisciplinary knowledge with the purpose of making optimal decisions regarding investments in projects. Adopting the methods for the selection of the optimal variant of an investment project as part of the cost and benefit analysis (CBA), by utilising dynamic and static methods. Application of the appropriate methods in the creation of investment studies. The ultimate goal is developing the ability to make correct decisions based on the analysis of economic features of an investment project.

1.2. Preconditions for taking the course

There are no preconditions.

1.3. Expected learning outcomes for the course

1. **Interpreting quality information which is relevant for making investment decisions.**
2. **Identifying and analysing investment risks.**
3. **Evaluating and recommending the value scale of all the assets invested in a project by appearance**
4. **Developing approaches to decision-making with reference to the use static and dynamic models.**

1.4. Course content

Fixed and current assets, total capital (amortization, revalorisation, average value of fixed assets; calculating the total capital). Indicators for the economic monitoring of the production process (productivity, rate of return, cost-effectiveness, liquidity, comparing indicators). Financing investment projects (sources, structure, dynamics, guarantees). Project-based financing of infrastructure projects. Threshold and limit of the rate of return. Functions of costs and revenue (standard and linear cost function, forming the market price, linear revenue function). Evaluating and planning projects costs. Cost-benefit analysis (cost-benefit analysis - CBA). Static and dynamic methods. Rate of return method. Net present value method. Expected net present value method. Internal rate of return method. Methods for the analysis and comparison of costs. Methods for comparing profit (reducing to the net present value). Methods for comparing the rate of return (internal rate of return). Methods for comparing the rate of return periods. Sensitivity analysis. Project control through the control of costs (S-curve and EVA). Project risks. Qualitative and quantitative risk analysis methods. Risk management.

1.5. Types of academic activities	☒ lectures ☒ seminars and workshops ☐ exercises ☐ remote education ☐ field classes	☒ independent tasks ☐ multimedia and web ☐ laboratory ☐ mentorship ☐ other _____

1.6. Comments		No.

1.7. Students' obligations

Independently creating a study with the assigned topic, and in the process, they should display the ability to apply economic principles in making investment decisions with the purpose of satisfying the principles of cost-efficiency and efficiency.

1.8. Monitoring the students' work

Attending classes	0.2	Activity during classes	0.2	Seminar paper	3.6	Experimental work	
Written exam		Oral exam	2.0	Essay		Research	
Project		Continuous knowledge testing		Paper		Practical work	
Portfolio							

1.9. Grading and evaluating the student's activities during classes and at the final exam

STUDENT ACTIVITY *	ECTS	LEARNING OUTCOME **	ACADEMIC ACTIVITY	EVALUATION METHOD	CREDITS	
					min	max
Attending classes	0.2	1,2,3,4	Lectures	Keeping attendance records	0	0
Working in groups	0.2	1,2,3	Lectures and workshops	Analysing the students' results	0	20
Writing a seminar paper	3.6	1,2,3	Seminar paper	Reviewing and grading seminar papers	0	35
Answering oral questions	2	1,2,3,4	Oral exam	Evaluating the students' answers	0	45

1.10. Mandatory reading (at the moment of application of the study programme proposal)

1. **Čulo, K (2010).: Ekonomika investicijskih projekata (Economy of Investment Projects), J.J. Strossmayer University, Osijek.**
2. **Guide to Cost Benefit Analysis of Investment Project, European Commission (2014), https://ec.europa.eu/inea/sites/inea/files/cba_guide_cohesion_policy.pdf (25.3.2019.).**
3. **Boromisa, A (2016).: Od troškova do koristi / Analiza troškova i koristi u pripremi projekta (From Costs to Benefits / Cost and Benefit Analysis in Project Preparation), Alinea, Zagreb.**

1.11. Additional reading (at the moment of application of the study programme proposal)

1. Van Horne, J.C., Wachowicz, J.M.Jr (2002).: Osnove financijskog menedžmenta (Fundamentals of Financial Management), Mate, Zagreb.

1.12. Number of copies of the required reading in relation to the number of students currently attending classes at the course

Title	Number of copies	Number of students
Economy of Investment Projects	10	5
Guide to Cost Benefit Analysis of Investment	online	5

Project		
From Costs to Benefits / Cost and Benefit Analysis in Project Preparation	1	5

1.13. Methods for monitoring quality which ensure the acquisition of the resulting knowledge, skills, and competencies

Quality is monitored through the following aspects:
1. **Validation of learning outcomes – by regularly gathering feedback from students regarding the achievement of planned learning outcomes, through various student surveys.**
2. **Study programme verification according to the learning outcomes – the analysis encompasses learning outcomes, methods for the presentation of learning materials and the quality of knowledge tests, and the students' academic load regarding the stated.**

General information

Course teacher	**Prof.dr.sc. Saša Marenjak, dipl.ing.građ.**	
Course title	**Maintenance Management of Buildings**	
Study programme	**Postgraduate University Study Programme Civil Engineering**	
Course status	Elective course in the module Organisation, Technology and Management	
Year	I	
Acquired credits and the form of implementing academic activities	ECTS coefficient of the student academic load	6.0
	Number of classes (lectures (L)+exercises (E)+seminars (S))	30+20+10

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1. COURSE DESCRIPTION

1.1. Course goals

Presenting the relevant categories of maintenance management of buildings, planning the activities and costs of maintenance management of buildings. Defining the areas of applicability, benefits, limitations, and sensitivity for the mentioned categories and costs.

1.2. Preconditions for taking the course

There are no preconditions.

1.3. Expected learning outcomes for the course

After passing the exam, the students will be able to:
1. **Independently design a maintenance management of buildings plan.**
2. **Select an appropriate strategy and define the activities related to maintenance management of buildings, solve a problem, generate a plan, and define the management costs.**
3. **Create a comparative analysis and a sensitivity analysis of feasible and optimal solutions for maintenance management of buildings.**

1.4. Course content

Basic principles of maintenance management of buildings, theory and practice. Role of the maintenance manager. Management, maintenance and use of buildings. The significance of buildings design for the quality of maintenance management of buildings. Cost and revenue optimisation in maintenance management of buildings. Risks in maintenance management of buildings. Methods and techniques in maintenance management of buildings (FMEA, RCM, ILS). Parameters for cost optimisation of maintenance management of buildings, calculation of the cost-optimal variant.

1.5. Types of academic activities	☒ lectures	☒ independent tasks
	☒ seminars and	☒ multimedia and

					workshops ☐ exercises ⊠ remote education ☐ field classes	web ☐ laboratory ⊠ mentorship ☐ other _____

1.6. Comments	The lectures and exercises will be held if the (formally set) minimum number of students enrol for the course, otherwise the classes will be held through consultations (individually) with students.

1.7. Students' obligations

Seminar paper, research and overview of the status in the area, repeating the examples from literature and solving examples from the real sector and disseminating the conclusions in the form of a scientific paper.

1.8. Monitoring the students' work

Attending classes	0	Activity during classes	0	Seminar paper	4.0	Experimental work	0
Written exam		Oral exam	1.0	Essay		Research	1.0
Project		Continuous knowledge testing		Paper		Practical work	
Portfolio							

1.9. Grading and evaluating the student's activities during classes and at the final exam

STUDENT ACTIVITY *	ECTS	LEARNING OUTCOME **	ACADEMIC ACTIVITY	EVALUATION METHOD	CREDITS	
					min	max
Writing a seminar paper	4.0	1, 2, 3	Seminar paper	Reviewing and grading the seminar paper	0	70
Research	1.0	1, 2, 3	Scientific (review) paper	Relevance of the overview of the status of achievements in the area of research	0	15
Oral exam	1.0	1,2,3,	Oral exam	Comprehension and interpretation	0	15

1.10. Mandatory reading (at the moment of application of the study programme proposal)

CIRIA, Facilities management manuals – a best practice guide, London, 2002.

1.11. Additional reading (at the moment of application of the study programme proposal)

Spedding A. CIOB Handbook of Facilities Management, Longman Scientific &Technical, 1994
Williams B., Facilities Economics, Building Economics Bureau, 2002.

1.12. Number of copies of the required reading in relation to the number of students currently attending classes at the course

Title	Number of copies	Number of students
Facilities management manuals	1	5

1.13. Methods for monitoring quality which ensure the acquisition of the resulting knowledge, skills, and competencies	

Student survey, publishing a scientific paper.

General information

Course teacher	**Doc.dr.sc. Mario Galić, dipl.ing.građ.**	
Course title	**Planning, Modelling and Simulating the Construction Process**	
Study programme	**Postgraduate University Study Programme Civil Engineering**	
Course status	Elective course in the module – Organisation, Technology and Management	
Year	I	
Acquired credits and the form of implementing academic activities	ECTS coefficient of the student academic load	6.0
	Number of classes (lectures (L)+exercises (E)+seminars (S))	30+0+30

1.   COURSE DESCRIPTION

1.1. Course goals	

Demonstrate the relevant models for planning, modelling, and simulating the construction process. Define the areas of applicability, benefits, limitations, and sensitivity for the mentioned models.

1.2. Preconditions for taking the course	

There are no preconditions.

1.3. Expected learning outcomes for the course	

After they pass the exam, the students will be able to:
1. **Independently structure and model a building process problem.**
2. **Select the appropriate method of modelling, problem solving, and generating simulation scenarios of the building process.**
3. **Create a comparative analysis and a sensitivity analysis of feasible and optimal solutions in the building process.**

1.4. Course content	

Methods for planning the time and resources in construction projects (stochastic and deterministic approach). Methods of monitoring, updating, and reporting the process of realisation of construction projects. Mathematical parameters for modelling discrete and quasi-continuous construction projects. Methods for creating dynamic process maps in construction manufacturing. Software for modelling and simulating the construction process (Enterprise Dynamics Software, Simu8, Arena Simulation Software, Matlab). Modelling system reliability in construction processes. Integrating and using data from the Building Information Modelling (BIM) environment. Methods for adding the optimisation results to the BIM model – active BIM. Simulating the construction process in the BIM environment.

1.5. Types of academic activities	☒ lectures ☒ seminars and workshops ☐ exercises ☒ remote education ☐ field classes	☒ independent tasks ☒ multimedia and web ☐ laboratory ☒ mentorship ☐ other _____
1.6. Comments	The lectures and exercises will be held if the (formally set) minimum number of	

				students enrol for the course, otherwise the classes will be held through consultations (individually) with students.

1.7.	*Students' obligations*

Seminar paper, research and overview of the status in the area, repeating the examples from literature and solving examples from the real sector and disseminating the conclusions in the form of a scientific paper.

1.8.	*Monitoring the students' work*

Attending classes	0	Activity during classes	0	Seminar paper	4.0	Experimental work	1.0
Written exam		Oral exam		Essay		Research	1.0
Project		Continuous knowledge testing		Paper		Practical work	
Portfolio							

1.9.	*Grading and evaluating the student's activities during classes and at the final exam*

STUDENT ACTIVITY *	ECTS	LEARNING OUTCOME **	ACADEMIC ACTIVITY	EVALUATION METHOD	CREDITS	
					min	max
Writing a seminar paper	4.0	1, 2, 3	Seminar paper	Reviewing and grading the seminar paper	0	60
Research	1.0	1, 2, 3	Scientific (review) paper	Relevance of the overview of the status of achievements in the area of research	0	20
Experimental work	1.0	1, 2, 3	Simulation model	Reviewing and evaluating the model	0	20

1.10.	*Mandatory reading (at the moment of application of the study programme proposal)*

1) **Mubarak, S. A. (2015). Construction project scheduling and control. 3rd edition, John Wiley & Sons.**
2) **Kerzner, H., & Kerzner, H. R. (2017). Project management: a systems approach to planning, scheduling, and controlling. 12th edition, John Wiley & Sons.**
3) **Radujković, M. (2012) et al.: Planiranje i kontrola projekata (Planning and Controlling Projects). University in Zagreb, Faculty of Civil Engineering, Zagreb.**
4) **Klanšek, U., (2011). Optimizacija v operativnem gradbeništvu. Fakulteta za gradbeništvo, Univerza v Mariboru.**

1.11.	*Additional reading (at the moment of application of the study programme proposal)*

1) Greiner, P., Mayer, P. E., & Stark, K. (2005). Baubetriebslehre-Projektmanagement. 3. Auflage, Springer-Verlag.
2) Melin, P., & Castillo, O. (2001). Modelling, simulation and control of non-linear dynamical systems: an intelligent approach using soft computing and fractal theory. CRC Press.
3) Martí, R., & Reinelt, G. (2011). The linear ordering problem: exact and heuristic methods in combinatorial optimization (Vol. 175). Springer Science & Business Media.
4) Sarjoughian, H. S., & Cellier, F. E. (Eds.). (2013). Discrete event modeling and simulation technologies: a

tapestry of systems and AI-based theories and methodologies. Springer Science & Business Media.
5) Wainer, G. A., & Mosterman, P. J. (2010). Discrete-event modeling and simulation: theory and applications. CRC press.
6) Bangsow, S. (2010). Manufacturing simulation with plant simulation and simtalk: usage and programming with examples and solutions. Springer Science & Business Media.

1.12. Number of copies of the required reading in relation to the number of students currently attending classes at the course

Title	Number of copies	Number of students
Construction project scheduling and control.	Available online	3
Project management: a systems approach to planning, scheduling, and controlling.	Available online	3
Planning and Controlling Projects.	15	3
Optimizacija v operativnem gradbeništvu	10	3

1.13. Methods for monitoring quality which ensure the acquisition of the resulting knowledge, skills, and competencies

Student survey, publishing a scientific paper.

General information

Course teacher	**Prof. dr. sc. Uroš Klanšek**
Course title	**Optimisation of Construction Processes**
Study programme	**Postgraduate University Study Programme Civil Engineering**
Course status	**Elective course in the module – Organisation, Technology and Management**
Year	I

Acquired credits and the form of implementing academic activities	ECTS coefficient of the student academic load	6.0
	Number of classes (lectures (L)+exercises (E)+seminars (S))	30+0+30

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1. COURSE DESCRIPTION

1.1. Course goals

The students will acquire advanced knowledge in the area of construction process optimisation, particularly the methods for exact linear, non-linear, integer, and mixed integer (non)linear mathematical programming.

1.2. Preconditions for taking the course

There are no preconditions.

1.3. Expected learning outcomes for the course

After they pass the exam, the students will be able to:
   1. **Independently formulate various optimisation problems in the construction process,**
   2. **Select the appropriate modelling software and the appropriate algorithm for solving specific optimisation problems,**
   3. **Develop a computer model and solve the selected optimisation problem.**

1.4. Course content

Overview of the modern optimisation methods.
Optimisation criterion. Analysing the optimisation problem. Formulating the optimisation problem. Selecting the optimisation method. Solving the optimisation problem.
Mathematical programming methods. Linear programming, LP. Non-linear programming, NLP. Mixed integer linear programming, MILP. Mixed integer non-linear programming. Modelling optimisation

problems. Sets. Input data: parameters, scalars, tables. Variables. Conditional (inequalities) equations. Target function. Comprehensive, (non)linear and discrete optimisation problems in construction processes: project planning problems, transport problems, routing problems, problems regarding assigning tasks and resources.

1.5. Types of academic activities	☒ lectures ☒ seminars and workshops ☐ exercises ☐ remote education ☐ field classes	☒ independent tasks ☐ multimedia and web ☐ laboratory ☒ mentorship ☐ other _____
1.6. Comments		The lectures and exercises will be held if the (formally set) minimum number of students enrol for the course, otherwise the classes will be held through consultations (individually) with students.

1.7. Students' obligations

Seminar paper, research and overview of the status in the area, repeating the examples from literature and solving examples from the real sector and disseminating the conclusions in the form of a scientific paper.

1.8. Monitoring the students' work

Attending classes	0	Activity during classes	0	Seminar paper	4.0	Experimental work	1.0	
Written exam		Oral exam		Essay		Research	1.0	
Project		Continuous knowledge testing		Paper		Practical work		
Portfolio								

1.9. Grading and evaluating the student's activities during classes and at the final exam

STUDENT ACTIVITY *	ECTS	LEARNING OUTCOME **	ACADEMIC ACTIVITY	EVALUATION METHOD	CREDITS	
					min	max
Writing a seminar paper	4.0	1, 2, 3	Seminar paper	Reviewing and grading seminar papers	0	60
Research	1.0	1, 2, 3	Scientific paper	Relevance of the overview of the status of achievements in the area of research	0	20
Experimental work	1.0	1, 2, 3	Optimisation model	Reviewing and evaluating the model	0	20

1.10. Mandatory reading (at the moment of application of the study programme proposal)

1) **W.L. Winston, Operations Research: Applications and Algorithms, 4th ed., Brooks/Cole, Cengage Learning, 2004.**
2) **R.A. Sarker, C.S. Newton, Optimization Modelling: A Practical Approach, CRC Press, Taylor & Francis Group, 2008.**

| 3) U. Klanšek, Optimizacija v operativnem gradbeništvu, Univerza v Mariboru, Fakulteta za gradbeništvo, 2011. |

1.11. Additional reading (at the moment of application of the study programme proposal)

1) The scientific papers from the area of construction process optimisation are available in databases WoSCC and Scopus.

1.12. Number of copies of the required reading in relation to the number of students currently attending classes at the course

Title	Number of copies	Number of students
Operations Research: Applications and Algorithms	0	0
Optimization Modelling: A Practical Approach	0	0
Optimizacija v operativnem gradbeništvu	10	0

1.13. Methods for monitoring quality which ensure the acquisition of the resulting knowledge, skills, and competencies

Student survey, publishing the scientific paper.

General information

Course teacher	**Izv.prof.dr.sc. Hrvoje Krstić, dipl.ing.građ.**
Course title	**Sustainable Construction Technologies**
Study programme	**Postgraduate University Study Programme Civil Engineering**
Course status	Elective course in the module Organisation, Technology and Management
Year	I
Acquired credits and the form of implementing academic activities	ECTS coefficient of the student academic load	6.0
	Number of classes (lectures (L)+exercises (E)+seminars (S))	30+0+30

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1. COURSE DESCRIPTION

1.1. Course goals

Presenting the technologies for sustainable building construction to the students, as well as the methods for measuring and diagnostic tools for determining the energy characteristics of buildings, with the goal of achieving sustainable development in the area of civil engineering.

1.2. Preconditions for taking the course

There are no preconditions.

1.3. Expected learning outcomes for the course

After passing the exam, the students will be able to:
  1. **Propose the technology for sustainable building construction**
  2. **Estimate the heat gains and losses in buildings**
  3. **Assign value to the use of renewable energy sources in building construction**
  4. **Re-examine the technology for the construction of near zero-energy buildings**
  5. **Select the appropriate diagnostic method for determining the energy characteristics of buildings**

1.4. Course content

The concept of sustainable construction; Introduction to environmental construction; Sustainable building design; New sustainable construction technologies; Architectural-energy and biological-energy demands of modern construction; Technologies for thermal protection of buildings; Thermal gains and

losses in buildings; Evaluation of thermal characteristics of existing buildings; Diagnostics and measurements in building construction for the purpose of determining the energy characteristics of buildings; Non-destructive and destructive methods for testing the thermal properties of buildings; Using renewable sources of energy in building construction; Using solar radiation – active and passive systems; Improving existing buildings for the purpose of rational energy use; Integrated energy renewal in buildings; Cost-optimal analysis of energy renewal; Technologies for constructing near zero-energy buildings; Energy independent buildings.

1.5. Types of academic activities	☒ lectures ☒ seminars and workshops ☐ exercises ☐ remote education ☐ field classes ☐ independent tasks ☐ multimedia and web ☐ laboratory ☐ mentorship ☐ other _____
1.6. Comments	No.

1.7. Students' obligations

Seminar paper, presentation of the paper, and the oral exam.

1.8. Monitoring the students' work

Attending classes	0.20	Activity during classes		Seminar paper	2.80	Experimental work	
Written exam		Oral exam	2.0	Essay		Research	1.0
Project		Continuous knowledge testing		Paper		Practical work	
Portfolio							

1.9. Grading and evaluating the student's activities during classes and at the final exam

STUDENT ACTIVITY *	ECTS	LEARNING OUTCOME **	ACADEMIC ACTIVITY	EVALUATION METHOD	CREDITS	
					min	max
Attending classes	0.20	1,2,3,4,5	Lectures	Keeping attendance records	0	0
Conducting independent research work and writing a research report	1.00	2,4	Research	Reviewing the report on the conducted research	0	20
Writing a seminar paper	2.80	1,2,3,4	Seminar paper	Reviewing and grading the seminar paper	0	45
Answering oral questions	2.00	1,2,3,4,5	Oral exam	Evaluating the provided answers	0	35

1.10. Mandatory reading (at the moment of application of the study programme proposal)

1. Dincer, I., Midilli, A., Kucuk, H. Progress in Sustainable Energy Technologies. Springer International Publishing, 2014.
2. Magrini, A. Building Refurbishment for Energy Performance, A Global Approach. Springer International Publishing, 2014.
3. Fülöp, L., Koški, Ž., Ištoka Otković, I., Krstić, H., Magyar, Z., Španić, M. Istraživanje zrakonepropusnosti prostorija u zgradama sa stajališta potrošnje energije i toplinskog komfora / Air tightness investigation of rooms from the point of view of energy and comfort, Scientific publication of the Project HUHR/1001/2.1.3/0009, Osijek, 2013.
4. Zbašnik Senegačnik, M. Pasivna kuća (Passive House), SUN ARH, 2009.

1.11. Additional reading (at the moment of application of the study programme proposal)

1. Mequignon, M., Ait Haddou, H. Lifetime Environmental Impact of Buildings. Springer International Publishing, 2014.
2. Deakin, M., Campbell, F., Reid, A., Orsinger, J. The Mass Retrofitting of an Energy Efficient—Low Carbon Zone. Springer-Verlag London, 2014.
3. Narbel, P.A., Hansen, J.A., Lien, J.R. Energy Technologies and Economics. Springer, 2014.

1.12. Number of copies of the required reading in relation to the number of students currently attending classes at the course

Title	Number of copies	Number of students
Progress in Sustainable Energy Technologies	0	5
Building Refurbishment for Energy Performance, A Global Approach	0	5
Istraživanje zrakonepropusnosti prostorija u zgradama sa stajališta potrošnje energije i toplinskog komfora / Air tightness investigation of rooms from the point of view of energy and comfort	12	5
Passive House	8	5

1.13. Methods for monitoring quality which ensure the acquisition of the resulting knowledge, skills, and competencies

Oral exam, submitting the research report, and the presentation of the seminar paper.

General information

Course teacher	Izv.prof.dr.sc. Ivana Šandrk Nukić, dipl.oec. Dr.sc. Barbara Medanić, prof. emer.,dipl.oec.
Course title	**Strategic Management**
Study programme	**Postgraduate University Study Programme Civil Engineering**
Course status	Elective course in the module Organisation, Technology and Management
Year	I
Acquired credits and the form of implementing academic activities	ECTS coefficient of the student academic load	6.0
	Number of classes (lectures (L)+exercises (E)+seminars (S))	30+0+30

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1. COURSE DESCRIPTION

1.1. Course goals

Acquiring the concept of a construction company as a system whose realisation of short-term and long-term goals depend on efficient functioning in a constantly changing environment.

1.2. Preconditions for taking the course

There are no preconditions.						

1.3. Expected learning outcomes for the course

After passing the exam, the students will be able to:
1. **Manage the internal environmental factors of a business system**
2. **Evaluate the external environmental factors of a business system**
3. **Formulate the long-term goals of a business system in a dynamic environment**
4. **Assign value to strategic choices/decisions**
5. **Manage the implementation of a strategy for a business system**

1.4. Course content

Fundamental functions of management – planning, organisation, control, leadership, human resource management. The concept of strategy and strategic management. Types of strategy – growth strategies, business strategies (Porter's generic strategies model and the lifecycle model), functional strategies (personnel, production, sales, and others). Internal and external environment strategy. Establishing the vision and mission. SWOT analysis and the BCG matrix as strategies for selecting the strategic goals of a company. Formulating and implementing a strategy. Strategic control.

1.5. Types of academic activities	☒ lectures ☒ seminars and workshops ☐ exercises ☒ remote education ☐ field classes	☒ independent tasks ☒ multimedia and web ☐ laboratory ☒ mentorship ☐ other _____

1.6. Comments	Classes may be held in English.

1.7. Students' obligations

Seminar paper. Essay. Oral exam.

1.8. Monitoring the students' work

Attending classes	0.1	Activity during classes		Seminar paper	1	Experimental work	
Written exam		Oral exam	1.5	Essay	1.5	Research	1.9
Project		Continuous knowledge testing		Paper		Practical work	
Portfolio							

1.9. Grading and evaluating the student's activities during classes and at the final exam

STUDENT ACTIVITY *	ECTS	LEARNING OUTCOME **	ACADEMIC ACTIVITY	EVALUATION METHOD	CREDITS	
					min	max
Attending classes	0.1	1,2,3,4,5	Lectures or consultations	Keeping attendance records	0	0
Writing a seminar paper	2.9	1,2,3,4,5	Mentored written expression	Reading and grading the paper	0	50

Writing an essay (3000 words)	1.5	1,2,3,4,5	Individual written expression	Reading and grading the essay	0	25
Answering questions	1.5	1,2,3,4,5	Oral exam	Evaluating the answers	0	25

1.10. Mandatory reading (at the moment of application of the study programme proposal)

Medanić, B.: Management u građevinarstvu (Management in Civil Engineering), Faculties of Civil Engineering Zagreb, Osijek, Split, and Rijeka, Osijek, 1997.
Sikavica,P., Bahtijarević Šiber, F., Pološki Vokić, N.: Temelji menadžmenta (Fundamentals of Management), Školska knjiga, Zagreb, 2008.

1.11. Additional reading (at the moment of application of the study programme proposal)

Buble,M. i dr.: Strateški menadžment (Strategic Management), Sinergija, Zagreb, 2005.
Bahtijarević Šiber,F., Sikavica,P., Pološki Vokić,N.: Suvremeni menadžment (Modern Management), Školska knjiga, Zagreb, 2008.

1.12. Number of copies of the required reading in relation to the number of students currently attending classes at the course

Title	Number of copies	Number of students
Management in Civil Engineering	10	0
Fundamentals of Management	1	0

1.13. Methods for monitoring quality which ensure the acquisition of the resulting knowledge, skills, and competencies

Student survey.

General information

Course teacher	**Prof.dr.sc. Zlata Dolaček-Alduk, dipl.ing.građ.**
Course title	**Quality Management in Construction Projects**
Study programme	**Postgraduate University Study Programme Civil Engineering**
Course status	Elective course in the module Organisation, Technology and Management
Year	I

Acquired credits and the form of implementing academic activities	ECTS coefficient of the student academic load	6.0
	Number of classes (lectures (L)+exercises (E)+seminars (S))	30+0+30

1. COURSE DESCRIPTION

1.1. Course goals

Understanding the quality management system in construction projects. Developing new knowledge and research capabilities regarding the problem of quality and management in construction projects, improving the existing solutions and discovering new solutions for quality management in the most demanding environment. Development of critical thinking. Scientific-research work is a mandatory component of the course.

1.2. Preconditions for taking the course

There are no preconditions.

1.3. Expected learning outcomes for the course

After passing the exam, the students will be able to:
1. **Interpret the quality management models in specific stages of a construction project.**
2. **Formulate the research problem in the area of quality management in construction projects.**
3. **Develop new methods for quality research (modelling, decision-making theories, empirical research).**
4. **Apply the appropriate statistical methods for quality analysis.**
5. **Interpret and present research results in the form of a seminar and/or a scientific-research paper.**

1.4.	*Course content*

Quality factors. Statistical quality control. Probability, information, statistical processes (concepts, application methods). Basic principles of operating characteristics. Autocorrelation, autoregression models. Total quality management (TQM), quality assurance (QA), quality control (QC). Information quality system. Defining the processes in construction, quality control in a process. Control and testing – sampling plans. Sampling variations and sampling distribution. Statistical control of the process. Quality cost analysis. Continuous quality improvement, self-evaluation, quality award models, business excellence models. The quality system in construction according to international standards.

1.5.	*Types of academic activities*	☒ lectures ☒ seminars and workshops ☐ exercises ☐ remote education ☐ field classes	☒ independent tasks ☐ multimedia and web ☐ laboratory ☒ mentorship ☐ other _____

1.6.	*Comments*	No.

1.7.	*Students' obligations*

A seminar paper that covers the research and overview of the status in the area, repeating examples from literature and solving the assigned example, and the dissemination of the conclusions in the form of a workshop and/or a scientific-research paper.

1.8.	*Monitoring the students' work*

Attending classes	1.0	Activity during classes		Seminar paper	3.0	Experimental work	
Written exam		Oral exam		Essay		Research	2.0
Project		Continuous knowledge testing		Paper		Practical work	
Portfolio							

1.9.	*Grading and evaluating the student's activities during classes and at the final exam*

STUDENT ACTIVITY *	ECTS	LEARNING OUTCOME **	ACADEMIC ACTIVITY	EVALUATION METHOD	CREDITS	
					min	max
Attending classes	1.0	1, 2, 3, 4, 5	Direct teaching	Keeping attendance records	0	0
Creating a seminar paper (analysis of existing research from the area of the seminar paper topic)	3.0	2, 3, 4, 5	Independent research and learning, discussion	Evaluating the entire achievement (summative evaluation)	0	60
Research	2.0	2, 3, 4	Independent research and	Evaluating the entire achievement	0	40

		learning			

1.10. Mandatory reading (at the moment of application of the study programme proposal)

1) **Juran, J.M.; Gryna, F.: Planiranje i analiza kvalitete (Quality Planning and Analysis), Mate, Zagreb, 1999.**
2) **Crosby, P.: Kvaliteta je besplatna (Quality is Free), Privredni vjesnik/Binoza press, Zagreb, 1996.**
3) **Kondić, Ž.: Statistička kontrola kvalitete (Statistical Quality Control), Polytechnic of Varaždin, Varaždin, 2012.**

1.11. Additional reading (at the moment of application of the study programme proposal)

1)   Beckford, J.: Quality, Routledge, London, 2002
2)   Montgomery, D.; Jennings, C.L.; Pfund, M.: Managing, Controlling and Improving Quality, John Wiley & Sons Wiley, Inc. 2011
3)   Jazbec, A.: Osnove statistike (Fundamentals of Statistics), Faculty of Forestry of the University of Zagreb, Zagreb, 2009.
4)   Juran, J.; Godfrey, B.: Juran's Quality Handbook, 5th Edition, McGraw-Hill, New York, 1999
5)   McCabe, S.: Quality Improvement Techniques in Construction, Addison Wesley Longman Limited, Harlow, Essex, 1998

1.12. Number of copies of the required reading in relation to the number of students currently attending classes at the course

Title	Number of copies	Number of students
Quality Planning and Analysis	1	0
Quality is Free	1	0
Statistical Quality Control	1	0

1.13. Methods for monitoring quality which ensure the acquisition of the resulting knowledge, skills, and competencies

The conditions resulting from the Study Plan of the Postgraduate University Study Programme Civil Engineering (Annual Activity Plan of the postgraduate study programme students and the Annual Mentor's Report or the Annual Study Advisor Report).
The conditions resulting from the Faculty's quality assurance system (internal judgment, student surveys).

General information

Course teacher	**Izv.prof.dr.sc. Hrvoje Krstić, dipl.ing.građ.**	
Course title	**Comprehensive Energy Modelling of Buildings**	
Study programme	**Postgraduate University Study Programme Civil Engineering**	
Course status	Elective course in the module Organisation, Technology and Management	
Year	I	
Acquired credits and the form of implementing academic activities	ECTS coefficient of the student academic load	6.0
	Number of classes (lectures (L)+exercises (E)+seminars (S))	30+0+30

1. COURSE DESCRIPTION

1.1. Course goals

Presenting energy modelling of buildings to students, as well as models for simulating and optimising energy consumption, and modelling indoor air quality, with the goal of achieving optimal project solutions with an advanced energy concept.

1.2. Preconditions for taking the course		

There are no preconditions.

1.3. Expected learning outcomes for the course

After passing the exam, the students will be able to:
1. **Create an energy model of a building**
2. **Compare the difference between the modelled and the actual energy consumption in buildings**
3. **Recommend advanced technological solutions for the reconstruction of existing buildings and the construction of new buildings**
4. **Plan the lifecycle costs of near zero-energy buildings**
5. **Re-examine the systems for monitoring energy consumption and thermal comfort in buildings**

1.4. Course content

Applicability of advanced technological solutions to the reconstruction of existing buildings and the construction of new buildings, and their effect on the building residents; Selecting the building reconstruction technology which is based on consumption models; Lifecycle costs of near zero-energy buildings; Building energy modelling (*BEM-Building Energy Modelling*); The elements of energy modelling – climate parameters, the micro-location of buildings, geometry, orientation, construction technology, thermo-technical systems, renewable and other sources of energy, lighting, HVAC, PTV, CNUS, mode of operation and users; Software tools for energy modelling and simulating energy consumption; Models for simulating and optimising energy consumption; The difference between the modelled and the actual energy consumption in buildings; Modelling the indoor air quality and the thermal comfort of buildings; Sick building syndrome; Optimising the design solutions with an advanced energy concept; Systems for monitoring energy consumption and thermal comfort in buildings; Smart buildings;

1.5. Types of academic activities	☒ lectures ☒ seminars and workshops ☐ exercises ☐ remote education ☐ field classes	☐ independent tasks ☐ multimedia and web ☐ laboratory ☐ mentorship ☐ other _____
1.6. Comments	No.	

1.7. Students' obligations

Seminar paper, presentation of the paper, and the oral exam.

1.8. Monitoring the students' work

Attending classes	0.20	Activity during classes		Seminar paper	2.80	Experimental work	
Written exam		Oral exam	2.0	Essay		Research	1.00
Project		Continuous knowledge testing		Paper		Practical work	
Portfolio							

1.9. Grading and evaluating the student's activities during classes and at the final exam

STUDENT ACTIVITY *	ECTS	LEARNING OUTCOME	ACADEMIC ACTIVITY	EVALUATION	CREDITS

		**		METHOD	min	max
Attending classes	0.20	1,2,3,4,5	Lectures	Keeping attendance records	0	0
Conducting independent research work and writing a research report	1.00	2,3	Research	Reviewing the report on the conducted research	0	20
Writing a seminar paper	2.80	1,2,3,4	Seminar paper	Reviewing and grading the seminar paper	0	45
Answering oral questions	2.00	1,2,3,4,5	Oral exam	Evaluating the provided answers	0	35

1.10. Mandatory reading (at the moment of application of the study programme proposal)
1. **Petrecca, G. Energy Conversion and Management. Springer International Publishing, 2014.** 2. **Green, D.C. Home Energy Information: Measuring and Managing Energy Consumption in Residential Buildings. SpringerBriefs in Energy, 2014.** 3. **Castilla, M., Domingo, J., Francisco, A., Berenguel, R.M. Comfort Control in Buildings. Springer, 2014.** 4. **Magrini, A. Building Refurbishment for Energy Performance, A Global Approach. Springer International Publishing, 2014.** 5. **Fülöp, L., Koški, Ž., Ištoka Otković, I., Krstić, H., Magyar, Z., Španić, M. Istraživanje zrakonepropusnosti prostorija u zgradama sa stajališta potrošnje energije i toplinskog komfora / Air tightness investigation of rooms from the point of view of energy and comfort, Scientific publication of the Project HUHR/1001/2.1.3/0009, Osijek, 2013.**
1.11. Additional reading (at the moment of application of the study programme proposal)
1. Kalz, D., Pfafferott, J. Thermal Comfort and Energy-Efficient Cooling of Nonresidential Buildings. Springer International Publishin 2. Mequignon, M., Ait Haddou, H. Lifetime Environmental Impact of Buildings. Springer International Publishing, 2014.
1.12. Number of copies of the required reading in relation to the number of students currently attending classes at the course

Title	Number of copies	Number of students
Energy Conversion and Management	0	5
Home Energy Information: Measuring and Managing Energy Consumption in Residential Buildings	0	5
Building Refurbishment for Energy Performance, A Global Approach	0	5
Istraživanje zrakonepropusnosti prostorija u zgradama sa stajališta potrošnje energije i toplinskog komfora / Air tightness investigation of rooms from the point of view of energy and comfort	12	5

1.13. Methods for monitoring quality which ensure the acquisition of the resulting knowledge, skills, and competencies
Oral exam, submitting the research report, and the presentation of the seminar paper.

General information

Course teacher	**Prof.dr.sc. Zlata Dolaček-Alduk, dipl.ing.građ.** **Doc.dr.sc. Mario Galić, dipl.ing.građ.**
Course title	**Technologies for the Automation of Construction, Monitoring, and Control Processes**
Study programme	**Postgraduate University Study Programme Civil Engineering**
Course status	Elective course in the module Organisation, Technology and Management
Year	I

Acquired credits and the form of implementing academic activities	ECTS coefficient of the student academic load	6.0
	Number of classes (lectures (L)+exercises (E)+seminars (S))	30+0+30

1. COURSE DESCRIPTION

1.1. Course goals

Acquiring the theoretical and experimental knowledge on the development, technological approaches, and research methods in the area of technology for the automation of the processes of construction, monitoring, and quality control. Developing the necessary skills for conducting scientific-research work in the area of technical sciences.

1.2. Preconditions for taking the course

There are no preconditions.

1.3. Expected learning outcomes for the course

After passing the exam, the students will be able to:
1. **Use simulation, data analysis, and visualisation techniques to characterise complex processes and evaluate the results of experiments.**
2. **Critically analyse and select the applicable automation technologies for specific construction processes.**
3. **Evaluate the potential for the development of automation technologies and propose improvements.**
4. **Create, calibrate, and test the laboratory model for an automated process of construction, monitoring, or control.**
5. **Interpret and present their research results in the form of a seminar paper and/or a scientific-research paper.**

1.4. Course content

Technologies for the automation of the construction process – methods and technologies for the automation of concrete and reinforced concrete elements prefabrication; concreting methods using 3D printing technology, technologies for the automation of masonry and finishing activities, technologies for the automation of underwater activities, technologies for the automation of building demolition activities, technologies for the automation of thoroughfare construction activities, automation of cranes, using the BIM environment to automate the construction process, the application of heuristic and meta-heuristic artificial intelligence algorithms.

Technologies for the automation of monitoring processes – activity monitoring by implementing an unmanned aerial vehicle system.

Technologies for the automation of control processes – tools for the automation of quality in the industry, BIM based quality control system, mapping process values with the goal of improving quality.

1.5. Types of academic activities	☒ lectures ☒ seminars and workshops ☐ exercises ☒ remote education	☒ independent tasks ☒ multimedia and web ☐ laboratory ☒ mentorship ☐ other

				☐ field classes		_____ _	

1.6. Comments	The lectures and exercises will be held if the (formally set) minimum number of students enrol for the course, otherwise the classes will be held through consultations (individually) with students.

1.7. Students' obligations

A seminar paper that covers the research and overview of the status in the area, experimental work on the laboratory automation model of the assigned process example, and the dissemination of the conclusions of the paper in the form of a workshop and/or a scientific-research paper.

1.8. Monitoring the students' work

Attending classes	1.0	Activity during classes		Seminar paper	3.0	Experimental work	2.0
Written exam		Oral exam		Essay		Research	
Project		Continuous knowledge testing		Paper		Practical work	
Portfolio							

1.9. Grading and evaluating the student's activities during classes and at the final exam

STUDENT ACTIVITY *	ECTS	LEARNING OUTCOME **	ACADEMIC ACTIVITY	EVALUATION METHOD	CREDITS	
					min	max
Attending classes	1.0	1, 2, 3, 4, 5	Direct teaching	Keeping attendance records	0	0
Creating a seminar paper (analysis of existing research from the area of the seminar paper topic)	3.0	1, 2, 3	Independent research and learning, discussion	Evaluating the entire achievement (summative evaluation)	0	60
Experimental work	2.0	2, 3, 4	Laboratory model	Testing and evaluating the model	0	40

1.10. Mandatory reading (at the moment of application of the study programme proposal)

1) **Bock T, Linner T: Construction Robots. Elementary Technologies and Single-Task Construction Robots. New York: Cambridge University Press, 2016.**
2) **Bock T, Linner T: Robot-Oriented Design. Design and Management Tools for the Deployment of Automation and Robotics in Construction. New York: Cambridge University Press, 2015.**
3) **Bosilj Vukšić, V, Hernaus, T, Kovačić A: Upravljanje poslovnim procesima (Managing Business Processes). Školska knjiga, Zagreb, 2008.**
4) **Conger S: Process Mapping and Management. Information Systems Collection, 2011.**

1.11. Additional reading (at the moment of application of the study programme proposal)

None.

1.12. Number of copies of the required reading in relation to the number of students currently attending classes at the course

Title	Number of copies	Number of students
Construction Robots. Elementary Technologies and Single-Task Construction	0	

Robots		
Robot-Oriented Design. Design and Management Tools for the Deployment of Automation and Robotics in Construction	0	
Managing Business Processes	0	
Process Mapping and Management	0	

1.13. Methods for monitoring quality which ensure the acquisition of the resulting knowledge, skills, and competencies

The conditions resulting from the Study Plan of the Postgraduate University Study Programme Civil Engineering (Annual Activity Plan of the postgraduate study programme students and the Annual Mentor's Report or the Annual Study Advisor Report).
The conditions resulting from the Faculty's quality assurance system (internal judgment, student surveys). Publishing a scientific paper.

* Every student activity/academic activity should be assigned with the appropriate share of ECTS credits for individual activities, so that the total number of ECTS credits match the credit value of the course.

** This column should contain the learning outcomes from item 1.3 which have been included in this student/teacher activity.

ELECTIVE COURSES IN THE MODULE HYDRAULIC ENGINEERING

General information	
Course teacher	**Izv.prof.dr.sc. Zoltán Melicz**
Course title	**Wastewater Treatment Methods**
Study programme	**Postgraduate University Study Programme Civil Engineering**
Course status	Elective course in the module Hydraulic Engineering
Year	I

Acquired credits and the form of implementing academic activities	ECTS coefficient of the student academic load	6.0
	Number of classes (lectures (L)+exercises (E)+seminars (S))	30+20+10

1. COURSE DESCRIPTION

1.1. Course goals	
The goal of the course is introducing the students to the fundamental technological procedures for the treatment of wastewater, gathering and processing input design data, technological and hydraulic calculation, and dimensioning the technological units of the wastewater treatment devices in the water and sludge line.	
1.2. Preconditions for taking the course	
There are no preconditions.	
1.3. Expected learning outcomes for the course	
After attending all of the lectures and exercises, the students should be able to:	

1. **Gain insight into the methods for the resolution of the technologically-technically most complex part of public drainage.**
2. **Evaluate the advantages, disadvantages, and limitations of various treatment technologies.**
3. **Independently propose solutions for every specific case.**
4. **Conduct scientific research in this area.**

1.4. Course content	
The connection between the functions of the canal system and the quality of wastewater with the determination of input data for dimensioning (biological and hydraulic load). Basic legal provisions. Preliminary treatment. I degree of treatment. Biological procedures for the II degree of treatment. Removal of fertile waste, III degree of treatment. Aerobic and anaerobic sludge stabilisation. Standard and alternative treatment procedures. Sludge processing until treatment.	

1.5. Types of academic activities	☒ lectures ☒ seminars and workshops ☒ exercises ☐ remote education ☒ field classes	☐ independent tasks ☐ multimedia and web ☐ laboratory ☒ mentorship ☐ other _____
1.6. Comments	No	

1.7. Students' obligations						
The students must regularly attend classes and solve tasks from the exercises and the seminar papers.						

1.8. Monitoring the students' work							
Attending classes	2	Activity during classes		Seminar paper	2	Experimental work	
Written exam		Oral exam		Essay		Research	
Project		Continuous knowledge testing	2	Paper		Practical work	
Portfolio							

1.9. Grading and evaluating the student's activities during classes and at the final exam

STUDENT ACTIVITY *	ECTS	LEARNING OUTCOME **	ACADEMIC ACTIVITY	EVALUATION METHOD	CREDITS	
					min	max
Attending classes and field classes	2	1	Lectures, field classes	Keeping attendance records	0	10
Completing problems from exercises	2	1	Exercises	Reviewing and correcting problems from exercises	0	40
Creating a seminar paper	2	2	Seminars	Reviewing and grading the seminar paper	0	50

1.10. Mandatory reading (at the moment of application of the study programme proposal)

- **Metcalf&Eddy – Wastewater Engineering Treatment and Reuse, McGrow-Hill**
- **Lecture materials (PowerPoint presentations and specifically prepared texts)**

1.11. Additional reading (at the moment of application of the study programme proposal)

- Manuals and texts, US-EPA, related to wastewater treatment (Internet).

1.12. Number of copies of the required reading in relation to the number of students currently attending classes at the course

Title	Number of copies	Number of students
Wastewater Engineering Treatment and Reuse		
Lecture materials (PowerPoint presentations and specifically prepared texts)		

1.13. Methods for monitoring quality which ensure the acquisition of the resulting knowledge, skills, and competencies

Analyses of exam and seminar results, student surveys on the quality of the classes, curriculum evaluation.

General information	
Course teacher	**Prof.dr.sc. Lidija Tadić**
Course title	**River Basin Management**
Study programme	**Postgraduate University Study Programme Civil Engineering**
Course status	Elective course in the module Hydraulic Engineering
Year	I

Acquired credits and the form of implementing academic activities	ECTS coefficient of the student academic load	6.0
	Number of classes (lectures (L)+exercises (E)+seminars (S))	30+20+10

1. COURSE DESCRIPTION

1.1. Course goals

Expanding the knowledge on the integrated management of river basins under the conditions of climate changes and sustainable development

1.2. Preconditions for taking the course

There are no preconditions.

1.3. Expected learning outcomes for the course

1. Recognising complex river basin processes.
2. Comparing and assigning value to processes created by the interaction between natural and anthropogenic influences.
3. Familiarisation with the methods for the resolution of specific problems at the basin.
4. Conducting scientific research.

1.4. Course content

Natural characteristics of the basin and the use of land. Balancing the waters in a basin. Multipurpose use of waters in a basin – soil-improvement practices, water supply. Ecological aspects of basin management – protection of surface waters and groundwaters. Problems with sediments. Watercourse revitalisation. Flood and drought risks and their minimisation. Modern methods for sustainable basin management. River basin modelling. Determining the connection between the natural characteristics of basins with the possibilities of human activity and the application of modern achievements in river basin management.

1.5. Types of academic activities	☒ lectures ☒ seminars and workshops ☐ exercises ☐ remote education ☐ field classes	☐ independent tasks ☐ multimedia and web ☐ laboratory ☒ mentorship ☐ other _____
1.6. Comments	No	
1.7. Students' obligations		

Regular class attendance, seminar paper.

1.8. Monitoring the students' work

Attending classes	2	Activity during classes		Seminar paper	2	Experimental work	
Written exam		Oral exam		Essay		Research	2
Project		Continuous knowledge testing		Paper		Practical work	
Portfolio							

1.9. Grading and evaluating the student's activities during classes and at the final exam

STUDENT ACTIVITY *	ECTS	LEARNING OUTCOME **	ACADEMIC ACTIVITY	EVALUATION METHOD	CREDITS	
					min	max
Attending classes	2	1,2	Lectures, mentorship	Keeping attendance records at lectures and consultations	0	10
Research	2	3	Mentorship	Reviewing research progress reports	0	40
Creating a seminar paper	2	2	Seminars	Reviewing and grading the seminar paper	0	50

1.10. Mandatory reading (at the moment of application of the study programme proposal)

• **Loucks, D.P., van Beek , E., Stedinger , J.R. (2005): Water Resources Systems Planning and Management, UNESCO Publishing**
• **B.Đorđević (1990): Vodoprivredni sistemi (Water Management Systems)**

1.11. Additional reading (at the moment of application of the study programme proposal)

• Professional and scientific articles published in relevant journals and at conferences.

1.12. Number of copies of the required reading in relation to the number of students currently attending classes at the course

Title	Number of copies	Number of students
Loucks, D.P., van Beek , E., Stedinger , J.R. (2005): Water Resources Systems Planning and Management, UNESCO Publishing	http://unesdoc.unesco.org/images/0014/001434/143430e.pdf	
B.Đorđević (1990): Vodoprivredni sistemi (Water Management Systems)	-	

1.13. Methods for monitoring quality which ensure the acquisition of the resulting knowledge, skills, and competencies

Monitoring class attendance or interest for the course through consultation activities, student activities, and presenting an individually created seminar paper.

General information		
Course teacher	**Prof.dr.sc. Roko Andričević**	
Course title	**Evaluation and Management of Environmental Risks**	
Study programme	**Postgraduate University Study Programme Civil Engineering**	
Course status	Elective course in the module Hydraulic Engineering	
Year	I	
Acquired credits and the form of implementing academic activities	ECTS coefficient of the student academic load	6.0
	Number of classes (lectures (L)+exercises (E)+seminars (S))	30+0+30

1. COURSE DESCRIPTION

1.1. Course goals
In this course, the students will become familiar with the fundamental principles and methodologies in the analysis of environmental risks and the techniques for modelling environmental risks in practical problems. The particular goal is familiarising students with the methods for risk management and making decisions for the development of environmental infrastructure. Nowadays, the legal regulations of the Republic of Croatia, and particularly the EU directives, regulate the obligation for analysis and risk evaluation as the basic indicator for accepting various projects and interventions in the environment.

1.2. Preconditions for taking the course
There are no preconditions.

1.3. Expected learning outcomes for the course
1. Analysing the environmental risks **2. Evaluating the environmental risks** **3. Applying the techniques for modelling environmental risks in practical problems** **4. Proposing decisions related to risk management**

1.4. Course content
Defining the concept of environmental risk. Hydrological risk analysis, quantification of the risk of exceeding limit values; Stochastic approach to risk analysis: hazard identification, physical and chemical properties, and exposure paths to potential environmental pollution. Particular attention will be dedicated to the exposure evaluation, which contains the following: categorisation of potential pollution sources, transport processes for the transfer of pollution through various media (water, soil, air), modelling the pollution amount at control locations and the reliability assessment. Characterising risks and risk management decision on the basis of existing regulations. Including the social and economic aspect in risk management methods.

1.5. Types of academic activities	☒ lectures ☒ seminars and workshops ☐ exercises ☐ remote education ☐ field classes	☐ independent tasks ☐ multimedia and web ☐ laboratory ☐ mentorship ☐ other _____

1.6. Comments	No

1.7. Students' obligations
The students must attend classes, create and present a seminar paper, and actively participate in carrying out student obligations.

1.8. Monitoring the students' work

Attending classes	2	Activity during classes		Seminar paper	2	Experimental work	
Written exam		Oral exam		Essay		Research	
Project		Continuous knowledge testing	2	Paper		Practical work	
Portfolio							

1.9. Grading and evaluating the student's activities during classes and at the final exam

STUDENT ACTIVITY *	ECTS	LEARNING OUTCOME **	ACADEMIC ACTIVITY	EVALUATION METHOD	CREDITS	
					min	max
Attending classes	2	1,2,3	Lectures	Keeping attendance records	0	10
Continuous knowledge testing	2	1,2,3	Lectures, consultations	Reviewing research progress reports	0	40
Seminar paper	2	1,2,3	Seminars and workshops	Reviewing and grading the seminar paper	0	50

1.10. Mandatory reading (at the moment of application of the study programme proposal)
• **National Research Council, 1983, Risk assessment: Managing the process, National Academy Press, Washington, D.C.**

1.11. Additional reading (at the moment of application of the study programme proposal)

•Galešić, M.; Andričević, R.; Gotovac, H.; Srzić, V., Concentration statistics of solute transport for the near field zone of an estuary. Advances in Water Resources. 94, 424-440, 2016.
•Andričević, R., Galešić, M., Contaminant dilution measure for the solute transport in an estuary. Advances in Water Resources, 117, 2018.
•Andričević, R.; Srzić, V.; Gotovac, H., Risk characterization for toxic chemicals transported in aquifers. Advances in Water Resources. 36 (2012), S. I.; 86-97.
•Andričević, R. And Cvetkovic, V. Evaluation of Risk from Contaminants Migrating by Groundwater, Water Resources Research, 32(3), 1996.
•Andričević, R., Daniels, J., Jacobson, R., Radionuclide migration using travel time transport approach and its application in risk analysis, J. Of Hydrology, 163, 1994.
•Crouch, E.A., Wilson, R., Risk/Benefit Analysis, Ballinger, Boston, MA, 1982.
•Fishoff, B., et.al., Acceptable Risk, Cambridge University Press, New York, 1981.

1.12. Number of copies of the required reading in relation to the number of students currently attending classes at the course			
Title	Number of copies	Number of students
• National Research Council, 1983, Risk assessment: Managing the process, National Academy Press, Washington, D.C.		

1.13. Methods for monitoring quality which ensure the acquisition of the resulting knowledge, skills, and competencies
By creating an individual seminar paper.

General information	
Course teacher	**Izv. prof. dr.sc. Marija Šperac**
Course title	**Selected Chapters of Hydrology**
Study programme	**Postgraduate University Study Programme Civil Engineering**
Course status	Elective course in the module Hydraulic Engineering
Year	I
Acquired credits and the form of implementing academic activities	ECTS coefficient of the student academic load

Acquired credits and the form of implementing academic activities	ECTS coefficient of the student academic load	6.0
	Number of classes (lectures (L)+exercises (E)+seminars (S))	30+0+30

1. COURSE DESCRIPTION

1.1. Course goals

Expanding on the theoretical knowledge on basic hydrological processes while training the attendees to understand and use the selected hydrological models and with a scientific-research approach to monitoring and evaluating the hydrological parameters.

1.2. Preconditions for taking the course

There are no preconditions.

1.3. Expected learning outcomes for the course

1. Statistical processing and analysis of hydrological processes;
2. Evaluating the reliability of hydrological parameters;
3. Applying digital technology in hydrological monitoring;
4. Creating hydrological forecasts.

1.4. Course content

Applying digital technology in hydrological monitoring. Analysing and evaluating the reliability of modern measuring technologies in hydraulic engineering. The application of parametric hydrology as replacement due to the lack of hydrological monitoring. Methods and application. Analysis of hydrological time series. Application of stochastic hydrology on large and small basins. Mathematical modelling of hydrological processes. Familiarisation with better-known hydrological models. Statistic processing and analysis of hydrological processes. Hydrological forecasts.

1.5. Types of academic activities	☒ lectures ☒ seminars and workshops ☐ exercises	☒ independent tasks ☐ multimedia and web ☐ laboratory ☐ mentorship

					☐ remote education ☐ field classes	☐ other _____

1.6. Comments	No.

1.7. Students' obligations
Attending classes, creating and presenting seminar papers.

1.8. Monitoring the students' work

Attending classes	1	Activity during classes		Seminar paper	2	Experimental work	
Written exam		Oral exam		Essay		Research	
Project		Continuous knowledge testing	3	Paper		Practical work	
Portfolio							

1.9. Grading and evaluating the student's activities during classes and at the final exam

STUDENT ACTIVITY *	ECTS	LEARNING OUTCOME **	ACADEMIC ACTIVITY	EVALUATION METHOD	CREDITS	
					min	max
Attending classes	1	1,2,3	Lectures	Keeping attendance records	0	10
Continuous knowledge testing	3	1,2,3	Independent tasks	Reviewing and evaluating the solutions to independent tasks	0	40
Seminar paper	2	1,2,3	Seminars	Reviewing and grading the seminar paper	0	50

1.10. Mandatory reading (at the moment of application of the study programme proposal)
• **H.Hrelja: Vjerovatnoća i statistika u hidrologiji (Probability and Statistics in Hydrology); Faculty of Civil Engineering of the University of Sarajevo, Sarajevo 2000.**   • **Prohaska, J.S. : Hidrologija: 1. deo: Hidro-meteorologija, hidrometrija i vodni režim (Hydrology, 1st Part: Hydro-Meteorology, Hydrometry, and Water Regimes), Belgrade: Faculty of Mining and Geology: Institute for Water Management ˝Jaroslav Černi˝, 2003.**   • **Prohaska, J.S. : Hidrologija: 2. deo: Hidrološko prognoziranje, modelovanje i praktična primena (Hydrology, 2nd Part: Hydrological Forecasting, Modelling and Practical Application), Belgrade: Faculty of Mining and Geology: Institute for Water Management ˝Jaroslav Černi˝, 2006**

1.11. Additional reading (at the moment of application of the study programme proposal)
•Bedient, F. et.al.: Hydrology and Floodplain Analysis, 6th Edition, Pearson 2018.

1.12. Number of copies of the required reading in relation to the number of students currently attending classes at the course

Title	Number of copies	Number of students
H.Hrelja: Vjerovatnoća i statistika u hidrologiji (Probability and Statistics in Hydrology)	1	
Prohaska, J.S. : Hidrologija: 1. deo: Hidro-meteorologija, hidrometrija i vodni režim (Hydrology, 1st Part: Hydro-Meteorology, Hydrometry, and Water Regimes)	1	
Prohaska, J.S. : Hidrologija: 2. deo: Hidrološko prognoziranje, modelovanje i praktična primena (Hydrology, 2nd Part: Hydrological Forecasting, Modelling and Practical Application)	1	

1.13. Methods for monitoring quality which ensure the acquisition of the resulting knowledge, skills, and competencies

Presenting seminar papers and lecture attendance.

General information

Course teacher	**Prof.dr.sc. Barbara Karleuša**
Course title	**Systematic Analysis in Hydraulic Engineering**
Study programme	**Postgraduate University Study Programme Civil Engineering**
Course status	Elective course in the module Hydraulic Engineering
Year	I
Acquired credits and the form of implementing academic activities	ECTS coefficient of the student academic load

Acquired credits and the form of implementing academic activities	ECTS coefficient of the student academic load	6.0
	Number of classes (lectures (L)+exercises (E)+seminars (S))	30+0+30

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1. COURSE DESCRIPTION

1.1. Course goals

The goal of the course is the systematic analytical overview of all the effects of hydraulic engineering interventions and structures, particularly regarding their integration into the environment, i.e., into natural ecosystems. The significance of this goal is reflected in the increased success in the management of water resources, i.e., the improved use and protection of water resources within natural ecosystems, as well as in the protection from excessive effects of water, especially flooding and soil erosion. Systematic analysis in hydraulic engineering contains most of the modern knowledge within the Theory of Hydraulic Engineering Systems.

1.2. Preconditions for taking the course

There are no preconditions.

1.3. Expected learning outcomes for the course

1. Defining natural and artificial elements of water management systems and their interactivity,
2. Analysing the elements in the procedures for the solution of complex problems,
3. Recognising the necessary steps and forming a solution to a problem,
4. Applying operational research methods for the optimisation of water management systems.

1.4. Course content

General concepts and history of systematic engineering in hydraulic engineering. Definitions and classification of hydraulic engineering and water management systems. Natural and artificial (constructed) parts of the system. Characteristics of the system, direct and feedback connections in the system, processes taking place in the system. System adaptability. Entropy. Principles of functional,

hierarchal, and echelon decomposition and aggregation of the system. Gnoseological formalisation of water management goals and management tasks. Cybernetic system schematics. Synergetic effects. Principles of reaching optimal management decisions. Systematisation of optimisation tasks, optimisation analysis and optimisation synthesis tasks. Forming target structures, limit sets, and the criteria for the valorisation of management decisions. Overview and application of operation research methods in the optimisation of water management systems. Simulating the operation of the system, mathematical simulation models. Reliability analyses of the system. Applied information and information systems in the management of water management systems. Water management information systems, "online" information and databanks. Environmental aspects of designing water management systems.

1.5. *Types of academic activities*	☒ lectures ☒ seminars and workshops ☐ exercises ☐ remote education ☐ field classes ☐ independent tasks ☐ multimedia and web ☐ laboratory ☐ mentorship ☐ other _____

1.6. *Comments*	No.

1.7. *Students' obligations*

Regular lecture attendance and creating the seminar paper.

1.8. *Monitoring the students' work*

Attending classes	2	Activity during classes		Seminar paper	2	Experimental work	
Written exam		Oral exam		Essay		Research	
Project		Continuous knowledge testing	2	Paper		Practical work	
Portfolio							

1.9. *Grading and evaluating the student's activities during classes and at the final exam*

STUDENT ACTIVITY *	ECTS	LEARNING OUTCOME **	ACADEMIC ACTIVITY	EVALUATION METHOD	CREDITS	
					min	max
Attending classes	2	1,2,3	Lectures	Keeping attendance records		10
Continuous knowledge testing	2	1,2,3	Lectures	Reviewing research progress reports		40
Seminar paper	2	1,2,3,4	Seminars and workshops	Reviewing and grading the seminar paper		50

1.10. Mandatory reading (at the moment of application of the study programme proposal)

- **Mass et al: Design of Water Resources Systems, Harvard University Press, Cambridge Ma 1970.**
- **Hall, W.A., Dracup, J.A.: Water Resources Systems Engineering, Mc Graw-Hill, New York, 1970.**
- **Đorđević, B.: Vodoprivredni sistemi (Water Management Systems), Naučna Knjiga, Belgrade, 1990.**
- **Karleuša, B.; Ožanić, N. Određivanje prioriteta u realizaciji vodnogospodarskih planova (Determining Priorities in the Realisation of Water Management Plans). // Građevinar : časopis Hrvatskog saveza građevinskih inženjera. 63 (2011) , 2; 151-161 (available on-line)**
- **Karleuša, B.; Beraković, B.; Rajčić, V. Ekspertni sustav za ocjenu uspješnosti planiranja u gospodarenju vodama (Expert System for the Evaluation of Design Performance in Water Management). // Građevinar : časopis Hrvatskog saveza građevinskih inženjera. 62 (2010) , 1; 1-11 (available on-line)**
- **Karleuša, B.; Beraković, B.; Ožanić, N. Primjena ELECTRE TRI metode na izbor varijante navodnjavanja. (The Application of the ELECTRE TRI Method on the Selection of the Irrigation Variant) // Građevinar. 57 (2005) , 1; 21-28 (available on-line)**

1.11. Additional reading (at the moment of application of the study programme proposal)

- D.P. Loucks: Water Resources Systems Analysis, International Institute for Hydraulic and Environmental Engineering, Delft, Netherlands.
- Major, C.D., Lenton, L.R.: Applied Water Resources System Planning, Prentice Hall Int. London, 1979.
- Haimes, Y.Y.: Hierarchical Analyses of Water Resources Systems, Mc Graw-Hill, New York, 1977.
- Karleuša, B.: Unapređenje gospodarenja vodama korištenjem ekspertnog sustava (Improving Water Management by Using an Expert System) / doctoral thesis. Zagreb: Faculty of Civil Engineering, 2005
- Karleuša, B.: Primjena postupaka višekriterijske optimalizacije u gospodarenju vodama (Applying Multiple-Criteria Optimisation in Water Management) / master's thesis. Zagreb: Faculty of Civil Engineering, 2002.

1.12. Number of copies of the required reading in relation to the number of students currently attending classes at the course		
Title	Number of copies	Number of students
Karleuša, B.; Ožanić, N. Određivanje prioriteta u realizaciji vodnogospodarskih planova (Determining Priorities in the Realisation of Water Management Plans). Građevinar : časopis HSGI. 63 (2011), 2; 151-161	Available on-line	
Karleuša, B.; Beraković, B.; Rajčić, V. Ekspertni sustav za ocjenu uspješnosti planiranja u gospodarenju vodama (Expert System for the Evaluation of Design Performance in Water Management). // Građevinar : časopis HSGI. 62 (2010) , 1; 1-11	Available on-line	

1.13. Methods for monitoring quality which ensure the acquisition of the resulting knowledge, skills, and competencies

By creating an individual seminar paper.

General information	
Course teacher	**Doc.dr.sc. Tamara Brleković**
Course title	**Groundwater Flow and Transport Process**
Study programme	**Postgraduate University Study Programme Civil Engineering**

Course status	Elective course in the module Hydraulic Engineering	
Year	I	
Acquired credits and the form of implementing academic activities	ECTS coefficient of the student academic load	6.0
	Number of classes (lectures (L)+exercises (E)+seminars (S))	30+0+30

1. COURSE DESCRIPTION

1.1. Course goals

This course offers a detailed overview of basic groundwater related transport processes which are based on physical and chemical principles. Special emphasis is on the component of spatial variability of physical and chemical parameters of the groundwater flow and their effect on the final result. Understanding the fundamental processes that result in the groundwater flow and transport of various substances is the key part of all expert studies and environmental studies which concern the interventions that affect groundwater.

1.2. Preconditions for taking the course

There are no preconditions.

1.3. Expected learning outcomes for the course

1. Describing the heterogeneous nature of the groundwater surroundings by using geostatic analyses;
2. Applying 3D numerical methods in modelling transport processes;
3. Using simple models for the practical problems of groundwater ecology;
4. Analysing the effect of specific parameters on groundwater flow.

1.4. Course content

Fundamentals of the description of subterranean formations with special emphasis on natural heterogeneity and anisotropy. Basic principles of groundwater flow and contaminant transport in geological formations and their mathematical description. Fundamentals of geo-chemistry and its modelling on the scale of practical problems in practice. Fundamentals of geo-statistics and its use in the description of heterogeneity of the hydraulic parameters of the different soil layers. Porosity and the relationship between the liquid and solid phases in porous environments. Darcy's law, hydraulic conductivity, permeability, and measurement methods, and the methods for the calibration of models used for modelling transport processes. The stochastic approach to describing spatial variability and parametric uncertainty in modelling basic transport processes. The concept of volumetric concentration and concentration based on mass flow. Models for describing contaminant transport and their application in the most common practical problems related to the groundwater flow and contamination.

1.5. Types of academic activities	☒ lectures ☒ seminars and workshops ☐ exercises ☐ remote education ☐ field classes	☐ independent tasks ☐ multimedia and web ☐ laboratory ☐ mentorship ☐ other _____

1.6. Comments	No.

1.7. Students' obligations

The students must attend lectures, create and present a seminar paper, and actively participate in carrying out their student obligations.

1.8. Monitoring the students' work

Attending classes	2	Activity during classes		Seminar paper	2	Experimental work	
Written exam		Oral exam		Essay		Research	
Project		Continuous knowledge testing	2	Paper		Practical work	
Portfolio							

1.9. Grading and evaluating the student's activities during classes and at the final exam

STUDENT ACTIVITY *	ECTS	LEARNING OUTCOME **	ACADEMIC ACTIVITY	EVALUATION METHOD	CREDITS	
					min	max
Attending classes	2	1,2,3,4	Lectures	Keeping attendance records	0	10
Continuous knowledge testing	2	1,2,3,4	Lectures	Reviewing research progress reports	0	40
Seminar paper	2	1,2,3,4	Seminar paper	Reviewing and grading the seminar paper	0	50

1.10. Mandatory reading (at the moment of application of the study programme proposal)

• **Bear, J., Cheng, A.H.D. Modeling Groundwater flow and contaminant transport, Springer, 2010.**
• **De Marsily, G. Quantitative hydrogeology: Groundwater hydrology for engineers, Academic Press, New York, 1986.**

1.11. Additional reading (at the moment of application of the study programme proposal)

•Sachse, A., Rink, K., He, W., Kolditz, O. OpenGeoSysTutorial Computational Hydrology I: Groundwater Flow Modeling, Springer. 2015.
•Selim, H.M., Ma, L. PhysicalNonequilibrium in Soils ModelingandApplication, AnnArborPress Chelsea,Michigan, 1998.

1.12. Number of copies of the required reading in relation to the number of students currently attending classes at the course

Title	Number of copies	Number of students

1.13. Methods for monitoring quality which ensure the acquisition of the resulting knowledge, skills, and competencies

By creating an individual seminar paper.

General information	
Course teacher	**Prof.dr.sc. Mladen Jurišić** **Izv.prof.dr.sc. Ivan Plaščak**
Course title	**Geoinformation Technologies and Environmental Management**

Study programme	**Postgraduate University Study Programme Civil Engineering**	
Course status	Elective course in the module Hydraulic Engineering	
Year	I	
Acquired credits and the form of implementing academic activities	ECTS coefficient of the student academic load	6.0
	Number of classes (lectures (L)+exercises (E)+seminars (S))	30+10+20

1. COURSE DESCRIPTION

1.1. Course goals

The goal of studies at this module is acquiring knowledge in geoinformatics and its application in process management (civil engineering, planning, and ecology). Mastering the fundamental knowledge from the area of geoinformatics and remote sensing, and using digital platforms (scanned, satellite, and aerophotogrammetry images and using unmanned aerial vehicles - drones) and the attribution of databases to digital platforms (software). Mastering the use of the latest GIS tools and applying them for specific problems and tasks in the area of the application of GIS technologies in construction and environmental protection (thematic maps – land use management planning). Familiarising students with the specific application of the global positioning system and navigation.

1.2. Preconditions for taking the course

There are no preconditions.

1.3. Expected learning outcomes for the course

1. Describing the basic principles and functioning of GIS and its components. Presenting the functioning of GPS and explaining and presenting the (D)GPS and GPS systems, and interpreting the basics of the land information system ZIS – LIS
2. Explaining the method of creation of thematic maps in civil engineering, particularly the maps intended for construction and waste management in the GIS environment, and indicating the application of geospatial data and the basics of geo-statistics – modelling;
3. Presenting the foundation of remote sensing in civil engineering and environmental protection, and studying the existing studies;
4. Presenting the navigation systems – (D)GPS and indicating the practical aspects of use of the global positioning system;
5. Interpreting the organised GIS systems at the state level (CORINE, LIS, LPIS – Arkod – Agronet) and cataloguing resources, and describing intelligent transport systems and satellite monitoring.

1.4. Course content

Fundamentals of the description of subterranean formations with special emphasis on natural heterogeneity and anisotropy. Basic principles of substance flow and transfer in subterranean geological formations and their mathematical description. Fundamentals of geo-chemistry and its modelling on the scale of practical problems in practice. Fundamentals of geo-statistics and its use in the description of heterogeneity of the hydraulic parameters of the subterranean space. Porosity and the relationship between the liquid and solid phases in porous environments. Darcy's law, hydraulic conductivity, permeability, and measurement methods, and the methods for the calibration of models used for modelling transport processes. The stochastic approach to describing spatial variability and parametric unreliability in modelling basic transport processes. The concept of volumetric concentration and concentration based on mass flow. Analytical models for describing the underground transfer of pollution and their application in the most common practical problems related to the flow and transfer of pollution.

1.5. Types of academic activities	☒ lectures ☒ seminars and workshops	☐ independent tasks ☐ multimedia and web

	☒ exercises ☐ remote education ☐ field classes	☐ laboratory ☐ mentorship ☐ other _____
1.6. Comments	No.	

1.7. Students' obligations

Continuous class (consultation) attendance and active participation in tasks during implementation. There will be two partial oral exams and seminars during the semester. These partial exams will cover the topics of General GIS, ZIS, Functioning of GIS, and Remote Sensing. The second partial exam will cover a part of the application of GIS, especially in construction and environmental protection and LPIS and the seminar paper related to thematic maps. Before the classes start, the students will be presented with the content of the module, exam dates, and the methods of implementation. The final exam will be implemented via seminar papers and orally. The students who have successfully passed the previous partial exams and completed their expected obligations may pass the course without taking the final exam.

1.8. Monitoring the students' work							
Attending classes	2	Activity during classes		Seminar paper	2	Experimental work	
Written exam		Oral exam		Essay		Research	
Project		Continuous knowledge testing	2	Paper		Practical work	
Portfolio							

1.9. Grading and evaluating the student's activities during classes and at the final exam

STUDENT ACTIVITY *	ECTS	LEARNING OUTCOME **	ACADEMIC ACTIVITY	EVALUATION METHOD	CREDITS	
					min	max
Attending classes	2	1-10	Lectures	Keeping attendance records	0	10
Continuous knowledge testing	2	1-10	Lectures	Reviewing research progress reports	0	40
Seminar paper	2	1-10	Seminar paper	Reviewing and grading the seminar paper	0	50

1.10. Mandatory reading (at the moment of application of the study programme proposal)

- **Jurišić M., Plaščak I. (2009): Geoinformacijski sustavi GIS u poljoprivredi i zaštiti okoliša (Geo-Information Systems GIS in Agriculture and Environmental Protection), Faculty of Agriculture Osijek;**
- **Jurišić M. (2013): Geoinformacijski sustavi GIS u poljoprivredi i zaštiti okoliša (Geo-Information Systems GIS in Agriculture and Environmental Protection), HANDBOOK, Faculty of Agriculture Osijek;**
- **www.arkod.hr**

1.11. Additional reading (at the moment of application of the study programme proposal)

• Burrough P. A., McDonnell R. A. (2006): Principles of Geographical Information Systems – Spatial Information Systems and Geostatistics, Oxford University Press., UK.

1.12. Number of copies of the required reading in relation to the number of students currently attending classes at the course

Title	Number of copies	Number of students
Jurišić M., Plaščak I. (2009): Geoinformacijski sustavi GIS u poljoprivredi i zaštiti okoliša (Geo-Information Systems GIS in Agriculture and Environmental Protection), Faculty of Agriculture Osijek.	50	
Jurišić M. (2013): Geoinformacijski sustavi GIS u poljoprivredi i zaštiti okoliša (Geo-Information Systems GIS in Agriculture and Environmental Protection), PRIRUČNIK, Faculty of Agriculture Osijek.	10	
Burrough P. A., McDonnell R. A. (2006): Principles of Geographical Information Systems – Spatial Information Systems and Geostatistics, Oxford University Press., UK.	3	

1.13. Methods for monitoring quality which ensure the acquisition of the resulting knowledge, skills, and competencies

Surveys and other methods included in the study plan.

General information

Course teacher	**Dr.sc. Ognjen Bonacci, prof.emer.**	
Course title	**Ecohydrology**	
Study programme	**Postgraduate University Study Programme Civil Engineering**	
Course status	Elective course in the module Hydraulic Engineering	
Year	I	
Acquired credits and the form of implementing academic activities	ECTS coefficient of the student academic load	6.0
	Number of classes (lectures (L)+exercises (E)+seminars (S))	30+15+15

1. COURSE DESCRIPTION

1.1. Course goals

Connecting dynamic and variable hydrological processes with ecological processes. Analysing the changes in the hydrological cycle.

1.2. Preconditions for taking the course

There are no preconditions.

1.3. Expected learning outcomes for the course

1. Explaining the interdisciplinary role of hydrology
2. Explaining the significance of hydrology in ecological processes
3. Applying the principles of ecohydrology on the hydrological cycle
4. Applying the knowledge in order to support sustainable development and environmental protection in the domain of water resources and open watercourse management

1.4. Course content

The connection between hydrology and ecology. Interdisciplinary approach in science. Sustainable development. Synthesis of Newton's and Darwin's approaches. The definition of ecohydrology. Principles and rules of ecology. Natural habitats and the pressure on those habitats. The integration role of the hydrological cycle. Global climate changes. Floods, flooded areas, and wetlands. Dryness, droughts, and dry areas. Open watercourses, the locations where hydrology, ecology, and biology interact. The concept of determining ecologically acceptable watercourses. Supporting sustainable development and environmental protection in the domain of water resources and open watercourse management. Ecohydrological role of dry wash open watercourses.

1.5. Types of academic activities	☒ lectures ☒ seminars and workshops ☐ exercises ☐ remote education ☐ field classes	☒ independent tasks ☐ multimedia and web ☐ laboratory ☐ mentorship ☐ other _____

1.6. Comments	No.

1.7. Students' obligations

Seminar paper, oral exam.

1.8. Monitoring the students' work

Attending classes	2	Activity during classes		Seminar paper	2	Experimental work	
Written exam		Oral exam		Essay		Research	
Project		Continuous knowledge testing	2	Paper		Practical work	
Portfolio							

1.9. Grading and evaluating the student's activities during classes and at the final exam

STUDENT ACTIVITY *	ECTS	LEARNING OUTCOME **	ACADEMIC ACTIVITY	EVALUATION METHOD	CREDITS	
					min	max
Attending classes	2	1,2,3	Lectures	Keeping attendance records	0	10

	2	1,2,3	Independent tasks	Reviewing research progress reports	0	40
Continuous knowledge testing						
Seminar paper	2	1,2,3	Seminar paper	Reviewing and grading the seminar paper	0	50

1.10. Mandatory reading (at the moment of application of the study programme proposal)	

•   Eagleson PS. 2002. Ecohydrology – Darwinian expression of vegetation form and function. Cambridge University Press, Cambridge.

•   Bonacci O. 2003. Ekohidrologija vodnih resursa i otvorenih vodotoka (Ecohydrology of Water Resources and Open Watercourses). Faculty of Civil Engineering and Architecture of the University of Split, Split.

•   Gordon N, NcMahon TA, Finlayson BL, Gippel CJ, Nathan RJ. 2005. Stream hydrology – an introduction for ecologists, Wiley, Chichester.

•   Datry T, Bonada N, Boulton A. 2017. Intermittent rivers and ephemeral streams – ecology and management. Alsevier & Academig Press, London.

1.11. Additional reading (at the moment of application of the study programme proposal)

•Wood PJ, Hannah DM, Sadler JP. 2007. Hydroecology and ecohydrology – past, present and future. Wiley, Chicester

1.12. Number of copies of the required reading in relation to the number of students currently attending classes at the course

Title	*Number of copies*	*Number of students*
Bonacci, Ognjen (2003): Ekohidrologija (Ecohydrology)	*4*	

1.13. Methods for monitoring quality which ensure the acquisition of the resulting knowledge, skills, and competencies

Seminar paper, oral exam.

General information		
Course teacher	**Prof.dr.sc. Enikö Anna Tamás**	
Course title	**Basis of Physical Modelling of Open Watercourses**	
Study programme	**Postgraduate University Study Programme Civil Engineering**	
Course status	Elective course in the module Hydraulic Engineering	
Year	I	
Acquired credits and the form of implementing academic activities	ECTS coefficient of the student academic load	6.0
	Number of classes (lectures (L)+exercises (E)+seminars (S))	30+30+0

1. 1.   COURSE DESCRIPTION

1.1.   Course goals

Acquiring knowledge on the physical modelling of open watercourses and the basic technologies of physical modelling. Verification of the acquired knowledge on the physical model constructed at the National University of Public Services, Faculty of Water Sciences, Baja, Hungary.

1.2.   Preconditions for taking the course

There are no preconditions.

1.3.   Expected learning outcomes for the course

1. Acquiring the fundamentals of physical modelling.
2. Constructing a physical model.
3. Assigning value to the measurement results on a physical model.
4. Applying the results of physical modelling.

1.4.   Course content

Fundamentals of planning a physical model; Theory of physical modelling; Application of various scales in the construction of a physical model; Measurements on a physical model; Independent setup of a simple physical model; Starting and describing a simple physical model; Comparison with numerical models; Discussion and results; Exam.

1.5. Types of academic activities	☒ lectures	☐ independent tasks
	☐ seminars and workshops	☐ multimedia and web
	☒ exercises	☒ laboratory
	☐ remote education	☐ mentorship
	☐ field classes	☐ other _____

1.6. Comments	No

1.7.   Students' obligations

Creating a study on the conducted laboratory testing

1.8.   Monitoring the students' work

Attending classes	2	Activity during classes		Seminar paper		Experimental work	2
Written exam	2	Oral exam		Essay		Research	
Project		Continuous knowledge testing		Paper		Practical work	
Portfolio							

1.9.   Grading and evaluating the student's activities during classes and at the final exam

STUDENT ACTIVITY *	ECTS	LEARNING OUTCOME **	ACADEMIC ACTIVITY	EVALUATION METHOD	CREDITS	
					min	max
Attending classes	2	1,2,3	Lectures, exercises	Keeping attendance records	0	10
Practical laboratory work	2	1,2,3	Laboratory work	Evaluating the implementation of the practical work and the report on the results	0	40
Written exam	2	1,2,3	Written exam	Reviewing and grading the written exam	0	50

1.10. Mandatory reading (at the moment of application of the study programme proposal)

1. Modelling Geomorphic Systems: Scaled Physical Models by Daniel L. Green, Geomorphological Techniques, Chap. 5, Sec. 3 (2014)

1.11. Additional reading (at the moment of application of the study programme proposal)

1. Movable Bed Physical Models by Hsieh Wen Shen, SpringerNature, NATO Science Series C, 1990

1.12. Number of copies of the required reading in relation to the number of students currently attending classes at the course

Title	Number of copies	Number of students
Modelling Geomorphic Systems: Scaled Physical Models by Daniel L. Green, Geomorphological Techniques, Chap. 5, Sec. 3 (2014)	https://www.geomorphology.org.uk/sites/default/files/geom_tech_chapters/5.3_PhysicalModelling_1.pdf	

1.13. Methods for monitoring quality which ensure the acquisition of the resulting knowledge, skills, and competencies

Continuous knowledge testing by attending classes, lectures and exercises and laboratory work, as well as the final exam.

General information	
Course teacher	**Izv.prof.dr.sc. Marijan Babić**
Course title	**River Hydraulics**
Study programme	**Postgraduate University Study Programme Civil Engineering**
Course status	Elective course in the module Hydraulic Engineering

Year	I		
Acquired credits and the form of implementing academic activities	ECTS coefficient of the student academic load		6.0
	Number of classes (lectures (L)+exercises (E)+seminars (S))		30+0+30

1. 1. COURSE DESCRIPTION

1.1. Course goals

The goal of the course is acquiring the understanding of hydraulic processes in rivers, including water flow, transfer of sediments, transfer of substances, and the transfer of ice, and acquiring knowledge on the mathematical modelling of these processes.

1.2. Preconditions for taking the course

There are no preconditions.

1.3. Expected learning outcomes for the course

1. Estimating the incidence of hydraulic processes in rivers, including water flow, transfer of sediments, transfer of substances, and the appearance and transfer of ice.
2. Mathematical formulation of these processes.
3. Modelling the mentioned processes.
4. Interpreting the acquired results.

1.4. Course content

Stationary and non-stationary flow in open beds (rivers);
Transfer of sediments and the hydro-morphological development of river geometry; Transfer and dispersion of substances in rivers; Formation of ice and frozen river hydraulics; Mathematical modelling of hydraulic processes in rivers.

1.5. Types of academic activities	☒ lectures	☒ independent tasks
	☒ seminars and workshops	☐ multimedia and web
	☐ exercises	☐ laboratory
	☐ remote education	☒ mentorship
	☐ field classes	☐ other _____

1.6. Comments	No

1.7. Students' obligations

Attending classes and creating the seminar paper.

1.8. Monitoring the students' work

Attending classes	2	Activity during classes		Seminar paper	2	Experimental work	
Written exam		Oral exam		Essay		Research	
Project		Continuous knowledge testing	2	Paper		Practical work	

Portfolio							

1.9. Grading and evaluating the student's activities during classes and at the final exam

STUDENT ACTIVITY *	ECTS	LEARNING OUTCOME **	ACADEMIC ACTIVITY	EVALUATION METHOD	CREDITS	
					min	max
Attending classes	2	1,2	Lectures, mentorship	Keeping attendance records at lectures and consultations	0	10
Continuous knowledge testing	2	1,2	Independent tasks	Reviewing research progress reports	0	30
Seminar paper	2	1,2	Mentorship	Reviewing and grading the seminar paper and tasks	0	60

1.10. Mandatory reading (at the moment of application of the study programme proposal)

Professional and scientific articles published in relevant journals and conferences, handbooks, and instructions for use of software suits (HEC-RAS and other).

1.11. Additional reading (at the moment of application of the study programme proposal)

Julien, P.Y., River Mechanics, Cambridge University Press (2002).
Olsen, N. R. B., Numerical Modeling and Hydraulics, Norwegian University of Science and Technology (2012)
Hicks, F., River Ice Engineering, CSI Publishing Platform (2016).
Professional and scientific articles published in relevant journals and conferences.

1.12. Number of copies of the required reading in relation to the number of students currently attending classes at the course

Title	Number of copies	Number of students
-	-	-

1.13. Methods for monitoring quality which ensure the acquisition of the resulting knowledge, skills, and competencies

Keeping attendance records, monitoring students' activity, and reviewing the created seminar paper.

* Every student activity/academic activity should be assigned with the appropriate share of ECTS credits for individual activities, so that the total number of ECTS credits match the credit value of the course.

** This column should contain the learning outcomes from item 1.3 which have been included in this student/teacher activity.

ELECTIVE COURSES IN THE MODULE ENGINEERING MECHANICS

General information

Course teacher	**Prof.dr.sc. Ivica Guljaš, dipl.ing.građ.**
Course title	**Nonlinear Behaviour Models of Materials and Structures**
Study programme	**Postgraduate University Study Programme Civil Engineering**
Course status	Elective course in the module Engineering Mechanics
Year	I
Acquired credits and the form of implementing academic activities	ECTS coefficient of the student academic load	6.0
	Number of classes (lectures (L)+exercises (E)+seminars (S))	30+20+10

1. COURSE DESCRIPTION

1.1. Course goals

The basic goal of this course is acquiring fundamental knowledge on the basic principles of material and geometric non-linearity, comprehending the simple numerical models of material and geometric non-linearity, and familiarising the students with the complex models of material and geometric non-linearity.

1.2. Preconditions for taking the course

Resistance of materials, Stability of structures, Building materials.

1.3. Expected learning outcomes for the course

Students will be able to:
1. **Design a way to respond to the demands of modelling the behaviour of materials and structures,**
2. **Select the behaviour parameters in linear and non-linear problems,**
3. **Construct and understand the problems that require solutions,**
4. **Evaluate the plastic deformations and cracks in structures and their elements,**
5. **Assign value to the algorithms for the solution of established physical tasks of desired accuracy, within the limitations set by the available resources.**

1.4. Course content

The importance and purpose of non-linear analyses of material and structure behaviour. Constitutive models of engineering materials. Designing and modelling the processes under which materials are destroyed in structures. Computer applications. Fundamentals of the plasticity theory, numerical solutions as part of stress analysis for structures, limit states, and the application to two-dimensional and three-dimensional problems in various materials. Non-linear constitutive models. Plasticity and vulnerability. Load bearing capacity and stability of line and flat systems under the conditions of material and geometric non-linearity. A numerical simulation of the construction degradation process.

1.5. Types of academic activities	☒ lectures ☒ seminars and workshops ☐ exercises ☐ remote education ☐ field classes	☒ independent tasks ☐ multimedia and web ☒ laboratory ☒ mentorship ☐ other ———————————
1.6. Comments	No.	

1.7. Students' obligations						

Regular class attendance, seminar paper, research paper, laboratory work.

1.8. Monitoring the students' work

Attending classes	0.5	Activity during classes		Seminar paper	2.0	Experimental work	
Written exam		Oral exam		Essay		Research	
Project		Continuous knowledge testing	2.0	Paper		Practical work	1.5
Portfolio							

1.9. Grading and evaluating the student's activities during classes and at the final exam

STUDENT ACTIVITY *	ECTS	LEARNING OUTCOME **	ACADEMIC ACTIVITY	EVALUATION METHOD	CREDITS	
					min	max
Attending classes	0.5	1 – 5	Lectures and exercises	Keeping records	0	0
Writing a seminar paper	2.0	3,4,5	Seminar	Grading the paper	0	30
Practical work	1.5	2,4,5	Practical application using numerical and experimental methods	Monitoring and evaluating the results	0	30
Answering the asked questions and assignments	2.0	1 – 5	Oral exam Homework	Grading the answers and assignments	0	40

1.10. Mandatory reading (at the moment of application of the study programme proposal)

1. **Chen.W.F.; Han, D.J.: Plasticity for Structural Engineers, J. Ross Publishing, USA, 2007.**
2. **D.R.J. Owen, E. Hinton, Finite Elements in Plasticity: Theory and Practice, Pineridge Press, Swansea, 1980.**
3. **Z.P. Bažant, L. Cedolin, Stability of Structures, Dover Publications, Mineola, New York, 2003.**
4. **Ghali, A., Nevilee, A.M., Brown, T.G.:, Structural Analysis – A Unified Classical and Matrix Approach, Spon Press, Taylor and Francis Group, London and New York, 2003.**

1.11. Additional reading (at the moment of application of the study programme proposal)

1. Altenbach, F.; Jablonski, F.; Muller, W.H.; Naumenko, K.; Schneider, P.: Advances in Mechanics of Materials and Structures, Springer International Publishing, Switzerland, 2018.
2. Ochsner, A.: Continuum Damage and Fracture Mechanics, Springer Science+Business Media Singapore 2016.

1.12. Number of copies of the required reading in relation to the number of students currently attending classes at the course

Title	Number of copies	Number of students
Not available at the moment	-	5

1.13. Methods for monitoring quality which ensure the acquisition of the resulting knowledge, skills, and competencies
Written and oral partial exams.

General information

Course teacher	**Prof.dr.sc. Ivica Guljaš, dipl.ing.građ.**	
Course title	**Advanced Structural Dynamics**	
Study programme	**Postgraduate University Study Programme Civil Engineering**	
Course status	Elective course in the module Engineering Mechanics	
Year	I	
Acquired credits and the form of implementing academic activities	ECTS coefficient of the student academic load	6.0
	Number of classes (lectures (L)+exercises (E)+seminars (S))	30 + 15 + 15

1. COURSE DESCRIPTION

1.1. Course goals
Modern dynamic structure modelling methods have become an integral part of efficient structure design. As they comprehend and master those methods, the students will become not only users, but active participants in their optimisation.

1.2. Preconditions for taking the course
Structure dynamics

1.3. Expected learning outcomes for the course
A student will be able to: 1. **Evaluate the dynamic feedback of structure and structure elements,** 2. **Formulate an analytical structure model for the purpose of determining the dynamic properties of a structure,** 3. **Design an experimental approach to determining modal parameters,** 4. **Select the non-linear feedback methods in modal analysis.**

1.4. Course content
Advanced Structural Dynamics: Modelling and Measurements. **Expanding the knowledge on the theory and analysis methods of loaded structures. The possibility of modelling and the results of measuring for the evaluation of existing and new buildings. A review and application of the practical consequences of modern research. Nonlinear feedback methods: time and frequency methods, physical and modal model, analytical and experimental models. Methods for the approximation of loads.** **The goal of the course is to expand the knowledge on the behaviour of structural elements under the effects of dynamic loads, procedures for the solution of linear and nonlinear problems, vibrations caused by human activity, dynamic interaction of vehicles and structures, certain aspects of the interaction between the structure and the ground, stochastic processes with special emphasis on the effects of wind, measurements and the use of the results of dynamic measurements for the evaluation of behaviour, signal processing, and operational modal analysis.**

1.5. Types of academic activities	☒ lectures	☒ independent tasks

			seminars and workshops		☐ multimedia and web

	☒ seminars and workshops	☐ multimedia and web
	☐ exercises	☒ laboratory
	☐ remote education	☒ mentorship
	☐ field classes	☐ other _____

1.6. Comments	No.

1.7. Students' obligations
Regular class attendance, seminar paper, research paper, laboratory work.

1.8. Monitoring the students' work							
Attending classes	0.5	Activity during classes		Seminar paper	2.0	Experimental work	1.5
Written exam		Oral exam		Essay		Research	
Project		Continuous knowledge testing	2.0	Paper		Practical work	
Portfolio							

1.9. Grading and evaluating the student's activities during classes and at the final exam

STUDENT ACTIVITY *	ECTS	LEARNING OUTCOME **	ACADEMIC ACTIVITY	EVALUATION METHOD	CREDITS	
					min	max
Attending classes	0.5	1,2,3,4	Lectures and exercises	Keeping records	0	0
Writing a seminar paper	2.0	2,3,4	Seminar	Grading the paper	0	30
Practical work	1.5	2,3	Experimental work	Monitoring and evaluating the results	0	30
Answering the asked questions and assignments	2.0	1,2,3,4	Oral exam Homework	Grading the answers and assignments	0	40

1.10. Mandatory reading (at the moment of application of the study programme proposal)

1. **Čaušević, M.: Dinamika konstrukcija (Structure Dynamics), Golden marketing – Tehnička knjiga, Zagreb, 2010.**
2. **Chopra, A.K.: Dynamics of Structures, Theory and Application to Earthquake Engineering, Prentice Hall, New Jersey, 2001.**
3. **Paz, M.: Matrix Structural Analysis & Dynamics, Theory and Computation, Computers and Structures, Inc., Berkeley, California, 2009.**

1.11. Additional reading (at the moment of application of the study programme proposal)

1. Bachmann, H. at al: Vibration Problems in Structures, Birkhauser Verlag Basel, Germany, 1997.		
2. Kausel, E.: Advanced Structural Dynamics, Cambridge University Press, Cambridge, UK, 2017.		

1.12. Number of copies of the required reading in relation to the number of students currently attending classes at the course		
Title	*Number of copies*	*Number of students*
Čaušević, M.: Dinamika konstrukcija (Structure Dynamics)	20	5

1.13. Methods for monitoring quality which ensure the acquisition of the resulting knowledge, skills, and competencies
Considering that we are assuming that the number of applied students will be low, constant individual work with the students has been made possible, which also enables their constant monitoring. The individual seminar paper should confirm the comprehension of the study materials.

General information		
Course teacher	**Izv.prof.dr.sc. Silva Lozančić,dipl.ing.građ.**	
Course title	**Mechanics of Wood Composites**	
Study programme	**Postgraduate University Study Programme Civil Engineering**	
Course status	Elective course in the module Engineering Mechanics	
Year	I	
Acquired credits and the form of implementing academic activities	ECTS coefficient of the student academic load	6.0
	Number of classes (lectures (L)+exercises (E)+seminars (S))	30+20+10

1. COURSE DESCRIPTION

1.1. Course goals
Learning how to determine and apply the most important measurements for the behaviour of composite materials, and knowing how to calculate systems using the theory of composite mechanics.

1.2. Preconditions for taking the course
There are no preconditions

1.3. Expected learning outcomes for the course
1. Evaluating the mechanical properties of wood composite systems   **2. Testing the coupling coefficients and other important mechanical material measurements for wood composite materials**   **3. Constructing a numerical computer model of a wood composite element**   **4. Testing the effects of long-term static load, the effect of the environment, and the effect of vibrations on wood composite systems**

1.4. Course content
I Why is wood composited //Ecological construction-construction using wood and its composites. Methods for compositing wood and other materials. Legal regulations and the general principles of wood composite systems. //   **II Theoretical and numerical calculation models //**   **Mechanisms for the transfer of loads between the elements in a wood composite system. Mechanical resistance and stability of wood composites. Coupling coefficients as the measurement of connection resilience. Theoretical and numerical behaviour models of wood composite structures. The effect of**

long-term loads on wood composite systems. The effect of the environment on wood composite systems.
III Practical part//
Experimental determination of coupling coefficients with wood-initial and rheological.
The effect of vibrations on wood composite systems.

1.5. Types of academic activities	☒ lectures ☒ seminars and workshops ☐ exercises ☐ remote education ☐ field classes	☒ independent tasks ☐ multimedia and web ☒ laboratory ☐ mentorship ☐ other _____
1.6. Comments	No.	

1.7.   Students' obligations

Attending classes, seminar paper: creating and testing a model-for the laboratory experiment and the numerical, oral exam

1.8.   Monitoring the students' work

Attending classes	2	Activity during classes		Seminar paper	2	Experimental work	0.5
Written exam		Oral exam	1	Essay		Research	
Project		Continuous knowledge testing		Paper		Practical work	0.5
Portfolio							

1.9.   Grading and evaluating the student's activities during classes and at the final exam

STUDENT ACTIVITY *	ECTS	LEARNING OUTCOME **	ACADEMIC ACTIVITY	EVALUATION METHOD	CREDITS	
					min	max
Attending classes	2	1,2,3,4	Lecture	Keeping records	0	0
Experimental work	1	2,4	Independent tasks and laboratory	Manging, reviewing, and monitoring	0	35
Seminar paper	2	1,2,3,4	Seminars and workshops	Reviewing the paper	0	55
Preparing the exam	1	1,2,3,4	Attending classes and laboratory exercises	Grading	0	10

1.10. Mandatory reading (at the moment of application of the study programme proposal)

1) **A Bjelanović, V. Rajčić: Drvene konstrukcije prema europskim normama (Wooden Structures According to European Standards), Hrvatska sveučilišna naklada, 2007.;**
2) **Eurocode 5: EN 1995-1-1, November 2004.;**
3) **CIB W18 Publication (compiled by Goerlacher, R.): Proceedings of the International Council for Research and Innovation in Building and Construction, Working Commission W 18 – Timber**

Structures, Meeting Thirty Eight, Karlsruhe, Germany, 29-31, August, 2005., Meeting Thirty Nine, Florence, Italy, 29-31, August, 2006. and Meeting Thirty Ten, Bled, Slovenia, 29-31, August, 2007.

4) **R. M. Jones: Mechanics of Composite Materials, Materials Science & Engineering Series, Taylor & Francis, 1999**

5) **Jack R. Vinson, Robert L. Sierakowski (auth.), Jack R. Vinson, Robert L. Sierakowski : The Behavior Of Structures Composed Of Composite Materials, NATO Science Series 361,Springer Netherlands**

1.11. Additional reading (at the moment of application of the study programme proposal)

1) Lozančić, S. :Doprinos spoznajama spregnutih konstrukcija drvo- beton (Contribution to the Knowledge about Wood-Concrete Composite Structures) 2003., doctoral thesis, Faculty of Civil Engineering, Osijek

2) Rajčić, V.: Faculty of Civil Engineering of the University of Zagreb „Karakteristike spregnutih nosača drvo-lagani (EPS) beton" (Characteristics of Wood-Light (EPS) Concrete Composite Beams), 2000.

3) Rajčić, V. Čižmar, D. Kompozitni materijali na osnovi drveta i polimera (Composite Wood and Polymer Based Materials) // Građevinar : časopis Hrvatskog saveza građevinskih inženjera = [the journal of the Croatian Association of Civil Engineers] / [glavni i odgovorni urednik, editor-in-chief Veselin Simović] 1949 60 (2008), 10 ; str. 859-865

4) Lacković, V. Šimić, V. Ponašanje kompozitnih materijala pri složenom opterećenju (Behaviour of Composite Materials Under Complex Loads)
URL: http://hrcak.srce.hr/index.php?show=clanak&id_clanak_jezik=10482

1.12. Number of copies of the required reading in relation to the number of students currently attending classes at the course

Title	Number of copies	Number of students
A Bjelanović, V. Rajčić: Drvene konstrukcije prema europskim normama (Wooden Structures According to European Standards)	5	5

1.13. Methods for monitoring quality which ensure the acquisition of the resulting knowledge, skills, and competencies

Consultations and the exam, self-evaluation via the student survey

General information		
Course teacher	**Doc. dr. sc. Davorin Penava, dipl. ing. građ.** **Dr. Vasilis Sarhosis**	
Course title	**Theory and Principles of Assessment and Retrofit of Historical Buildings**	
Study programme	**Postgraduate University Study Programme Civil Engineering**	
Course status	Elective course in the module Engineering Mechanics	
Year	I	
Acquired credits and the form of implementing academic activities	ECTS coefficient of the student academic load	6.0
	Number of classes (lectures (L)+exercises (E)+seminars (S))	30+0+30

1. COURSE DESCRIPTION

1.1. Course goals

The basic goal of the course is teaching about the theoretical bases and principles of evaluating and reconstructing historical buildings. Familiarising the students with the activities and demands regarding historical buildings, leading toward the correct choice of the theoretical or empirical method of calculation for evaluating historical buildings, followed by finding the most appropriate method for the reconstruction of the building, if necessary. The part of the teaching materials in the course also covers the empirical methods for determining the condition of buildings or parts of buildings, followed by continuous monitoring and classification in datasets.

1.2. Preconditions for taking the course	

There are no preconditions.

1.3. Expected learning outcomes for the course	

After completing their study obligations for this course, the students will be able to:
1) Assign value to the comprehensive knowledge and understanding of scientific principles and methodology required to support their education in their engineering discipline, and the understanding and knowledge about the scientific principles of related disciplines, in order to enable the appreciation of the scientific and engineering context, and in order to support their understanding of relevant historical, present, and future developments and technologies;
2) Compare and select various calculation models while considering their limitations, in order to resolve engineering problems and carry out the appropriate reconstruction interventions;
3) Evaluate the needs of the business and the needs of the users, including considerations like the wider engineering context, perception of the wider public, and aesthetics;
4) Re-examine the relevant legal requirements that regulate the activities and responsibilities in engineering, and the awareness that it can be different at the international level;
5) Compare the characteristics of specific measuring instruments, with great knowledge and understanding of a wide variety of engineering materials and components.

1.4. Course content	

Introduction to the course, Cultural and historical value of historical buildings and their preservation; Types and methods of construction and the basic structural elements of historical buildings; Original building materials of historical buildings; Activities and requirements of historical buildings; Historical buildings in earthquake-prone areas; Calculation models for the preservation of historical buildings; Procedures for passive and active monitoring of the behaviour of historical heritage buildings; Innovative methods and construction materials for the purpose of protection of historical buildings; In-situ static and dynamic testing of historical buildings; 3D laser imaging and estimating the condition of the building; Methods for the reinforcement and protection of historical buildings; Traditional wooden frames filled with masonry; Structures from archaeological sites; The legal framework regarding activities with historical buildings.

1.5. Types of academic activities	☒ lectures ☒ seminars and workshops ☐ exercises ☒ remote education ☐ field classes	☒ independent tasks ☒ multimedia and web ☐ laboratory ☐ mentorship ☐ other _____

1.6. Comments	No.	

1.7. Students' obligations	

Attending classes; Seminar paper; Oral exam.

1.8. Monitoring the students' work	

Attending classes	2.0	Activity during classes		Seminar paper	3.0	Experimental work	
Written exam		Oral exam	1.0	Essay		Research	

Project		Continuous knowledge testing		Paper		Practical work	
Portfolio							

STUDENT ACTIVITY *	ECTS	LEARNING OUTCOME **	ACADEMIC ACTIVITY	EVALUATION METHOD	CREDITS	
					min	max
Attending classes	2.0	1-9	Lectures and seminars	Attendance records	0	0
Creating a seminar paper	3.0	1-9	Seminar paper	Grading	0	70
Oral answers to asked questions	1.0	1-9	Oral exam	Grading	0	30

1.10. Mandatory reading (at the moment of application of the study programme proposal)

1) **Feilden, B. M. (Bernard M. (2003) Conservation of historic buildings. Architectural Press.**
2) **Forsyth, M. (ed.) (2008) Materials and Skills for Historic Building Conservation. Oxford, UK: Blackwell Publishing Ltd.**
3) **Harris, R. (1993) Discovering timber-framed buildings. Shire.**
4) **Hopkins, O. (2012) Reading architecture : a visual lexicon. Lawrence King.**
5) **Hoxley, M. (2009) Good practice guide : building condition surveys. RIBA Publishing.**
6) **Asteris, P. G. and Plevris, V. (2015) Handbook of research on seismic assessment and rehabilitation of historic structures. IGI Global.**
7) **Swallow, P. (2004) Measurement and recording of historic buildings. Donhead.**

1.11. Additional reading (at the moment of application of the study programme proposal)

1) Bennett, F. (Frank E. and Pinion, A. (2000) Roof slating and tiling. Donhead.
2) Fitz, S. (Stephan) et al. (1998) Conservation of historic brick structures : case studies and reports of research. Donhead.
3) Lynch, G. C. J. (2007) The history of gauged brickwork : conservation, repair and modern application. Elsevier/Butterworth-Heinemann.
4) Schofield, J. (1997) Lime in building : a practical guide. Black Dog.
5) Sorić, Z. (2016) Masonry structures | Zidane konstrukcije. Zagreb: University of Zagreb, Zagreb, Croatia.

1.12. Number of copies of the required reading in relation to the number of students currently attending classes at the course

Title	Number of copies	Number of students
Not available at the moment	-	5

1.13. Methods for monitoring quality which ensure the acquisition of the resulting knowledge, skills, and competencies

The evaluation of the learning outcomes implemented by regularly gathering feedback from the students regarding whether specific learning outcomes are being achieved and whether all the outcomes have been covered (analysis of the student survey on the quality of teachers, attendance and communication during lectures, as well as the analysis of individual/group seminar papers).

Proving the validity of the study programme according to the learning outcomes is implemented through the analysis of the connection between the learning outcomes, teaching methods, and testing the students' knowledge at the study programme level. It also includes the evaluation on the way the determined learning outcomes affect the students' academic load.

General information		
Course teacher	**Prof. dr. sc. Ivica Kožar, dipl. ing. građ. (University of Rijeka, Faculty of Civil Engineering)**	
Course title	**Inverse Modelling and Parameter Identification**	
Study programme	**Postgraduate University Study Programme Civil Engineering**	
Course status	Elective course in the module Engineering Mechanics	
Year	I	
Acquired credits and the form of implementing academic activities	ECTS coefficient of the student academic load	6.0
	Number of classes (lectures (L)+exercises (E)+seminars (S))	30+0+30

1. COURSE DESCRIPTION

1.1. Course goals

The primary goal of the course is connecting the model and the experiment, whether in a laboratory or in the field. The course describes the procedures for the development of mathematical structure models with parameters and determining the optimal parameters on the basis of measurements, where it is assumed that the parameters may not be measured directly. The emphasis is placed on inverse procedures with discretised models (final elements, differences, volumes) and on the procedures for determining parameters that cannot be measured. The formation of the measuring model (measuring matrix) and the methods for the determination of parameters from the measurement data are described.

1.2. Preconditions for taking the course

There are no preconditions.

1.3. Expected learning outcomes for the course

After completing their study obligations for this course, the students will be able to:
1) **Evaluate the quality of a model of a structure;**
2) **Assign value to the usability of a structure model for the purpose of determining the required values (displacement and load);**
3) **Select the appropriate connection between the parameters of the model and the measurement data (construct a measuring matrix);**
4) **Determine the model parameters from the measurements of the structure;**
5) **Assign value to the usability of the measuring results of a structure for the purpose of determining the relevant parameters.**

1.4. Course content

Conducting simple measurements using a mobile app and gathering the measurement data. Formulating the mathematical model that connects the measurement and the relevant parameter («forward model»), where the parameter has been set implicitly. Formulating the inverse model and the measuring matrix which directly connects the model parameters and the series of the measurement data. Presentation of the effect of discretization (final elements, final differences, final volumes) on the formulation of the inverse problem. Presentation of the cutting variants of the least squares method (linear and nonlinear, Levenberg-Marquardt), stochastically based procedures (various variants of the Monte Carlo method), Kalman filter.

1.5. Types of academic activities	☒ lectures ☒ seminars and workshops ☐ exercises ☒ remote education ☐ field classes	☒ independent tasks ☒ multimedia and web ☐ laboratory ☐ mentorship ☐ other _____

| 1.6. Comments | | No. | |

1.7. Students' obligations

Attending classes; Seminar paper; Oral exam.

1.8. Monitoring the students' work

Attending classes	2.0	Activity during classes		Seminar paper	3.0	Experimental work	
Written exam		Oral exam	1.0	Essay		Research	
Project		Continuous knowledge testing		Paper		Practical work	
Portfolio							

1.9. Grading and evaluating the student's activities during classes and at the final exam

STUDENT ACTIVITY *	ECTS	LEARNING OUTCOME **	ACADEMIC ACTIVITY	EVALUATION METHOD	CREDITS	
					min	max
Attending classes	**2.0**	**1-9**	**Lectures and seminars**	**Attendance records**	**0**	**0**
Creating a seminar paper	**3.0**	**1-9**	**Seminar paper**	**Grading**	**0**	**70**
Oral answers to asked questions	**1.0**	**1-9**	**Oral exam**	**Grading**	**0**	**30**

1.10. Mandatory reading (at the moment of application of the study programme proposal)

1) **Liu, G.R., Han, X. (2003) Computational Inverse Techniques in Nondestructive Evaluation. CRC Press.**
2) **Ibrahimbegović, A. (ed.) (2016) Computational Methods for Solids and Fluids (Multiscale Analysis, Probability Aspects and Model Reduction). Springer.**
3) **Lyshevski, S.E. (2003) Engineering and Scientific Computations Using MATLAB. Wiley - Interscience.**
4) **Menke, W. (2012) Geophysical Data Analysis: Discrete Inverse Theory. Academic Press.**

1.11. Additional reading (at the moment of application of the study programme proposal)

1) Lozzi-Kožar, D. and Kožar, I. (2017) ESTIMATION OF THE EDDY THERMAL CONDUCTIVITY FOR LAKE BOTONEGA. *Engineering Review, Vol. 37, Issue 3, 322-334*
2) Kožar, I., Torić Malić, N., Rukavina, T. (2018) Inverse model for pullout determination of steel fibers. Coupled Systems Mechanics, *Vol. 7, No. 197-209*
3) Kožar, I. and Lozzi-Kožar, D. (2017) FLUX DETERMINATION USING FINITE ELEMENTS: GLOBAL VS. LOCAL CALCULATION. Tehnički vjesnik 24, No.1, 247-252
4) Kožar, I., Rukavina, T., Torić Malić, N. (2017) SIMILARITY OF STRUCTURES BASED ON MATRIX SIMILARITY. Tehnički vjesnik 24, No.1, 239-246

1.12. Number of copies of the required reading in relation to the number of students currently attending classes at the course		
Title (The teacher has access to the mandatory reading materials in PDF form and he can provide the students with the necessary chapters)	Number of copies	Number of students
Not available at the moment	-	5

1.13. Methods for monitoring quality which ensure the acquisition of the resulting knowledge, skills, and competencies
The evaluation of the learning outcomes implemented by regularly gathering feedback from the students regarding whether specific learning outcomes are being achieved and whether all the outcomes have been covered (analysis of the student survey on the quality of teachers, attendance and communication during lectures, as well as the analysis of individual/group seminar papers).   Proving the validity of the study programme according to the learning outcomes is implemented through the analysis of the connection between the learning outcomes, teaching methods, and testing the students' knowledge at the study programme level. It also includes the evaluation on the way the determined learning outcomes affect the students' academic load.

General information

Course teacher	**doc.dr.sc. Tanja Kalman Šipoš**	
Course title	**Numerical Models for the Behaviour of Elements, Systems, and Loads**	
Study programme	**Postgraduate University Study Programme Civil Engineering**	
Course status	Elective course in the module Engineering Mechanics	
Year	I	
Acquired credits and the form of implementing academic activities	ECTS coefficient of the student academic load	6.0
	Number of classes (lectures (L)+exercises (E)+seminars (S))	30+0+30

1. COURSE DESCRIPTION

1.1. Course goals
Acquiring the fundamental knowledge on the numerical methods used in computer calculations of structures. Familiarising the students with the significant modern approaches, methods, and trends in numerical calculations of structures. Learning to solve problems related to finding numerical solutions, accuracy, sensitivity, stability, convergence. Mandatory use of open-source software and commercial software.

1.2. Preconditions for taking the course
There are no preconditions.

1.3. Expected learning outcomes for the course
1. Evaluation of the effect of the selected numerical method on the total numerical solution of the problem. **2. Formulation of the basic numerical approaches.** **3. Preparation of the numerical model in the application of modern numerical models for the calculation of structures and loads.** **4. Evaluation of the effective numerical solutions of structures and loads**

1.4. Course content
Introduction to numerical methods for the evaluation of the behaviour of structures. Theoretical approach to numerical methods. Discretisation, interpolation, and numerical integration. Formulating the numerical model concepts at the material and element levels. Selection of the appropriate numerical model at the material and element levels. Formulating the structure response model. Selecting the appropriate numerical model for the description of the nonlinear behaviour of a structure. Numerical models and the selection of various types of loads. Problems related to the selection of the appropriate numerical models via accuracy, sensitivity analysis, stability, and convergence. Application of open-source and commercial software for simulating the behaviour of structural systems and loads. Valorisation of numerical calculations.

1.5. Types of academic activities	☒ lectures ☒ seminars and workshops ☐ exercises ☐ field classes ☐ field classes	☐ independent tasks ☐ multimedia and web ☐ laboratory ☐ mentorship ☐ other

1.6. Comments	-

1.7. Students' obligations

Seminar paper and oral exam

1.8. Monitoring the students' work

Attending classes	0.5	Activity during classes		Seminar paper	3.5	Experimental work	
Written exam		Oral exam	2	Essay		Research	
Project		Continuous knowledge testing		Paper		Practical work	
Portfolio							

1.9. Grading and evaluating the student's activities during classes and at the final exam

STUDENT ACTIVITY *	ECTS	LEARNING OUTCOME **	ACADEMIC ACTIVITY	EVALUATION METHOD	CREDITS min	CREDITS max
Attending classes	0.5	1,2,3	Lectures	Keeping attendance records	0	0
Writing a seminar paper	3.5	1,2,3,4	Seminar paper	Reviewing and grading the seminar paper	0	70
Answering oral questions	2	3,4	Oral exam	Evaluating the provided answers	0	30

1.10. Mandatory reading (at the moment of application of the study programme proposal)

1. M. Meštrović, 2017. Nelinearna statika greda i okvira (Nonlinear statics of beams and frames), Zagreb, Faculty of Civil Engineering.
2. M. A. Crisfield. 1991. Non-linear finite element analysis of solids and structures vol.1. John Wiley & sons, chapters 4, 9.
3. P. Wriggers. 2008. Nonlinear finite element methods. Berlin, Springer.
4. M. N. Fardis, E. C. Carvalho, P. Fajfar, A. Pecker, 2015. Seismic Design of Concrete Buildings to Eurocode 8, CRC Press,
5. A. Ibrahimbegović ,2009. Nonlinear solid mechanics. Theoretical formulations and finite element solution methods, Springer
6. Ulrich Häußler-Combe, 2014. Computational Methods for Reinforced Concrete Structures, Wiley, Ernst & Sohn.

1.11. Additional reading (at the moment of application of the study programme proposal)

OpenSees, 2016.Open System for Earthquake Engineering Simulation, User Command-Language Manual, ver 2.5.0", http://opensees.berkeley.edu/wiki/index.php/Command_Manual

1.12. Number of copies of the required reading in relation to the number of students currently attending classes at the course		
Title	Number of copies	Number of students
Meštrović, Mladen, Nelinearna statika greda i okvira (Nonlinear statics of beams and frames), Zagreb: Faculty of Civil Engineering, 2017	8	5

1.13. Methods for monitoring quality which ensure the acquisition of the resulting knowledge, skills, and competencies
Conducting scientific research and creating and presenting the seminar paper.

General information		
Course teacher	**Doc.dr.sc. Goran Gazić**	
Course title	**Experimental Models of Loads and Structures**	
Study programme	**Postgraduate University Study Programme Civil Engineering**	
Course status	Elective course in the module Engineering Mechanics	
Year	I	
Acquired credits and the form of implementing academic activities	ECTS coefficient of the student academic load	6.0
	Number of classes (lectures (L)+exercises (E)+seminars (S))	30+0+30

1. COURSE DESCRIPTION

1.1. Course goals

The basic goal of the course is:
1. Familiarising the students with the principles of model testing
2. Training and preparing the students for independent planning and organising of experimental research
3. Training the students to conduct standardised (normative) testing
4. Training the students to implements specific research depending on the type of load and the type of structure
5. Training the student to process and interpret the results of measurements
6. Training the students to evaluate and compare the results of measurements

1.2. Preconditions for taking the course

There are no preconditions

1.3. Expected learning outcomes for the course

After completing the course, the students will be able to:
1. Independently plan and organise experimental research
2. Conduct standardised (normative) testing
3. Design specific research depending on the type of load and the type of structure
4. Process and interpret the results of the measurements
5. Evaluate and compare the results of the measurements

1.4. Course content

Introduction to model analogy; dimensional analysis; laws of similarity; the effect of the size of the test sample; measuring devices-principles and application; planning and conducting tests on the elements and models of the structure; normative testing; in-situ planning and implementation of testing; simulation of static loads; simulation of dynamic loads; processing and interpretation, and the appropriate presentation of results.

1.5. Types of academic activities	☒ lectures ☒ seminars and workshops ☐ exercises ☐ remote education ☐ field classes	☒ independent tasks ☐ multimedia and web ☒ laboratory ☒ mentorship ☐ other _____

1.6. Comments	No

1.7. Students' obligations

Seminar paper

1.8. Monitoring the students' work

Attending classes	0.5	Activity during classes	0.5	Seminar paper	5	Experimental work	
Written exam		Oral exam		Essay		Research	
Project		Continuous knowledge testing		Paper		Practical work	
Portfolio							

1.9. Grading and evaluating the student's activities during classes and at the final exam

STUDENT ACTIVITY *	ECTS	LEARNING OUTCOME **	ACADEMIC ACTIVITY	EVALUATION METHOD	CREDITS	
					min	max
Attending classes	0.5	1, 2, 3, 4, 5	Lectures and exercises	Attendance records	0	0
Solving individual problems	0.5	1, 2, 3	Lectures and exercises	Reviewing the solved problems	0	20
Writing a seminar paper	5	1, 2, 3, 4, 5	Seminar paper	Reviewing the seminar paper	0	80

1.10. Mandatory reading (at the moment of application of the study programme proposal)

D. Aničić: *Ispitivanje konstrukcija (Testing Structures)*, J. J. Strossmayer University of Osijek, Faculty of Civil Engineering Osijek, 2002.

1.11. Additional reading (at the moment of application of the study programme proposal)

Harris, H.G, Sabnis, G.M., *Structural modeling and experimental techniques*, 2nd edition, CRC Press, 1999.

1.12. Number of copies of the required reading in relation to the number of students currently attending classes at the course

Title	Number of copies	Number of students
D. Aničić: Ispitivanje konstrukcija (Testing Structures)	10	5

1.13. Methods for monitoring quality which ensure the acquisition of the resulting knowledge, skills, and competencies	

Keeping lecture and consultation attendance records. Review of the seminar paper according to topics.

General information

Course teacher	**Izv.prof.dr.sc. Mirjana Bošnjak-Klečina, dipl.ing.građ.**	
Course title	**Stability of Historical Religious Buildings**	
Study programme	**Postgraduate University Study Programme Civil Engineering**	
Course status	Elective course in the module Engineering Mechanics	
Year	I	
Acquired credits and the form of implementing academic activities	ECTS coefficient of the student academic load	6.0
	Number of classes (lectures (L)+exercises (E)+seminars (S))	30+10+20

1. COURSE DESCRIPTION

1.1. Course goals

Recognising the importance of the cultural value of historical religious buildings, methods of construction, original used materials, and the basic structural system. Familiarising the students with some of the methods and materials used for the reinforcement and protection of such buildings while preserving their originality.

1.2. Preconditions for taking the course

There are no preconditions for taking the course.

1.3. Expected learning outcomes for the course

1. Evaluating the historical importance of the structure and the originality of the parts of the structure
2. Evaluating the level of damage the building has suffered by a visual inspection
3. Recommending the appropriate methods for determining the conditions of the building materials
4. Evaluating the condition of the structural elements of the building
5. Proposing the methods and materials for the reinforcement and protection of the structure

1.4. Course content

The cultural value of historical religious buildings; construction methods; load-bearing systems; standard structural system for the transfer of loads: roof structure, substructures like: arches, fornixes, domes, masonry; load transfer and distribution – load transfer within the structural system from the roof to the foundations; original methods for achieving stability; the effects of earthquakes on the structure; original materials, calculation models (by applying the finite element method and related methods) for determining stability; destructive and non-destructive methods for determining the condition of the building materials; procedures for passive and active monitoring of the behaviour of historical religious buildings; the evaluation of the condition of a building; methods and materials for reinforcing and protecting historical religious buildings which are permitted according to conservation rules.

1.5. Types of academic activities	☒ lectures ☒ seminars and workshops ☐ exercises ☐ remote education	☒ independent tasks ☐ multimedia and web ☒ laboratory ☒ mentorship

		☐ field classes	☐ other _____

1.6. Comments	No.

1.7. Students' obligations
Regular class attendance, seminar paper, research paper.

1.8. Monitoring the students' work

Attending classes	2.0	Activity during classes		Seminar paper	2.0	Experimental work	
Written exam		Oral exam		Essay		Research	
Project		Continuous knowledge testing	2.0	Paper		Practical work	
Portfolio							

1.9. Grading and evaluating the student's activities during classes and at the final exam

STUDENT ACTIVITY *	ECTS	LEARNING OUTCOME **	ACADEMIC ACTIVITY	EVALUATION METHOD	CREDITS	
					min	max
Attending classes	2.0	1-5	Lectures and exercises	Keeping records	0	0
Creating a seminar paper	2.0	1-5	Seminar paper	Grading	0	60
Answering the asked questions and assignments	2.0	1-5	Oral exam Homework	Grading	0	40

1.10. Mandatory reading (at the moment of application of the study programme proposal)

1. **De Vent, I. (2011.) Prototype of diagnostic decision support tool for structural damage in masonry. Delft, University of Technology.**
2. **Lourenço, P. J. B. B. (1996.) Computational strategies for masonry structures. Delft, University of Technology.**
3. **Beckmann, P. and Bowles, R. (2004.) Structural aspects of building conservation. Oxford, Elsevier Butterworth-Heinemann.**
4. **Addleson, L. (1989.) Building failures; a guide to diagnosis, remedy and prevention. London, Butterworth Architecture.**
5. **Asteris, P. G. and Plevris, V. (2015.) Handbook of research on seismic assessment and rehabilitation of historic structures. IGI Global.**
6. **Sorić, Z. (2016.) Zidane konstrukcije (Masonry Structures). Zelina,**
7. **Vukičević-Samardžija, D. (1986.) Sakralna gotička arhitektura u Slavoniji (Religious Gothic Architecture in Slavonia). Zagreb, Centre for Historical Sciences.**

1.11. Additional reading (at the moment of application of the study programme proposal)

1. Brencich, A. and Lagomarsino, S. (1998.) A macro-element dynamic model for masonry shear walls. In: Pande GN and Middleton J, ed. Computer methods in structural masonry – 4. London, E&FN Spon.
2. Triantafillou, T. (2011.) Textile-Reinforced Mortars (TRM): A new generation of Composite Materials as Alternative to Fibrereinforced Polymers (FRP) for strengthening and Seismic Retrofitting of Structures, Composite materials. London, Springer-Verlag.
3. Ahnert, R. and Krause, K. H. (1996.) Typische Baukonstruktionen von 1860 bid 1960, zur Beurteilung der vorhandenen Bausubstanz. Band 1. Berlin, Verlag fur Bauwesen.
4. Ahnert, R. and Krause, K. H. (1996.) Typische Baukonstruktionen von 1860 bid 1960, zur Beurteilung der vorhandenen Bausubstanz. Band 2. Berlin, Verlag fur Bauwesen.

1.12. Number of copies of the required reading in relation to the number of students currently attending classes at the course

Title	Number of copies	Number of students
Not available at the moment	-	5

1.13. Methods for monitoring quality which ensure the acquisition of the resulting knowledge, skills, and competencies

By creating and presenting the seminar paper, homework, and the oral exam.

General information

Course teacher	**Izv. prof. dr. sc. Ivana Miličević** **Prof.dr.sc. Ivanka Netinger Grubeša**	
Course title	**New Materials in Civil Engineering**	
Study programme	**Postgraduate University Study Programme Civil Engineering**	
Course status	Elective course in the module Engineering Mechanics	
Year	I	
Acquired credits and the form of implementing academic activities	ECTS coefficient of the student academic load	6.0
	Number of classes (lectures (L)+exercises (E)+seminars (S))	30+0+30

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1. COURSE DESCRIPTION

1.1. Course goals

The goal of the course is acquiring fundamental knowledge about the theory and technology of new materials in construction, with the purpose of reaching optimal decisions in selecting modern materials to be used in construction, considering the requirements of the structure.

1.2. Preconditions for taking the course

There are no preconditions.

1.3. Expected learning outcomes for the course

1. **Defining the basic properties of composite materials based on cement, wood, fibreglass, and other new types of materials.**
2. **Testing, analysing, and interpreting the structure and properties of new materials.**
3. **Optimising the composition of composite materials.**
4. **Selecting the optimal type of material depending on the requirements of the structure.**

1.4. Course content

Modern development of cement composites (micro-reinforced concrete, self-compacting concrete, transparent concrete, self-healing concrete, high performance concrete, recycled materials concrete, green concrete, smart concrete, jet high-performance concrete, flexible concrete, concrete fabric, vacuum concrete, injection mixtures, geopolymers/liquid stone, mortar). The relationship between technology, structure, and properties of cement composites. Modern development of masonry structural materials (materials and products based on clay, polystyrene, autoclaved aerated concrete, mineral bonded wood wool board, unfired bricks). Composite materials and wood-based products, transparent wood, electrified wood. Composite polymer-based materials, fibreglass, transparent polycarbonates. New types of reinforcement materials (microfibres of various types and origins, load-bearing reinforcement of various types and origins), transparent aluminium. Ceramics used as cladding. Optimisation of the properties of new materials dependent on the structural requirements.

1.5. Types of academic activities	☒ lectures ☒ seminars and workshops ☐ exercises ☐ remote education ☐ field classes ☐ independent tasks ☐ multimedia and web ☐ laboratory ☐ mentorship ☐ other

1.6. Comments	---

1.7. Students' obligations

Regular class attendance and creating a seminar paper.

1.8. Monitoring the students' work

Attending classes	0.5	Activity during classes		Seminar paper	3.5	Experimental work	
Written exam		Oral exam	2	Essay		Research	
Project		Continuous knowledge testing		Paper		Practical work	
Portfolio							

1.9. Grading and evaluating the student's activities during classes and at the final exam

STUDENT ACTIVITY *	ECTS	LEARNING OUTCOME **	ACADEMIC ACTIVITY	EVALUATION METHOD	CREDITS	
					min	max
Attending classes	0.5	1,2,3	Lectures	Keeping attendance records	0	0
Writing a seminar paper	3.5	1,2,3,4	Seminar paper	Reviewing and grading the seminar paper	0	70
Answering oral questions	2	1,2,3,4	Oral exam	Evaluating the provided answers	0	30

1.10. Mandatory reading (at the moment of application of the study programme proposal)

- **Advanced Engineering Materials and Modelling, Ashutosh Tiwari, N. Arul Murugan and Rajeev Ahuj, WILEY-Scrivener, 2018.**
- **Materials: Engineering, Science, Processing and Design 4th Edition by Michael F. Ashby, Hugh Shercliff, David Cebon, 2019.**
- **New Trends in Eco-efficient and Recycled Concrete (Woodhead Publishing Series in Civil and Structural Engineering) Paperback – 26 Nov 2018. by Jorge de Brito, Francisco Agrela**

• **Materials Engineering: Bonding, Structure, and Structure-Property Relationships 1st Edition by Susan Trolier-McKinstry, Robert E. Newnham, 2017.**

1.11. Additional reading (at the moment of application of the study programme proposal)

• Materials for Construction and Civil Engineering: Science, Processing, and Design, M. Clara Gonçalves, Fernanda Margarido, 2015. • Sustainable Construction Materials: Glass Cullet (Woodhead Publishing Series in Civil and Structural Engineering) 1st Edition by Ravindra K. Dhir OBE, Jorge de Brito, Gurmel S. Ghataora, Chao Qun Lye, 2018. • Sustainable Construction Materials: Recycled Aggregates (Woodhead Publishing Series in Civil and Structural Engineering) Hardcover – 21 Jan 2019 by Ravindra K. Dhir OBE, Jorge de Brito, Rui V. Silva, Chao Qun Lye • Ceramic Materials: Science and Engineering 2nd Edition, by C. Barry Carter, M. Grant Norton, 2013.

1.12. Number of copies of the required reading in relation to the number of students currently attending classes at the course

Title	Number of copies	Number of students
Not available at the moment	-	5

1.13. Methods for monitoring quality which ensure the acquisition of the resulting knowledge, skills, and competencies

The students' activities are monitored by keeping lecture attendance records and the monitoring the students' effort in creating the semester paper.

* Every student activity/academic activity should be assigned with the appropriate share of ECTS credits for individual activities, so that the total number of ECTS credits match the credit value of the course.

** This column should contain the learning outcomes from item 1.3 which have been included in this student/teacher activity.

ELECTIVE COURSES IN THE MODULE TRANSPORTATION ENGINEERING AND GEOTECHNICS

General information			
Course teacher	**Prof.dr.sc. Sanja Dimter**		
Course title	**Flexible Pavement Structures**		
Study programme	**Postgraduate University Study Programme Civil Engineering**		
Course status	Elective course in the module Transportation Engineering and Geotechnics		
Year	I		
Acquired credits and the form of implementing academic activities	ECTS coefficient of the student academic load		6.0
	Number of classes (lectures (L)+exercises (E)+seminars (S))		30+0+30

1. COURSE DESCRIPTION

1.1. Course goals

The goal of the course is training the students in advanced analysis of flexible pavement structures and the analysis of the parameters which are relevant for the design and behaviour of flexible pavement structures.

1.2. Preconditions for taking the course

There are no preconditions.

1.3. Expected learning outcomes for the course

1. **Applying the required/selected structural design method for flexible pavement structures and analysing the calculation results**
2. **Analysing and selecting the parameters which are important for the behaviour of flexible pavement structures**
3. **Evaluating the model of the behaviour of a flexible pavement structure with reference to the selected parameters**
4. **Interpreting and presenting the research results in the form of a scientific-research paper**

1.4. Course content

Introductory chapters on flexible pavement structures (basic features, relevant parameters, basic design settings). Methods for the calculation of stress, deformations, and displacement in flexible pavement structures. Software for the calculation of stress and deformations. Selecting the method for the planned calculations. Characterisation of the materials used for flexible pavement structures: modulus of elasticity for specific layers of the pavement structure and subgrade, Poisson coefficients. Relevant climate factors. Structural models and input parameters (traffic load, structure geometry, property of the materials used for the pavement structure and subgrade. Allowed stress and deformations. The concept of cumulative utilisation of the pavement structure. The crack problem; theory and mechanisms. Special asphalt mixtures. The concept of perpetual pavements. Selection and application of alternative materials in designing and building flexible pavement structures.

1.5. Types of academic activities	☒ lectures ☒ seminars and workshops ☐ exercises ☐ remote education ☐ field classes	☐ independent tasks ☐ multimedia and web ☐ laboratory ☐ mentorship ☐ other _____

1.6. Comments			No.	

<table>
<tr><td colspan="5">1.7. Students' obligations</td></tr>
<tr><td colspan="5">Regular class attendance, creating and defending the seminar paper as the final exam, preparing the seminar paper topic for an article.</td></tr>
</table>

1.8. Monitoring the students' work

Attending classes	1.0	Activity during classes		Seminar paper	3.0	Experimental work	
Written exam		Oral exam	2.0	Essay		Research	
Project		Continuous knowledge testing		Paper		Practical work	
Portfolio							

1.9. Grading and evaluating the student's activities during classes and at the final exam

STUDENT ACTIVITY *	ECTS	LEARNING OUTCOME **	ACADEMIC ACTIVITY	EVALUATION METHOD	CREDITS	
					min	max
Attending classes	1.0	1,2,3,4	Consultation classes	Keeping attendance records	0	0
Creating a seminar paper (analysis of the existing research from scientific papers in the field of the seminar paper topic)	3.0	1,2,3	Independent research and writing a seminar paper	Reviewing and grading the seminar paper	0	50
Final exam	2.0	1,2,3,4	Oral exam	Evaluating the students' answers	0	50

1.10. Mandatory reading (at the moment of application of the study programme proposal)

- *Mallick, R.B., El-Korchi, T.: Pavement engineering: Principles and Practice, 3rd edition, Taylor and Francis Group, 2017. https://doi.org/10.1201/9781315119205*
- *Shin-Che, H., Di Benedetto, H.: Advances in Asphalt Materials, 1st Edition Road and Pavement Construction, Elsevier Science & Technology 2015. eBook ISBN: 9780081002711*
- *COST 333 Development of New Bituminous Pavement Design Method, Final Report of the Action, 1999.*
- *Babić, B.: Projektiranje kolničkih konstrukcija (Designing Pavement Structures), HDGI, Zagreb, 1997.*

1.11. Additional reading (at the moment of application of the study programme proposal)

- Loizos, A., Partl, M., Scarpas, T., Al-Qadi, I.: Advanced testing and Characterization of Bituminous Materials, Taylor and Francis Group, 2009.
- Selected scientific articles published in relevant journals

1.12. Number of copies of the required reading in relation to the number of students currently attending classes at the course

Title	Number of copies	Number of students
Mallick, R.B., El-Korchi, T.: *Pavement engineering: Principles and Practice*, 3rd	1	5

edition, Taylor and Francis Group, 2017. https://doi.org/10.1201/9781315119205		
Shin-Che, H., Di Benedetto, H.: *Advances in Asphalt Materials,* 1st Edition Road and Pavement Construction, Elsevier Science & Technology 2015. eBook ISBN: 9780081002711	1	5
COST 333 *Development of New Bituminous Pavement Design Method,* Final Report of the Action, 1999.	1	5
Babić, B.: *Projektiranje kolničkih konstrukcija (Designing Pavement Structures)*, HDGI, Zagreb, 1997.	5	5

1.13. Methods for monitoring quality which ensure the acquisition of the resulting knowledge, skills, and competencies	
The teacher will monitor and report whether the student is carrying out their activities independently, on the dynamics of meeting the requirements for enrolment to the following year of the study programme, and on the quality of the published articles which resulted from the teaching materials at the course; if necessary, student evaluation will be conducted via surveys.	

General information

Course teacher	**Prof.dr.sc. Aleksandra Deluka-Tibljaš**	
Course title	**Analysis of Asphalt Mixtures**	
Study programme	**Postgraduate University Study Programme Civil Engineering**	
Course status	Elective course in the module Transportation Engineering and Geotechnics	
Year	I	
Acquired credits and the form of implementing academic activities	ECTS coefficient of the student academic load	6.0
	Number of classes (lectures (L)+exercises (E)+seminars (S))	30+0+30

1. COURSE DESCRIPTION

1.1. Course goals
The goal of the course is training the students for experimental testing of asphalt mixtures and testing of non-standard types of asphalt mixtures. Through theoretical and experimental work, the students will adopt the standard methods for testing asphalt mixtures, as well as non-standard testing focused at ensuring the durability of asphalt mixtures.
1.2. Preconditions for taking the course
There are no preconditions
1.3. Expected learning outcomes for the course

After successfully passing the course, the student will be trained to:
   1. Prepare the asphalt mixture while adhering to the standing norms
   2. Conduct the experimental testing of the asphalt mixture

3. **Analyse the existing research related to the selected type of the asphalt mixture and the property**
4. **Conduct specific testing for the selected type of the asphalt mixture**
5. **Prepare a scientific article in English based on the research conducted as part of the course**

1.4. Course content	

- Theoretical analysis of construction materials and the parameters which are significant for designing asphalt mixtures.
- Introduction to design and designing asphalt mixtures according to various design criteria (fatigue, rutting, temperature...).
- Advanced methods for testing various types of asphalt mixtures. Testing asphalt mixtures with various percentages of added recycled materials.
- Experimental methods for the determination of the effect of the initial composition of the mixture on the behaviour of the mixture when used.

1.5. Types of academic activities	x lectures · ⊠ seminars and workshops · x exercises · ☐ remote education · ☐ field classes x independent tasks · ☐ multimedia and web · x laboratory · ☐ mentorship · ☐ other _____
1.6. Comments	No comments

1.7. Students' obligations	

- Creating a seminar paper
- Reports from conducted laboratory testing
- Preparing the article for publication

1.8. Monitoring the students' work

Attending classes	2	Activity during classes		Seminar paper	0.5	Experimental work	1.5
Written exam		Oral exam	0.5	Essay		Research	1.5
Project		Continuous knowledge testing		Paper	1	Practical work	
Portfolio							

1.9. Grading and evaluating the student's activities during classes and at the final exam

STUDENT ACTIVITY *	ECTS	LEARNING OUTCOME **	ACADEMIC ACTIVITY	EVALUATION METHOD	CREDITS	
					min	max
Experimental determination of the properties of asphalt mixtures	2.0	1,2,4	Laboratory exercises	Grading the seminar paper	8	10
Analysis of the existing research (scientific articles) according to a	1.5	3	Seminar, consultation classes	Grading the seminar paper – oral defence	6	10

defined topic (type of mixture, property...)						
Preparing a scientific article	2.5	5	Seminar, consultations	Evaluation of the prepared article	6	10

1.10. Mandatory reading (at the moment of application of the study programme proposal)

1. **Freddy L. Roberts, Prithvi S. Kandhal, E. Ray Brown, Dah-Yinn Lee and Thomas W. Kennedy: "Vruće asfaltne mješavine" (Hot Mix Asphalt Materials), HDGI, 2003**
2. Rajib B. Mallick, Tahar El-Korchi: **"Pavement Engineering: Principles and Practice", Taylor and Francis Group, 2013**

- **Selected scientific articles**
- **Applicable norms, standards, and regulations**
- **Applicable reports from COST actions**

1.11. Additional reading (at the moment of application of the study programme proposal)

1. Athanassios Nikolaides: "Highway Engineering: Pavements, Materials and Control of Quality", Taylor and Francis Group, 2013
2. Huang, Shin-che, Di Benedetto, Hervé: "Advances in Asphalt Materials", Elsevier Science & Technology 2015
3. Andreas Loizos, Manfred N. Partl, Tom Scarpas, Imad L. Al-Qadi; "Advanced Testing and Characterization of Bituminous Materials", Taylor and Francis Group, 2009

1.12. Number of copies of the required reading in relation to the number of students currently attending classes at the course

Title	Number of copies	Number of students
Hot Mix Asphalt Materials	6	Roberts et al. Vruće asfaltne mješavine (Hot Mix Asphalt Materials), HDGI, 2003.
Pavement Engineering: Principles and Practice	1	

1.13. Methods for monitoring quality which ensure the acquisition of the resulting knowledge, skills, and competencies

According to the Quality Ordinance of the Faculty/University.

General information	
Course teacher	**izv.prof.dr.sc. Ivana Barišić**
Course title	**Rigid Pavements**
Study programme	**Postgraduate University Study Programme Civil Engineering**
Course status	Elective course in the module Transportation Engineering and Geotechnics
Year	I
	ECTS coefficient of the student academic load

ECTS coefficient of the student academic load: 6.0

Acquired credits and the form of implementing academic activities	Number of classes (lectures (L)+exercises (E)+seminars (S))	30+20+10

1. COURSE DESCRIPTION

1.1. Course goals

The goal of the course is familiarising the students with the specifics of the impacts on rigid pavements, the procedures for rigid pavement design, the properties of the materials, new materials and technologies, and the construction methods of specific types of rigid pavements.

1.2. Preconditions for taking the course

There are no preconditions.

1.3. Expected learning outcomes for the course

By studying the literature, the latest research, and their own activities related to tasks and laboratory research, the students will be able to:
1. evaluate the requirements for designing and constructing rigid pavements,
2. recommend the application of new methods and materials when designing and constructing rigid pavements,
3. compare the variant solutions for the types of rigid pavements
4. interpret and present the results of the conducted research in the form of a scientific-research paper

1.4. Course content

Regulations and guidelines in the area of designing and constructing concrete pavement structures. Load analysis: types of loads (effects), load spectra. Types of concrete pavements. Characteristics of the foundation and the base. Concrete surface of the roadway: materials, transfer of loads, joints. Calculations and design of rigid pavement structure. Application of modern software for the calculation and dimensioning of rigid roadway structures. Characterisation of the materials for the purposes of calculations and design. Specifics of the construction of rigid pavements. Possibilities of the application of new systems and materials. Concrete pavement maintenance. Analysis of the characteristics of the movement of vehicles with regard to the specificities of the rigid pavement structure system and the surface properties of the pavement.

1.5. Types of academic activities	☒ lectures ☐ seminars and workshops ☒ exercises ☐ remote education ☐ field classes	☐ independent tasks ☐ multimedia and web ☒ laboratory ☐ mentorship ☐ other _____

1.6. Comments	No comments

1.7. Students' obligations

Studying the latest scientific and professional literature, conducting laboratory testing, attending lectures and exercises, creating a seminar paper.

1.8. Monitoring the students' work

Attending classes		Activity during classes		Seminar paper	2	Experimental work	2
Written exam		Oral exam		Essay		Research	2
Project		Continuous knowledge testing		Paper		Practical work	
Portfolio							

1.9. Grading and evaluating the student's activities during classes and at the final exam

STUDENT ACTIVITY *	ECTS	LEARNING OUTCOME **	ACADEMIC ACTIVITY	EVALUATION METHOD	CREDITS	
					min	max
Studying the literature	1	1	Verbal – reading, writing, conversation	Answers to questions	10	15
Independent laboratory work and the analysis of results	2	2	Practical – laboratory research	Analysis of the testing results	25	35
Writing a seminar paper	2	3, 4	Verbal – reading, writing, conversation	Grading the seminar paper	40	50

1.10. Mandatory reading (at the moment of application of the study programme proposal)

Babić, B., Projektiranje kolničkih konstrukcija (Designing Pavement Structures), HDGI Zagreb, 1997.
Delatte, N., Concrete pavement design, construction and performance, Taylor & Francis, 2008
Griffiths, G., Thom, N., Concrete pavement design guidance notes, Taylor & Francis, 2007

1.11. Additional reading (at the moment of application of the study programme proposal)

National concrete pavement technology center, Guide to concrete overlays, ACPA Publication, 2014
Aloa, O.O., Design and construction of concrete roads

1.12. Number of copies of the required reading in relation to the number of students currently attending classes at the course

Title	Number of copies	Number of students
Babić, B., Projektiranje kolničkih konstrukcija (Designing Pavement Structures), HDGI Zagreb, 1997.	6	min 5
Delatte, N., Concrete pavement design, construction and performance, Taylor & Francis, 2008	0	min 5
Griffiths, G., Thom, N., Concrete pavement design guidance notes, Taylor & Francis, 2007	0	min 5

1.13. Methods for monitoring quality which ensure the acquisition of the resulting knowledge, skills, and competencies

Analysis of the student survey results, the number and category of the papers published in co-authorship with the students.

General information	
Course teacher	**Izv.prof.dr.sc. Miroslav Šimun**
Course title	**Management of Modern Roadways**
Study programme	**Postgraduate University Study Programme Civil Engineering**

Course status	Elective course in the module **Transportation Engineering and Geotechnics**	
Year	I	
Acquired credits and the form of implementing academic activities	ECTS coefficient of the student academic load	6.0
	Number of classes (lectures (L)+exercises (E)+seminars (S))	30+0+30

1.	COURSE DESCRIPTION

1.1. Course goals

Management of modern roadways is a series of procedures and methods used for making decisions and determining strategies for the evaluation of the condition of the roadways and the necessary level of maintenance, with the goal of road serviceability during its service life. The procedures and methods include the activities related to planning the value of investments, implementation of design, works, and maintenance bases on the characteristics of the condition of the roadway. The management system includes the activities related to the comparison of alternative approaches to making decisions and the application of the optimal method.

1.2. Preconditions for taking the course

There are no preconditions

1.3. Expected learning outcomes for the course

1. **Evaluate the determined characteristics of the condition of modern roadways.**
2. **Propose the conditions for a specific property regarding the serviceability of the road.**
3. **Assign value to the condition of the road network as a whole, while at the same time formulating the method for incremental improvements.**
4. **Recommending a systematic approach to the selected model for roadway management, with the goal of cost optimisation.**

1.4. Course content

Introduction to roadway management systems. Tools for analysis and making decisions on the level of roadway management. Analysis of the requirements for roadway interventions, economic evaluation of the intervention depending on the level of the intervention and programming and predicting the condition depending on the implemented procedure. Models for predicting the condition of the roadway on the basis of gathered characteristics, depending on the plan of economic investments. Methods and devices for gathering characteristics of roadway layers and processing data for the purpose of roadway management. Basic subsystems of roadway management. Planning, programming, and budgeting investments and regular maintenance. Connecting the data on the condition of the roadway with the database of the road management system. Designing, constructing, maintaining, and reconstructing roadways based on an established building management system. Research into roadway behaviour and condition studies. Implementing the roadway management system into the road maintenance standard. Guidelines for further research based on specific roadway behaviour.

1.5. Types of academic activities	☒ lectures ☒ seminars and workshops ☐ exercises ☐ remote education ☐ field classes	☐ independent tasks ☐ multimedia and web ☐ laboratory ☐ mentorship ☐ other _____
1.6. Comments	No	
1.7. Students' obligations		

Creating and presenting a seminar paper and preparing an article. Positively graded seminar paper and the oral exam.

1.8.	*Monitoring the students' work*					

Attending classes	1.0	Activity during classes	1.0	Seminar paper	2.0	Experimental work	
Written exam		Oral exam	2.0	Essay		Research	
Project		Continuous knowledge testing		Paper		Practical work	
Portfolio							

1.9. Grading and evaluating the student's activities during classes and at the final exam

STUDENT ACTIVITY *	ECTS	LEARNING OUTCOME **	ACADEMIC ACTIVITY	EVALUATION METHOD	CREDITS	
					min	max
Attending classes	1.0	1 and 2	Consultation classes	Keeping records	5	10
Activity during classes	1.0	1 and 2	Consultation classes	Keeping records	5	10
Seminar paper	2.0	1,2,3,4	Presenting the independent research	Reviewing and grading the paper	25	40
Final exam	2.0	1,2,3,4	Oral exam	Evaluating the answers to the questions	20	40

1.10. Mandatory reading (at the moment of application of the study programme proposal)

- **Haas, R., W. R. Hudson, and J. P. Zaniewski (1994). Modern Pavement Management. Krieger Publishing Company. Malabar, Florida, USA.**
- **Transportation Association of Canada (1997). Pavement Design and Management Guide. Transportation Association of Canada, Ottawa, Canada.**
- **Hudson, W. R., R. Haas and W. Uddin, (1997). Infrastructure Management: Integrating Design, Construction, Maintenance, Rehabilitation, and Renovation. McGraw Hill. New York, USA.**
- **Richard Robinson, Uno Danielson, Martin Snaith, (1999). Road Maintenance Management: Concept and Systems, Basingstoke Macmillan, TRID.**

1.11. Additional reading (at the moment of application of the study programme proposal)

- *COST 354 Performance Indicators for Road Pavements WP2* "Selection and assessment for individual performance Indicators" 25. April 2007.
- dTIMS Infrastructure Asset Management Software.

- Puž, Radić, Bleiziffer: Gospodarenje građevinama transportne infrastrukture, Transportna infrastruktura i transport, (Managing Transport Infrastructure Structures, Transport Infrastructure and Transport) 3(2012).
- B. Kuvačić, T. Rukavina, Sustav gospodarenja kolnicima na hrvatskim prometnicama - postavke i principi (Roadway Management System on Croatian Thoroughfares – Postulates and Principles), Proceedings: Fourth Croatian Conference on Road Maintenance, Šibenik, 2009, p. 33-40

1.12. Number of copies of the required reading in relation to the number of students currently attending classes at the course

Title	Number of copies	Number of students
Haas, R., W. R. Hudson, and J. P. Zaniewski (1994). Modern Pavement Management. Krieger Publishing Company. Malabar, Florida, USA.	1	
Transportation Association of Canada (1997). Pavement Design and Management Guide. Transportation Association of Canada, Ottawa, Canada.	1	
Hudson, W. R., R. Haas and W. Uddin, (1997). Infrastructure Management: Integrating Design, Construction, Maintenance, Rehabilitation, and Renovation. McGraw Hill. New York, USA.	1	
Richard Robinson, Uno Danielson, Martin Snaith, (1999). Road Maintenance Management: Concept and Systems, Basingstoke Macmillan, TRID.	1	

1.13. Methods for monitoring quality which ensure the acquisition of the resulting knowledge, skills, and competencies

The students will create their seminar papers during the semester, the course of the creation process will be monitored via consultations. The prerequisite for taking the exam is the presentation of the seminar paper and a positive grade.

General information

Course teacher	**Izv.prof.dr.sc. Irena Ištoka Otković, dipl.ing.građ.**	
Course title	**Transport Modelling**	
Study programme	**Postgraduate University Study Programme Civil Engineering**	
Course status	Elective course in the module Transportation Engineering and Geotechnics	
Year	I	
Acquired credits and the form of implementing academic activities	ECTS coefficient of the student academic load	6.0
	Number of classes (lectures (L)+exercises (E)+seminars (S))	30+10+20

1. COURSE DESCRIPTION

1.1. Course goals		

The goal of the course is the acquisition of specialised knowledge required to apply simulation transport modelling and to integrate scientific knowledge from various areas in planning, designing, and optimising the transport infrastructure by applying microsimulations.

1.2. Preconditions for taking the course

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1.3. Expected learning outcomes for the course

After passing the exam, the students will be able to:
  1. **Select the appropriate calibration method and calibrate a simulation model**
  2. **Conceptualise the application of simulation modelling on the selected research problem**
  3. **Evaluate the effect of transport technologies and conceptual solutions on a specific existing or planned segment of the transport network**
  4. **Evaluate and publish their research results**

1.4. Course content

Application of new scientific knowledge in the analysis of the transport flow. Selecting the methodology and the calibration of the simulation model. Application of the acquired knowledge in simulation transport modelling on the selected scientific and professional problems from the area of civil engineering. Multiple criteria analysis, analysis of various what-if scenarios. Application of simulation modelling in the formation and optimisation of the transport offer according to the principles of sustainable urban mobility. The application of simulations for the analysis of the effect of new transport technologies and new conceptual solutions for the local transport network and transport structures. Analysis of the transport safety parameters. Case study.

1.5. Types of academic activities	☒ lectures ☒ seminars and workshops ☒ exercises ☐ remote education ☐ field classes ☒ independent tasks ☐ multimedia and web ☐ laboratory ☒ mentorship ☐ other _____
1.6. Comments	No

1.7. Students' obligations

Attending classes, seminar paper, independent application of the acquired knowledge on the selected problem, oral defence of the seminar paper. Interpretation of results and the preparation for publishing a paper.

1.8. Monitoring the students' work

Attending classes	1	Activity during classes		Seminar paper	3	Experimental work	
Written exam		Oral exam		Essay		Research	
Project /research	2	Continuous knowledge testing		Paper		Practical work	
Portfolio							

1.9. Grading and evaluating the student's activities during classes and at the final exam

STUDENT ACTIVITY *	ECTS		ACADEMIC ACTIVITY		CREDITS

		LEARNING OUTCOME **		EVALUATION METHOD	min	max
Attending classes	1	1,2,3,4	Lectures and exercises	Keeping attendance records	0	20
Applying the acquired knowledge in the analysis of the selected project/research problem	2	1,2,3	Student's independent work	Evaluation of the results and the interpretation of the achieved modelling results	0	35
Seminar paper	3	1,2,3,4	Mentorship and the oral exam	Evaluation of the seminar paper and its defence	0	45

1.10. Mandatory reading (at the moment of application of the study programme proposal)

1. **Legac I. and associates: Gradske prometnice (City Transport Infrastructure), Faculty of Transport and Traffic Sciences, Zagreb, 2011**
2. **Šraml, M., Jovanović, G.: Mikrosimulacije u prometu (Microsimulations in Transport) (working textbook with the application of VISSIM), Maribor, 2014., electronic textbook available at the course site**
3. **Rothery R.W.: Car Following Models. Austin, TX: University of Texas; 2006.**

1.11. Additional reading (at the moment of application of the study programme proposal)

1. Treiber M, Kesting A. Traffic flow Dynamics – Data, Models and Simulation. Springer; 2013. (e-book) available online
2. Underwood, S.: Automated, Connected, and Electric Vehicle Systems: Expert Forecast and Roadmap for Sustainable Transportation, Graham Institute for Sustainability, University of Michigan, Ann Arbor, 2014, available online
3. Gillis, D., Semanjski, I., Lauwers, D: How to Monitor Sustainable Mobility in Cities? Literature Review in the Frame of Creating a Set of Sustainable Mobility Indicators, Sustainability 2016, 8, 29; doi:10.3390/su8010029
4. Selected scientific articles published in relevant journals

1.12. Number of copies of the required reading in relation to the number of students currently attending classes at the course

Title	Number of copies	Number of students
Legac I. and associates: Gradske prometnice, (City Transport Infrastructure) Faculty of Transport and Traffic Sciences, Zagreb, 2011	10	10
Šraml, M., Jovanović, G.: Mikrosimulacije u prometu (Microsimulations in Transport) (working textbook with the application of VISSIM), Maribor, 2014., electronic textbook	available online	10
Rothery R.W.: Car Following Models. Austin, TX: University of Texas; 2006.	available online	10

1.13. Methods for monitoring quality which ensure the acquisition of the resulting knowledge, skills, and competencies

The teacher will monitor the activities of the students by keeping attendance records, grading the creation and the defence of the seminar paper, and publishing the results of a paper from the topic of the seminar paper. Student evaluation via survey will be conducted if necessary.

General information	
Course teacher	**Prof.dr.sc. Mensur Mulabdić, dipl.ing.građ.**
	Izv.prof. dr.sc. Krunoslav Minažek, dipl.ing.građ.
Course title	**Computer Modelling in Geotechnics**
Study programme	**Postgraduate University Study Programme Civil Engineering**
Course status	Elective course in the module Transportation Engineering and Geotechnics
Year	I

Acquired credits and the form of implementing academic activities	ECTS coefficient of the student academic load	6.0
	Number of classes (lectures (L)+exercises (E)+seminars (S))	30+0+30

1. COURSE DESCRIPTION

1.1. Course goals

Familiarising the students with the theoretical soil models that describe the stress-strain characteristics of soil and their potential application for the simulation of laboratory experiments and computer analyses of buildings made from the soil, as well as familiarising them with the principles of numerical modelling of geotechnical engineering projects.

1.2. Preconditions for taking the course

Necessary previous knowledge: Soil Mechanics, Geotechnical Engineering.

1.3. Expected learning outcomes for the course

1. Analysing the theoretical models that describe the stress-strain characteristics of soil for the various conditions of stress and strain,
2. Evaluating the possibilities for the application of numerical algorithms for the simulation of laboratory tests,
3. Comparing the application of various numerical algorithms for the computer analysis of buildings made from soil, while considering the interactions soil-structure,
4. Assigning value to and evaluating the principles of numerical modelling of a geotechnical engineering problems.

1.4. Course content

Introduction and methods for modelling geo-materials and multiphase materials. Formulation of the finite element method for a one-dimensional problem. Demonstrating a solution to a one-dimensional problem by using software (ABAQUS, PLAXIS). Cam clay model for clays. Elastic-plastic models for soil, rock, asphalt, and concrete. Modelling stress distribution in the soil. Modelling settlement and consolidation. Modelling laboratory experiments for strength. Modelling shallow and deep foundations. Modelling of retaning walls (and reinforced soil walls). Modelling waterflow through the soil. Modelling the stability of slopes.

1.5. Types of academic activities	☒ lectures ☒ seminars and workshops ☐ exercises ☐ remote education ☐ field classes	☐ independent tasks ☐ multimedia and web ☐ laboratory ☒ mentorship ☐ other _____

1.6. Comments	Language: Croatian, English Consultation classes, selected lectures if necessary	

1.7. Students' obligations

Created and defended seminar paper.

1.8. Monitoring the students' work

Attending classes		Activity during classes		Seminar paper	2	Experimental work	
Written exam		Oral exam		Essay		Research	
Project		Continuous knowledge testing	2	Paper		Practical work	2
Portfolio							

1.9. Grading and evaluating the student's activities during classes and at the final exam

STUDENT ACTIVITY *	ECTS	LEARNING OUTCOME **	ACADEMIC ACTIVITY	EVALUATION METHOD	CREDITS	
					min	max
Creating the theoretical part of the seminar paper	3	1.,4.	Independent work and consultations with the course teacher	Evaluation of the seminar paper according to stages (through consultations), evaluation of the finished paper and the final presentation, evaluation of the oral exam	0	50
Creating a numerical model of a geotechnical engineering problem	3	2., 3.	Work in the computer classroom or independently or with the course teacher	Evaluation after the review of the results of the conducted numerical calculations, evaluation of the oral exam	0	50

1.10. Mandatory reading (at the moment of application of the study programme proposal)

Sam Helwany, Applied Soil Mechanics with ABAQUS Applications, John Wiley and Sons , 2007.

1.11. Additional reading (at the moment of application of the study programme proposal)

Larry J. Segerlind, Applied finite element analysis 2nd edition, John Wiley and sons, 1984.
Soil Behavior and Critical State Soil Mechanics, by D. M. Wood, Cambridge University Press, 1990
Geotechnical Modelling, by D. M. Wood, Spoon Press, 2004

1.12. Number of copies of the required reading in relation to the number of students currently attending classes at the course

Title	Number of copies	Number of students

Sam Helwany, Applied Soil Mechanics with ABAQUS Applications, John Wiley and Sons , 2007.	1	10

1.13. Methods for monitoring quality which ensure the acquisition of the resulting knowledge, skills, and competencies

The students will create their seminar papers during the semester. The course of the creation will be monitored through consultations. After submitting the paper, the students will have the right to take the exam. The final grade will be formed on the basis of an independently created seminar paper and the oral part of the final exam.

Course description

General information

Course teacher	**Prof.dr.sc. Dietmar Adam (Technical University Vienna, Austria)**	
Course title	**Earth Structures and Dynamic Soil Compaction**	
Study programme	**Postgraduate University Study Programme Civil Engineering**	
Course status	Elective course in the module Transportation Engineering and Geotechnics	
Year	I	
Acquired credits and the form of implementing academic activities	ECTS coefficient of the student academic load	6.0
	Number of classes (lectures (L)+exercises (E)+seminars (S))	30+0+30

1. COURSE DESCRIPTION

1.1. Course goals

Recognising the basic principles of static and dynamic soil compaction, the effect of the operation of machinery, the efficiency of compaction in non-cohesive soil under the effects of changing amplitudes and frequencies of the operation of machinery, and the use of existing advanced models for the analysis of the dynamic effect of machinery on soil compaction.

1.2. Preconditions for taking the course

Necessary previous knowledge: Soil Mechanics, Geotechnical Engineering

1.3. Expected learning outcomes for the course

1. **Analysing the advanced technologies for the compaction of cohesive and non-cohesive soil from the standpoint of their role in earth structures, and the application efficiency of existing compaction methods,**
2. **Recognising, explaining, and comparing the operational principles and use of advanced solutions in dynamic compaction machines,**
3. **Formulating the numerical models for the research of dynamic soil compaction, for the purposes of railroads and roads,**
4. **Assigning value and controlling the planned methods of compaction for specific types of soil at specific positions in structures.**

1.4. Course content

Features of earth dams and soil embankments. Selecting and determining the properties of soil for building earth structures. The effect of the anisotropy of the soil properties on the characteristic of earth structures. 3D / 2D analysis of the filtration of water through dams and embankments, and the underlaying foundation soil. Static and dynamic stability of the body of dams and embankments in 3D / 2D analyses. Dynamic soil compaction. Numerical models of soil compaction. Non-linearity and

viscosity. The effect of frequencies and amplitudes. Large panels as vibrators. Evaluation of influential depth. The continuous compaction control method "CCC method" – history, development, future.

1.5. Types of academic activities	☒ lectures ☒ seminars and workshops ☐ exercises ☐ remote education ☐ field classes	☐ independent tasks ☐ multimedia and web ☐ laboratory ☒ mentorship ☐ other _____
1.6. Comments	Language: Croatian, German Consultation classes, selected lectures if necessary	

1.7. Students' obligations

Created and defended seminar paper.

1.8. Monitoring the students' work

Attending classes		Activity during classes		Seminar paper	2	Experimental work	
Written exam		Oral exam		Essay		Research	
Project		Continuous knowledge testing	2	Paper		Practical work	2
Portfolio							

1.9. Grading and evaluating the student's activities during classes and at the final exam

STUDENT ACTIVITY *	ECTS	LEARNING OUTCOME **	ACADEMIC ACTIVITY	EVALUATION METHOD	CREDITS	
					min	max
Creating the theoretical part of the seminar paper	3	1.-3.	Independent work and consultations with the course teacher	Evaluation of the seminar paper according to stages (through consultations), evaluation of the finished paper, evaluation of the oral exam	0	50
Creating a numerical model of a geotechnical engineering problem of dynamic soil compaction	3	4.	Work in the computer classroom or independently or with the course teacher	Evaluation after the review of the results of the conducted numerical calculations, evaluation of the oral exam	0	50

1.10. Mandatory reading (at the moment of application of the study programme proposal)

F.E. Richart Jr., J.R. Hall, R.D. Woods: Vibration of Soils and Foundations (International Series in Theoretical and Applied Mechanics), Prentice Hall, USA, 1970.

Braja M. Das, G.V. Ramana: Principles of Soil Dynamics 2nd edition, PWS-Kent Publishing Company, USA, 2010.

1.11. Additional reading (at the moment of application of the study programme proposal)

Jansen, R.B. Advanced dam engineering for design, construction and rehabilitation, Springer Science & Business Media, USA, 2012.
D. Adam & S. Larsson (eds.) 40 Years of Roller Integrated Continuous Compaction Control (CCC), Symposium Proceedings, Eigner Druck, Vienna, 2018.

1.12. Number of copies of the required reading in relation to the number of students currently attending classes at the course

Title	Number of copies	Number of students
F.E. Richart Jr., J.R. Hall, R.D. Woods: Vibration of Soils and Foundations (International Series in Theoretical and Applied Mechanics), Prentice Hall, USA, 1970.	1	10
Braja M. Das, G.V. Ramana: Principles of Soil Dynamics 2nd edition, PWS-Kent Publishing Company, USA, 2010.	1	10

1.13. Methods for monitoring quality which ensure the acquisition of the resulting knowledge, skills, and competencies

The students will create their seminar papers during the semester. The course of the creation will be monitored through consultations. After submitting the paper, the students will have the right to take the exam. The final grade will be formed on the basis of an independently created seminar paper and the oral part of the final exam.

General information

Course teacher	**Prof.dr.sc. Mensur Mulabdić, dipl.ing.građ.** **doc.dr.sc. Stanislav Lenart, dipl.ing.građ.,**
Course title	**Efficiency Mechanisms of Geosynthetics**
Study programme	**Postgraduate University Study Programme Civil Engineering**
Course status	Elective course in the module Transportation Engineering and Geotechnics
Year	I
Acquired credits and the form of implementing academic activities	ECTS coefficient of the student academic load	6.0
	Number of classes (lectures (L)+exercises (E)+seminars (S))	30+0+30

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1.   COURSE DESCRIPTION

1.1.   Course goals

Familiarity with the basic and critical elements of the interaction of soil and geosynthetics, methods of testing and dimensioning applied in various structures, formulation and the evaluation of criteria for the application of geosynthetics for various functions in the soil.

1.2. Preconditions for taking the course

Necessary previous knowledge: Soil Mechanics, Geotechnical Engineering

1.3. Expected learning outcomes for the course

1. **Analysing the basic mechanisms of the interaction geosynthetics-soil for all the functions of geosynthetics,**
2. **Analysing and evaluating the modern research methods and proving the interaction in the laboratory on models and in the field;**
3. **Comparing the existing knowledge on testing and modelling of the interaction between geosynthetics and soil with the advanced techniques for testing and modelling the interaction between geosynthetics and soil.**
4. **Assigning value to various solutions from the standpoint of efficiency, performance, durability, and reliability.**

1.4. Course content	

Permeability of geotextiles, Giroud's theory, separation and filtration, experiments and experiences. Comparing and evaluating various criteria for the functions of filtration and separation, reinforced soil – various structures of embankments, foundation soil, slopes, facing elements. Interaction as the consequence of structure of materials and the properties of soil and geosynthetics – difference between geotextiles and geonets, geocells. Reinforcement by the transfer of tensile force – tensile reinforcement. Reinforcement by preventing lateral movements of soil particles – stabilisation. Behaviour of reinforced soil under static and dynamic conditions. Interaction mechanisms of geosynthetics and soil, various approaches. Pullout and triaxial shear tests. Laboratory and model tests of geosynthetics for various functions. The effect of the type of soil compaction (performance) and the cyclic load from vehicles.

1.5. Types of academic activities	☒ lectures ☒ seminars and workshops ☐ exercises ☐ remote education ☐ field classes ☒ independent tasks ☐ multimedia and web ☐ laboratory ☒ mentorship ☐ other _____
1.6. Comments	Language: Croatian, English Consultation classes, selected lectures if necessary
1.7. Students' obligations	

Creating an independent paper / seminar / attendance at workshops, consultations.

1.8. Monitoring the students' work	

Attending classes	2	Activity during classes		Seminar paper	2	Experimental work	
Written exam		Oral exam		Essay		Research	
Project		Continuous knowledge testing	2	Paper		Practical work	
Portfolio							

1.9. Grading and evaluating the student's activities during classes and at the final exam	

STUDENT ACTIVITY *	ECTS	LEARNING OUTCOME **	ACADEMIC ACTIVITY	EVALUATION METHOD	CREDITS	
					min	max

	3	1.-4.	Independent work and consultations with the course teacher	Evaluation of the seminar paper according to stages (through consultations), evaluation of the finished paper and the final presentation	0	50
Creating the independent/seminar paper	3	1.-4.	Independent work and consultations with the course teacher	Evaluation of the seminar paper according to stages (through consultations), evaluation of the finished paper and the final presentation	0	50
Defending the seminar paper and the oral exam	3	1.-4.	Consultations with the course teacher, oral exam	Evaluation of the oral exam	0	50

1.10. Mandatory reading (at the moment of application of the study programme proposal)

Sarsby, R.W. Geosynthetics in civil engineering, Woodhead publishing in textiles, England, 2007.
Koerner R. M. Design with geosynthetics 5th edition, Pearson Prentice Hall, USA, 2005.

1.11. Additional reading (at the moment of application of the study programme proposal)

German Geotechnical Society, Recommendations for Design and Analysis of Earth Structures using Geosynthetic Reinforcements – EBGEO, Ernst & Sohn, Germany, 2011.

1.12. Number of copies of the required reading in relation to the number of students currently attending classes at the course

Title	Number of copies	Number of students
Sarsby, R.W. Geosynthetics in civil engineering, Woodhead publishing in textiles, England, 2007.	1	10
Koerner R. M. Design with geosynthetics 5th edition, Pearson Prentice Hall, USA, 2005.	1	10

1.13. Methods for monitoring quality which ensure the acquisition of the resulting knowledge, skills, and competencies

The students will create their seminar papers during the semester. The course of the creation will be monitored through consultations. After submitting the paper, the students will have the right to take the exam. The final grade will be formed on the basis of an independently created seminar paper and the oral part of the final exam.

General information

Course teacher	**Izv.prof.dr.sc. Krunoslav Minažek, dipl.ing.građ.**	
Course title	**Laboratory and In-Situ Soil Tests**	
Study programme	**Postgraduate University Study Programme Civil Engineering**	
Course status	Elective course in the module Transportation Engineering and Geotechnics	
Year	I	
Acquired credits and the form of implementing academic activities	ECTS coefficient of the student academic load	6.0
	Number of classes (lectures (L)+exercises (E)+seminars (S))	30+0+30

1. COURSE DESCRIPTION
1.1. Course goals
Differentiating and evaluating the possibilities and the limitations of laboratory and in situ methods for testing the physical and mechanical properties of soil, recognising the critical elements in the application of testing methods,

and defining the theoretical background for the conduction and interpretation of laboratory and in situ soil testing by using critical states and the theory of behaviour of unsaturated soil.			

1.2. Preconditions for taking the course

Necessary previous knowledge: Soil Mechanics, Geotechnical Engineering

1.3. Expected learning outcomes for the course

1. Familiarity with the theoretical background for the application of testing methods,
2. Recognising and evaluating the critical elements in the conduction of testing,
3. Evaluating testing results,
4. Selecting the appropriate testing methods within the programme of exploratory works for various structures.

1.4. Course content

Advanced soil testing in triaxial shear - static. Simple shearing, direct and triaxial shear – analysis and comparison. Local deformations. Experiments under dynamic loads. CPTU – theory and the models of soil failures, development of pore pressure, soil deformations. DMT - theory and the models of soil failures, development of pore pressure, soil deformations. Critical elements and procedures. SCPT and SDMT – postulates and procedures. Comparing CPT and DMT, advantages and disadvantages. Significant correlations for the determination of soil parameters.

1.5. Types of academic activities	☒ lectures ☐ independent tasks ☒ seminars ☐ multimedia and and workshops web ☐ exercises ☒ laboratory ☐ remote ☒ mentorship education ☐ other ☒ field classes _____
1.6. Comments	Lectures only if there is a sufficient number of students, consultations otherwise.

1.7. Students' obligations

Creating an independent paper / seminar / attendance at workshops, consultations.

1.8. Monitoring the students' work

Attending classes		Activity during classes		Seminar paper	2	Experimental work		2	
Written exam		Oral exam		Essay		Research			
Project		Continuous knowledge testing	2	Paper		Practical work			
Portfolio									

1.9. Grading and evaluating the student's activities during classes and at the final exam

STUDENT ACTIVITY *	ECTS	LEARNING OUTCOME **	ACADEMIC ACTIVITY	EVALUATION METHOD	CREDITS	
					min	max
Creating the independent/seminar paper	3	1., 4.	Independent work and consultations with the course teacher	Evaluation of the seminar paper according to stages (through consultations), evaluation of the	0	50

				finished paper and the final presentation, evaluation of the oral exam		
Conducting experimental research in a laboratory / in-situ	3	2., 3.	Work in a laboratory or in the field, independently or with the course teacher	Evaluation after the review of the results of the conducted testing, evaluation of the oral exam	0	50

1.10. Mandatory reading (at the moment of application of the study programme proposal)

Roy E. Hunt, Geotechnical investigation methods a field guide for geotechnical engineers, CRC Press, USA,2007.
Burt G. Look, Handbook of Geotechnical Investigation and DesignTables, Taylor & Francis, Netherlands, 2007.

1.11. Additional reading (at the moment of application of the study programme proposal)

A. Tarantino, E. Romero, Y.-J. Cui, Laboratory and Field Testing of Unsaturated Soils (reprinted from Geotechnical and Geological Engineering, Volume 26, No. 6, 2008) , Springer, USA, 2009.
Roy E. Hunt, Geotechnical Engineering Investigation Handbook 2nd edition, CRC Press, USA, 2005.
C. R. I. Clayton, M. C. Matthews and N. E. Simons, Site Investigation 2nd edition, Wiley-Blackwell, USA, 1995.

1.12. Number of copies of the required reading in relation to the number of students currently attending classes at the course

Title	Number of copies	Number of students
Roy E. hunt, Geotechnical investigation methods a field guide for geotechnical engineers, CRC Press, USA,2007.	1	10
Burt G. Look , Handbook of Geotechnical Investigation and DesignTables, Taylor & Francis, Netherlands, 2007.	1	10

1.13. Methods for monitoring quality which ensure the acquisition of the resulting knowledge, skills, and competencies

The students will create their seminar papers during the semester. The course of the creation will be monitored through consultations. After submitting the paper, the students will have the right to take the exam. The final grade will be formed on the basis of an independently created seminar paper and the oral part of the final exam.

Course description

General information

Course teacher	**Prof.dr.sc. Mensur Mulabdić, dipl.ing.građ.**	
Course title	**Soil Dynamics and Foundations**	
Study programme	**Postgraduate University Study Programme Civil Engineering**	
Course status	Elective course in the module Transportation Engineering and Geotechnics	
Year	I	
Acquired credits and the form of implementing academic activities	ECTS coefficient of the student academic load	6.0
	Number of classes (lectures (L)+exercises (E)+seminars (S))	30+0+30

1. COURSE DESCRIPTION

1.1.	*Course goals*

Familiarisation with the behaviour of soil under dynamic/cyclic load; acquiring the knowledge on the effect of the soil in the dynamic behaviour of structures; familiarisation with the laboratory and field methods for testing the dynamic properties of the soil; laboratory and field experiments used to determine / evaluate the dynamic properties of the soil and the susceptibility to liquefaction; familiarisation with the dynamic analyses of geotechnical structures through simplified and complex procedures, familiarisation with the modelling of the soil-structure interaction.

1.2.	*Preconditions for taking the course*

Necessary previous knowledge: Soil Mechanics, Geotechnical Engineering

1.3.	*Expected learning outcomes for the course*

1. Distinguishing the behaviour of soil under dynamic and static load conditions;
2. Evaluating the methods for determining the properties of soil under the effects of cyclic loads;
3. Familiarisation with the fundamentals of analysis of the dynamic soil response and the effects of the soil on the dynamic response of the structure;
4. Familiarisation and valorisation of the methods for the determination of risk of soil liquefication.

1.4.	*Course content*

Types and effects of dynamic loads affecting soil (earthquake, traffic, operation of machinery, waves, explosions). Behaviour of soil under dynamic loads – significant parameters of soil properties and characteristics of the load. Seismology and earthquakes. Soil movements. Seismic hazard. Wave propagation through the soil. Determining the relevant properties of soil in the laboratory and in the field. Analysis of the soil response. Location effects. Liquefication. Seismic stability of slopes. Seismic design of retaining walls. Vibration of the foundation. Observation of the interaction between the foundation soil and the structure for static and dynamic loads. Soil modelling in the integral calculation soil-structure. Analysis of the typical foundation types for loads coming from the structure and from the excitation in the soil.

1.5. *Types of academic activities*	☒ lectures ☒ seminars and workshops ☐ exercises ☐ remote education ☐ field classes	☒ independent tasks ☐ multimedia and web ☐ laboratory ☒ mentorship ☐ other _____
1.6. *Comments*		<mark>Lectures only if there is a sufficient number of students, consultations otherwise.</mark>

1.7.	*Students' obligations*

Creating an independent paper / seminar / attendance at workshops, consultations.

1.8.	*Monitoring the students' work*

Attending classes	2	Activity during classes		Seminar paper	2	Experimental work	

Written exam		Oral exam		Essay		Research		
Project		Continuous knowledge testing	2	Paper		Practical work		
Portfolio								

1.9. Grading and evaluating the student's activities during classes and at the final exam

STUDENT ACTIVITY *	ECTS	LEARNING OUTCOME **	ACADEMIC ACTIVITY	EVALUATION METHOD	CREDITS	
					min	max
Creating the independent/seminar paper	3	1.-4.	Independent work and consultations with the course teacher	Evaluation of the seminar paper according to stages (through consultations), evaluation of the finished paper and the final presentation	0	50
Defending the seminar paper and the oral exam	3	1.-4.	Consultations with the course teacher, oral exam	Evaluation of the oral exam	0	50

1.10. Mandatory reading (at the moment of application of the study programme proposal)

Steven L. Kramer : Geotechnical Earthquake Engineering, Prentice Hall, New Jersey, 1996.
Braja M. Das, G.V. Ramana: Principles of Soil Dynamics 2nd edition, PWS-Kent Publishing Company, USA, 2010.
E.Nonveiller: Mehanika tla i temeljenje (Soil Mechanics and Anchoring), Školska knjiga , Zagreb, 1982.

1.11. Additional reading (at the moment of application of the study programme proposal)

A.Szavits-Nossan : Pojave u tlu izazvane potresom (Effects in the Soil Caused by Earthquakes), Seminar DIT: Soil Dynamics, 1988.

1.12. Number of copies of the required reading in relation to the number of students currently attending classes at the course

Title	*Number of copies*	*Number of students*
Steven L. Kramer : Geotechnical Earthquake Engineering, Prentice Hall, New Jersey, 1996.	1	10
Braja Das: Principles of Soil Dynamics, PWS-Kent Series in Engineering, 1992.	1	10
E.Nonveiller: Mehanika tla i temeljenje (Soil Mechanics and Anchoring), Školska knjiga , Zagreb, 1982.	1	10

1.13. Methods for monitoring quality which ensure the acquisition of the resulting knowledge, skills, and competencies

The students will create their seminar papers during the semester. The course of the creation will be monitored through consultations. After submitting the paper, the students will have the right to take the exam. The final grade will be formed on the basis of an independently created seminar paper and the oral part of the final exam.

* Every student activity/academic activity should be assigned with the appropriate share of ECTS credits for individual activities, so that the total number of ECTS credits match the credit value of the course.

** This column should contain the learning outcomes from item 1.3 which have been included in this student/teacher activity.