Sveučilište Josipa Jurja Strossmayera u Osijeku
Građevinski i arhitektonski fakultet Osijek
Josip Juraj Strossmayer University of Osijek
Faculty of Civil Engineering and Architecture Osijek

CIVIL ENGINEERING DOCTORAL STUDY PROGRAM

Academic year 2024/2025

Osijek, July 2024

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CONTENT

GENERAL INFORMATION

The study program is aligned with:

- Zakon o visokom obrazovanju i znanstvenoj djelatnosti (NN 119/22)
https://narodne-novine.nn.hr/clanci/sluzbeni/2022_10_119_1834.html

- Statutom Sveučilišta Josipa Jurja Strossmayera u Osijeku, 2023.
http://www.unios.hr/wp-content/uploads/2023/10/STATUT-2023-10-16.pdf

- Pravilnikom o poslijediplomskim studijima na Sveučilištu Josipa Jurja Strossmayera u Osijeku, 2023.
http://www.unios.hr/wp-content/uploads/2023/12/PRAVILNIK-o-poslijediplomskim-studijima-na-Sveu%C4%8Dili%C5%A1tu-Josipa-Jurja-Strossmayera-u-Osijeku-20231130.pdf

- Pravilnikom o studijima i studiranju na Sveučilištu Josipa Jurja Strossmayera u Osijeku, 2023.
http://www.unios.hr/wp-content/uploads/2023/12/PRAVILNIK-o-studijima-i-studiranju-30XI2023.pdf

- Strategijom Sveučilišta Josipa Jurja Strossmayera u Osijeku od 2011.-2020.
http://www.unios.hr/wp-content/uploads/2015/07/SJJS_Strategija_Sveucilista_HR.pdf

- Statutom Građevinskog i arhitektonskog fakulteta Osijek, 2023.
http://www.gfos.unios.hr/download/statut-gradevinskog-i-arhitektonskog-fakulteta-osijek-2023.pdf

- Strategijom razvitka Građevinskog i arhitektonskog fakulteta Osijek 2023.-2027.
http://www.gfos.unios.hr/download/strategija-razvoja-grafos-2023-2027-1.pdf

- Pravilnikom o uvjetima za izbor u znanstvena zvanja (NN 28/17, 72/19, 21/21)
https://narodne-novine.nn.hr/clanci/sluzbeni/2017_03_28_652.html

- Pravilnikom o izmjenama i dopunama Pravilnika o uvjetima za izbor u znanstvena zvanja (NN 111/22)
https://narodne-novine.nn.hr/clanci/sluzbeni/2022_09_111_1637.html

- Pravilnik o znanstvenim i interdisciplinarnim područjima, poljima i granama te umjetničkom području, poljima i granama
https://narodne-novine.nn.hr/clanci/sluzbeni/2024_01_3_69.html

Name of study programme: Doctoral Study of Civil Engineering

Coordinator and provider of the study programme: Josip Juraj Strossmayer University of Osijek, Faculty of Civil Engineering and Architecture Osijek

Type of study programme: Doctoral study

Level: Postgraduate, 8.2 HKO

Language of performance: Standard Croatian language (possible in English with the consent of the Committee for Postgraduate Studies).

Scientific or artistic field of study: 2. Technical Sciences

Scientific field of study: 2.05. Civil engineering

2.15. Basic technical sciences

Scientific branches of the study programme:

2.05.01 Geotechnics

2.05.02 Load-bearing structures

2.05.03 Hydraulic Engineering

2.05.04 Roads

2.05.05 Organization and technology of construction

2.15.03 Materials

2.15.04 Fluid Mechanics

2.15.05 Organization of work and production

2.15.06 Technical mechanics (mechanics of rigid and deformable bodies)

Enrolment quota: maximum 15 students per academic year

Cost of doctoral studies for EU citizens: 6.000,00 €

Doctoral tuition costs for non-EU citizens: 18.000,00 €

Place of the study program: The building of the Faculty of Civil Engineering and Architecture Osijek is located on the Campus of the Josip Juraj Strossmayer University of Osijek, Ulica Vladimira Preloga 3. The building has a floor area of 3239 m2. It has six floors (Po + Su + Pr + 3) and a height of 19.3 m, and the total gross developed area is 10,600 m2. It consists of several programmatic and functional units, seven departments (70 cabinets), laboratories (5 laboratory units) and spaces for teaching (lecture halls, drawing rooms and practicums), administration (dean's office and secretariats with accompanying rooms) and a faculty library, student rooms and shared facilities (auditoriums, forums, open classroom, canteen, corridors) and auxiliary and technical rooms. The building can accommodate 1348 students and 179 faculty employees at full capacity.

Contractual relations between students and doctoral study holders: A student in a doctoral study programme (doctoral student) enrols **in a full-time study programme** and studies within the full-time teaching schedule or **in an extraordinary status** and studies within the framework of a full-time or adjusted teaching schedule by the implementation plan of the study. A study contract is concluded with each doctoral student. The agreement regulates mutual rights and obligations during studies, obligations and methods of financing

studies and other issues critical for the contracting parties. **A visiting doctoral student** with full-time or part-time status from another university enrols in parts of the doctoral study programme in a special agreement with other universities on the recognition of ECTS credits.

Duration of study: The doctoral study of Civil Engineering lasts **three (3) years**. A doctoral student has a regular or part-time status during the prescribed duration of the doctoral study and **no longer than twice the specified study duration (6 years).** The duration of the study does not include the period of suspension of the rights and obligations of the doctoral student, i.e. the deadline for the completion of the study is extended for the period that the suspension of the rights and obligations of the doctoral student lasted.

ECTS credits: 180 ECTS credits are acquired upon completion of doctoral studies. The doctoral study is carried out within the full-time teaching schedule for postgraduate students in regular status who generally acquire 60 ECTS credits in one year of doctoral study. As part of the whole or adjusted teaching timetable, the doctoral study is carried out according to the adapted implementation plan for postgraduate students in part-time status, who usually acquire 30 to 60 ECTS credits in one year of doctoral study.

Start and end of classes: The beginning and end of each academic year are defined by the Senate Decision on the teaching calendar.

Structure and organisation of doctoral studies: By the Ordinance on Postgraduate Studies of the Josip Juraj Strossmayer University of Osijek, upon enrollment or as a rule during the first semester, the Committee for Postgraduate Studies assigns a study advisor from the List of Proposed Study Advisors for the academic year. The list of proposed study advisors consists of teachers in the scientific-teaching title who participate in the implementation of doctoral studies and meet the criteria of study holders for the appointment of study advisors, mentors and co-mentors in the doctoral study of Civil Engineering.

As a rule, the Study Advisor is selected by the student with the consent of the Study Advisor through the Statement on the Selection of the Study Advisor on the prescribed form, and the Committee makes the final decision on the appointment of the Study Advisor for Postgraduate Studies. The study advisor assists the doctoral student during his studies and monitors his work and achievements until the appointment of a mentor. In the first semester of each academic year, the doctoral student must submit the Annual Work Plan on the prescribed form jointly signed by the doctoral student and the study advisor/mentor. The doctoral student and the study advisor/mentor are obliged to jointly submit a report to the Committee for Postgraduate Studies on the work and advancement of the doctoral student during the doctoral study on the prescribed form once a year. A doctoral student has the right to change the study advisor, mentor, doctoral research proposal and topic of the doctoral thesis once during the study. To implement the change, the doctoral

student submits a written request and an explanation with the statement of the current mentor to the Committee for Postgraduate Studies, and the Faculty Council decides on the request.

By the Ordinance on Postgraduate Studies at the Josip Juraj Strossmayer University of Osijek, the doctoral student is assisted in the preparation of the doctoral thesis by a mentor appointed by the Faculty Council of the study holder at the proposal of the student, and with the consent of the Committee for Postgraduate Studies. The Faculty Council of the doctoral study holder appoints a mentor with his/her prior written consent to accept mentorship according to the prescribed form. The following may be appointed as a mentor in the doctoral study:

- a teacher of the holder of the doctoral study who is in a scientific-teaching or artistic-teaching position (assistant professor, associate professor, full professor or full professor in permanent election) and who participates in the implementation of the doctoral study and meets the criteria of the study holder for the appointment of study advisors, mentors and co-mentors in the doctoral study of Civil Engineering,
- a teacher who is not an employee of the University or the university constituent of the doctoral study holder but is an external associate and participates in the implementation of the doctoral study and meets the criteria of the study holder for the appointment of study advisors, mentors and co-mentors in the doctoral study of Civil Engineering,
- professor emeritus who participates in the implementation of the doctoral study and meets the criteria of the study holder for the appointment of study advisors, mentors and co-mentors in the doctoral study of Civil Engineering,
- a person who is a distinguished international scientist and is not employed in the institution of the holder of the doctoral study but participates in teaching at the doctoral study based on a special contract or is the leader or associate on a scientific research project within which the research would be carried out and the doctoral thesis would be prepared, and meets the criteria of the study holder for the appointment of study advisors, mentors and co-mentors in the doctoral study of Civil Engineering,
- exceptionally, a scientist may be appointed to a scientific position (research associate, senior research associate, scientific advisor or scientific advisor in permanent election) if he/she has scientific papers that represent a significant contribution to the field of research of the doctoral thesis or is a leader or associate on a scientific research project within which the research would be carried out and the doctoral dissertation would be prepared and meets the criteria of the study holder for the appointment of study advisors, mentor and co-mentor in the doctoral study of Civil Engineering.

The appointment of two mentors must be possible for interdisciplinary research or research in more than one institution.

If the appointed mentor is not a teacher, external associate or professor emeritus of the doctoral study holder, a commentator who is an employee of the University or the university constituent of the doctoral study holder and employed in a scientific-teaching or artistic-teaching position is appointed. In addition to the mentor in the doctoral study, a commentator from the institution of the study holder or other institution in the country and abroad who meets the criteria of the study holder for the appointment of study advisors, mentors and co-mentors in the doctoral study of Civil Engineering may be appointed. The commentator can be a teacher or a scientist in a scientific-teaching or scientific title.

The doctoral study program is structured modularly so that the student, together with the study advisor, following the scope of research from which the doctoral thesis is being conducted, in addition to the compulsory course *Theoretical Assumptions and Principles of Scientific Research*, chooses the other five (5) courses in the study depending on the enrolled module, according to the following models:

- Module Load-bearing structures
  - Out of the required five (5) courses, the student chooses at least three (3) courses within the module, while the rest can be chosen from the Engineering Mechanics module or general electives.

- Module Organization, Technology and Management
  - Out of the required five (5) courses, the student chooses four (4) elective courses within the module and one (1) general elective course, noting that by choosing a course, he/she must earn at least 18 ECTS credits in courses belonging to the field of technical sciences, or
  - Out of the required five (5) courses, the student chooses three (3) elective courses within the module, one (1) general elective course and one (1) course from other modules, noting that by choosing a course, he must earn at least 18 ECTS credits in courses belonging to the field of technical sciences.

- Module Hydraulic Engineering
  - Out of the required five (5) courses, the student chooses four (4) elective courses within the module and one (1) general elective course.

- Engineering Mechanics Module
  - Out of the required five (5) courses, the student chooses three (3) elective courses within the module, one (1) general elective course and one (1) course from other modules, or
  - Out of the required five (5) courses, the student chooses three (3) elective courses within the module and two (2) courses from the other modules.

- Module Roads and Geotechnics
  - Out of the required five (5) courses, the student chooses all five (5) elective courses within the module, in which case the distribution of courses on Module 3+2 is in favour of the specialisation or
  - Out of the five (5) required courses, the student chooses four (4) within the module, and one (1) course can be a general elective or elective course in other modules of study. By choosing this model of course selection, the distribution of courses on the module is 3+1 depending on the chosen orientation, road or geotechnics, in favour of the orientation.

The Commission for Postgraduate Studies recognises examinations and other fulfilled obligations based on special agreements between holders of postgraduate studies in the country and abroad, such as mobility agreements within the ERASMUS+ or CEEPUS program. Otherwise, the applicant is obliged to submit, at his/her own expense, a decision of the competent body of the University on the academic recognition of the completed study obligation or ECTS credits.

1. ACADEMIC DEGREE OBTAINED UPON COMPLETION OF STUDIES

Academic degree obtained upon completion of studies:

Upon completion of the doctoral study of Civil Engineering, postgraduate students acquire the academic title Doctor of Science (PhD) in the scientific field of Technical Sciences, the scientific field of Civil Engineering or Basic Technical Sciences, depending on the scientific contribution of the doctoral thesis.

2. ACADEMIC CONDITIONS FOR ENROLMENT AT THE BEGINNING OF THE STUDY, CONDITIONS FOR ENROLMENT OF THE STUDENT IN THE NEXT YEAR OF STUDY, AS WELL AS PREREQUISITES FOR ENROLMENT IN STUDY OBLIGATIONS

Enrolment in the doctoral study programme is carried out based on a public tender announced by the Faculty Council of the study holder, published in the daily press and on the website of the doctoral study holder, as a rule, six months before the start of classes.

The public tender for enrolment in doctoral studies includes:

1) the name of the doctoral study (scientific/artistic field and field or interdisciplinary field of science/art and scientific/artistic fields),
2) the name of the holder of the doctoral study,
3) the number of enrolment places for doctoral studies in full-time or part-time status,
4) conditions and criteria for enrolment,
5) the criteria for the selection of candidates and the manner of conducting the procedure for the selection of candidates determined by the authorised councils of the doctoral study holders,
6) deadline and documents to be attached to the application for the competition,
7) the deadline for submitting the candidate's objection,
8) the deadline for enrolment and information on the enrolment procedure to ensure the equality of all candidates
9) registration documents,
10) study costs and
11) other data determined by the authorised councils of the doctoral study holder.

The candidate's application for the competition is submitted within the established deadline of the competition for enrolment in doctoral studies on the prescribed form of the study holder. With the application for the competition, the candidate must enclose the documentation determined by the competition. In the application, the candidate must indicate whether the status is a full-time doctoral study with a full-time teaching schedule or part-time doctoral study with an adjusted teaching schedule. In the application for the

competition, the candidate may attach copies of documents. Upon enrolment in the doctoral study, he or she must submit all documents in the original for inspection.

2.1. Academic conditions for enrolment at the beginning of studies

In the doctoral study of Civil Engineering can be enrolled:

- applicants with completed undergraduate and graduate university studies in civil engineering who have earned a total of at least 300 ECTS credits with a minimum mean grade of 3.00, which is determined as the arithmetic mean of the grade point average of the undergraduate university study exam and the grade point average of the graduate university study exam in the scientific field of civil engineering. Persons with a completed university undergraduate study according to the study system before 2005 who have the lowest common grade point average of 3.00 (lectures and exercises) of study and persons who have completed a university postgraduate scientific study programme leading to the academic degree of Master of Science in the scientific field of technical sciences, the scientific field of civil engineering or basic technical sciences.

- applicants with completed university, undergraduate and graduate studies in other scientific fields in the scientific field of technical sciences and the scientific field of natural sciences who have earned at least 300 ECTS credits with a minimum mean grade of 3.00, which is determined as the arithmetic mean of the grade point average of the undergraduate university study exam and the grade point average of the graduate university study exam. Applicants who have completed university undergraduate studies according to the study system before 2005 who have the lowest common grade point average of 3.00 (lectures and exercises) of study, and persons who have completed university postgraduate scientific studies that lead to the academic degree of Master of Science in other scientific fields in the scientific field of technical sciences and the scientific field of natural sciences. Applicants must meet the requirement of achieving a minimum of 150 ECTS credits in passed courses belonging to the scientific field of Civil Engineering. Applicants who have not attained the prescribed number of ECTS credits must pass differential exams determined by the Committee for Postgraduate Studies. The student enrols in differential exams after enrolling in the study. Students must pass differential exams until enrollment in the 2nd year of study. Differential exams are not included in the teaching load of doctoral students in doctoral studies.

2.2. Criteria for evaluating applicants

Applicants who have met all the conditions of the competition undergo a further evaluation and ranking process.

When applying for enrollment, the applicant chooses one to a maximum of three offered study advisors who provide areas for research and/or potential topics of the doctoral thesis. For selected study advisors, the applicant indicates the order of the desired selection from the first (highest priority) to the highest third (lowest priority). Rankings are created separately for each study advisor (potential mentor).

The criteria for selecting applicants for enrollment in the doctoral study of Civil Engineering are as follows:

1) Success at the previous level of study A (30)
2) Passed exams, published papers, knowledge and skills acquired by working in industry B (30)
3) Student Awards C (10)
4) Evaluation of the applicant's interview with Study Advisor D (20)
5) Examination of knowledge in the scientific field of interest and English E (10)

The total number of points is determined based on the sum of the points of criteria from A to E. Applicants with **at least 50 points** (provided that they also meet the conditions listed under the individual selection criteria) will be included in the ranking list of the study advisor, where they will be ranked from those with the highest number of points to those with the lowest. Each study advisor has its ranking list of applicants, and enrollment will be approved for applicants who enter the enrollment quota of the respective study advisor. If the applicant is within the enrolment quota on the ranking lists of more than one study advisor, he or she is approved for enrolment in the ranking list of the study advisor for whom he or she has stated the highest priority. At the same time, he or she is removed from the ranking lists of other study advisors where that one position is vacated, i.e. In these rankings, applicants below that position move up one place.

In the case of an equal number of points, preference is given to applicants who enrol in the study programme in full-time status. If two or more applicants are tied according to this criterion, the points are considered in order of the following criteria: D, A, B, E, C.

The method of determining points within categories A to E is defined as follows:

A = 8*a1+2*a2-20

a1 - average grade of all passed exams during the university undergraduate and graduate study or undergraduate study. The average grade of a1 **cannot be less than 3.0**. Applications from applicants with an average grade of A1 less than 3.00 will not be considered.

a2 – grade of the thesis.

In criterion A, the number of points cannot exceed 30.

B = b1 + b2*15

b1 – number for the doctoral study of the relevant passed exams in the university postgraduate master's study and university specialist study.

b2 – evaluation of scientific research work in the last five years in the field of the selected study module:

- article in the proceedings of the domestic conference 0.10
- article in the Proceedings of the International Conference 0.25

- article in a non-indexed professional journal 0.25
- article in a journal indexed in other databases 0.50
- article in a journal indexed in CC, SCI, and SCI Expanded 1.00
- other forms of non-formal learning (professional exam, membership in the Chamber, etc. 0.25

Published scientific articles are scored with the equal value of the corresponding scientific article.

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

In criterion B, the number of points cannot exceed 30.

C = c1+c2+c3+c4

c1 – University Award or State-Level Award 10

c2 – Faculty Award 5

c3 – n is the number of courses on which the candidate worked as a demonstrator during his studies 2*n

c4 – if the candidate has participated in classes at a higher education institution 2

In criterion C, the number of points cannot exceed 10.

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

At the interview with the study advisor (potential mentor), the candidate's motivation and interest in the study are checked, and the candidate's general attitude towards scientific research work is evaluated.

D – Assessment of the candidate's motivation and interest in the study: from 0 to 20.

In criterion D, the candidate must have a minimum of 10 points, and the maximum number of points cannot exceed 20.

E = English language proficiency assessment

E – written English language proficiency test grade: 0 to 10.

The Committee for Postgraduate Studies conducts a written examination of English language proficiency, which consists of translating a text from Croatian into English from the relevant field for which the candidate has applied. **In criterion E, the number of points cannot be more than 10 or less than 5.** The minimum level of English language proficiency that is assessed as satisfactory is the level corresponding to at least level A1 according to the Common European Framework of Reference for Foreign Languages. If the applicant submits a valid certificate of English language proficiency corresponding to the A2 level according to the Common European Framework of Reference for Foreign Languages, he is not obliged to take the English language proficiency test and is awarded the maximum number of points (10), 5 points are awarded for the A1 level.

If all the criteria are met, the Committee for Postgraduate Studies determines the list of selected applicants for enrolment in doctoral studies. It is published on the notice board and study holder's website. The time limit for objection and the time limit for responding to the objection are published. The Faculty Council of Doctoral Study Holders has adopted the decision on Enrollment for the Committee for Postgraduate Studies proposal.

The ranking list of applicants is determined based on the grade point average of the undergraduate and graduate, i.e. undergraduate or master's degree in science, published scientific and professional papers and other scientific and professional achievements in the last five years before the announcement of the competition for enrolment in postgraduate university studies. Interviewing applicants for the competition is a mandatory part of the competition procedure. The competition candidate has the right to inspect the results of his/her evaluation procedure in selecting candidates, ranking candidates, and other tender documentation following personal data protection regulations. A candidate has the right to file an objection to the election procedure within 24 hours after the announcement of the results of the candidate selection procedure. The objection is submitted to the Committee for Postgraduate Studies, which is obliged to consider the candidate's objection and decide within the deadline set by the competition for enrolment in doctoral studies.

2.3. Acquisition of the status of a doctoral student by transferring from another doctoral study

Acquiring the status of a doctoral student or continuing the status of a doctoral student in the doctoral study of Civil Engineering is possible by transferring from a related doctoral study:

- for doctoral studies carried out within the same scientific or artistic field and field within the doctoral school or university constituent,

- from one university constituent to another university constituent of the University or a doctoral school to a university constituent,
- from other higher education institutions in the Republic of Croatia,
- from other higher education institutions abroad with a mandatory decision on recognising the period of study by the competent authority.

The doctoral student must submit the application for approval of the transfer to the holder of the doctoral study considered by the Committee for Postgraduate Studies and approve or reject it based on the enrolment criteria.

2.4. Conditions for enrolment of doctoral students in the higher year of study

2.4.1. Conditions for enrolment in the higher year of study for doctoral students in full-time status

When enrolling in a higher year of study, the doctoral student is obliged to pass the verification of the fulfilment of the conditions for the previous academic year following the criteria (**Table 1, Table 3 and Table 4**) and to have an accepted annual work plan and a positive assessment of the work and progress of the study advisor/mentor for the previous academic year of study of the Committee for Postgraduate Studies. As a rule, the performance grade is negative if the doctoral student has not fulfilled the obligations corresponding to the accepted annual plan and the conditions for enrolment in the next year of study.

To enrol in the second year of study, a PhD student must acquire a minimum of **60 ECTS** credits:

- Compulsory teaching activities – **18 ECTS** → pass compulsory and two elective courses,
- Elective teaching activities – maximum **10 ECTS** → activities **Table 3**,
- Scientific research – **32 ECTS** → activities **Table 4**.

To enrol in the third year of study, a PhD student must acquire a minimum of **120 ECTS** credits:

- Compulsory teaching activities – **18 ECTS** → pass three elective courses,
- Elective teaching activities – maximum **10 ECTS** → activities **Table 3**,
- Scientific research – **17 ECTS** → activities **Table 4**,
- Submission of the doctoral thesis topic – **5 ECTS,**
- Public defence of the doctoral thesis topic – **10 ECTS.**

Before submitting the doctoral thesis topic, the doctoral student must have passed all study exams and have **a minimum of 90 ECTS** credits.

Upon completion of the third year of study, the doctoral student acquires **180 ECTS** credits:

- Elective teaching activities – maximum **10 ECTS** → activities **Table 3**,
- Scientific research – **20 ECTS** → activities **Table 4**,
- Doctoral thesis and defence of the doctoral thesis – **30 ECTS.**

Before the public defence of the doctoral thesis, the doctoral student is obliged to have published or accepted for publication at least one scientific paper of the A category, whereby the category of the paper and the equivalent value for each author is determined following the applicable Ordinance on Amendments to the

Ordinance on the Conditions for Election to Scientific Titles (NN 111/22), in which the only or one of the principal authors is the work and the paper must be in the field of research of the doctoral thesis. The main authorship is proven through the Proposal for appointing the principal authors of the scientific paper form.

Table 1 Structure of Studies for Doctoral Students in Full-Time Status

<table>
<tr><th>YEAR</th><th colspan="2">FORM OF ACTIVITY</th><th>DESCRIPTION OF THE ACTIVITY</th><th>ECTS</th></tr>
<tr><td rowspan="4">I. year of study</td><td rowspan="3">Teaching</td><td rowspan="2">Compulsory teaching activities</td><td>Compulsory course</td><td>6</td></tr>
<tr><td>Elective courses</td><td>12</td></tr>
<tr><td colspan="2">Elective Teaching Activities</td><td>maks. 10</td></tr>
<tr><td>Extracurricular</td><td colspan="2">Scientific research</td><td>32</td></tr>
<tr><td colspan="4">Minimum number of points in the first year of study</td><td>60</td></tr>
<tr><td colspan="4">Condition for enrolment in the second year of study</td><td>60</td></tr>
<tr><td rowspan="5">II. year of study</td><td rowspan="2">Teaching</td><td>Compulsory teaching activities</td><td>Elective courses</td><td>18</td></tr>
<tr><td colspan="2">Elective Teaching Activities</td><td>maks. 10</td></tr>
<tr><td rowspan="3">Extracurricular</td><td colspan="2">Scientific research</td><td>17</td></tr>
<tr><td colspan="2">Submission of the topic of the doctoral thesis</td><td>5</td></tr>
<tr><td colspan="2">Public defence of the topic of the doctoral thesis</td><td>10</td></tr>
<tr><td colspan="4">Minimum number of points in the second year of study</td><td>60</td></tr>
<tr><td colspan="4">Condition for enrolment in the third year of study</td><td>120</td></tr>
<tr><td rowspan="3">III. year of study</td><td>Teaching</td><td colspan="2">Elective Teaching Activities</td><td>maks. 10</td></tr>
<tr><td rowspan="2">Extracurricular</td><td colspan="2">Scientific research</td><td>20</td></tr>
<tr><td colspan="2">Doctoral thesis</td><td>30</td></tr>
<tr><td colspan="4">Minimum number of points in the third year of study</td><td>60</td></tr>
<tr><td colspan="4">Total is acquired upon completion of studies</td><td>180</td></tr>
</table>

2.4.2. Conditions for enrolment in a higher year of study for a doctoral student in part-time status

When enrolling in a higher year, the doctoral student is obliged to undergo a verification of the fulfilment of the conditions for the previous academic year following the criteria (**Table 2, Table 3 and Table 4**) and to have an accepted annual work plan and a positive assessment of the work and progress of the study advisor/mentor for the year of study of the Committee for Postgraduate Studies. As a rule, the performance grade is negative if the student has not fulfilled the obligations corresponding to the accepted annual plan and the conditions for enrollment in the higher year of study.

To enrol in the second year of study, a doctoral student must acquire a minimum of **45 ECTS** credits:

- Compulsory teaching activities – **18 ECTS** → pass compulsory and two elective courses,
- Elective teaching activities – maximum **7 ECTS** → activities **Table 3.**
- Scientific research – **20 ECTS** → activities **Table 4.**

To enrol in the third year of study, a doctoral student must acquire a minimum of **100 ECTS** credits:

- Compulsory teaching activities – **18 ECTS** → pass three elective courses,
- Elective teaching activities – maximum **10 ECTS** → activities **Table 3.**
- Scientific research – **17 ECTS** → activities **Table 4**,
- Submission of the doctoral thesis topic – **5 ECTS,**
- Public defence of the doctoral thesis topic – **10 ECTS.**

Before submitting the doctoral thesis topic, the doctoral student must have passed all study exams and have **a minimum of 90 ECTS** credits.

Upon completion of the third year of study, the doctoral student acquires **180 ECTS** credits:

- Elective teaching activities – maximum **13 ECTS** → activities **Table 3**.
- Scientific research – **32 ECTS** → activities **Table 4**,
- Doctoral thesis and defence of the doctoral thesis – **30 ECTS.**

Before the public defence of the doctoral thesis, the doctoral student is obliged to have published or accepted for publication at least one scientific paper of the A category, whereby the category of the paper and the equivalent value for each author is determined following the applicable Ordinance on Amendments to the Ordinance on the Conditions for Election to Scientific Titles (NN 111/22), in which the only or one of the principal authors is the work and the paper must be in the field of research of the doctoral thesis. The main authorship is proven through the Proposal for appointing the principal authors of the scientific paper form.

Table 2 Structure of Studies for Doctoral Students in Part-time Status

<table>
<tr><th>YEAR</th><th colspan="3">FORM OF ACTIVITY</th><th>DESCRIPTION OF THE ACTIVITY</th><th>ECTS</th></tr>
<tr><td rowspan="4">I. year of study</td><td rowspan="3">Teaching</td><td colspan="2" rowspan="2">Compulsory teaching activities</td><td>Compulsory course</td><td>6</td></tr>
<tr><td>Elective courses</td><td>12</td></tr>
<tr><td colspan="3">Elective Teaching Activities</td><td></td></tr>
<tr><td>Extracurricular</td><td colspan="3">Scientific research</td><td></td></tr>
<tr><td colspan="5">Minimum number of points in the first year of study</td><td>45</td></tr>
<tr><td colspan="5">Condition for enrolment in the second year of study</td><td>45</td></tr>
<tr><td rowspan="5">II. year of study</td><td rowspan="2">Teaching</td><td colspan="2">Compulsory teaching activities</td><td>Elective courses</td><td>18</td></tr>
<tr><td colspan="3">Elective Teaching Activities</td><td></td></tr>
<tr><td rowspan="3">Extracurricular</td><td colspan="3">Scientific research</td><td></td></tr>
<tr><td colspan="3">Submission of the topic of the doctoral thesis</td><td></td></tr>
<tr><td colspan="3">Public defence of the topic of the doctoral thesis</td><td></td></tr>
<tr><td colspan="5">Minimum number of points in the second year of study</td><td>60</td></tr>
<tr><td colspan="5">Condition for enrolment in the third year of study</td><td>100</td></tr>
<tr><td rowspan="3">III. year of study</td><td>Teaching</td><td colspan="3">Elective Teaching Activities</td><td>najviše 13</td></tr>
<tr><td rowspan="2">Extracurricular</td><td colspan="3">Scientific research</td><td>32</td></tr>
<tr><td colspan="3">Doctoral thesis</td><td>30</td></tr>
<tr><td colspan="5">Minimum number of points in the third year of study</td><td>75</td></tr>
<tr><td colspan="5">Total is acquired upon completion of studies</td><td>180</td></tr>
</table>

Table 3 ECTS credits for teaching activities

Optional teaching activities covering teaching and knowledge transfer:		**ECTS**	
		Min	**Max**
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 (each performance/holding of the workshop 3 ECTS credits, and the duration of each workshop is min. one academic hour).	**3**	**12**
2.	Pedagogical-psychological and didactic-methodical training.	**6**	
3.	Cooperation in teaching courses in technical sciences in civil engineering or basic technical sciences of university, undergraduate or graduate studies (seminars, exercises), which earns ECTS credits (1 ECTS credit is equal to active participation in classes for 20 contact hours).	**1**	**6**
4.	Authorship or co-authorship of a university textbook, manual, script or book, and editing of peer-reviewed professional, teaching or scientific publications.	**6**	
5.	Authorship or co-authorship of reviewed teaching materials from individual teaching units in courses in the field of technical sciences in the field of civil engineering or basic technical sciences of a university, undergraduate or graduate study (each authorship or co-authorship 2 ECTS credits).	**2**	**6**
6.	Co-mentorship is required to prepare a final or graduate thesis in technical sciences in civil engineering or basic technical sciences of a university, undergraduate or graduate study (each co-mentorship is 2 ECTS credits).	**2**	**6**
7.	Attend workshops on business and entrepreneurship development and project management, starting a start-up (each workshop attendance is 1 ECTS credit, and the duration of each workshop is min. 2 academic hours).	**1**	**4**
8.	Attend workshops on searching for information sources - catalogues, databases, and other online sources, as well as scientific communication and dissemination (each workshop attendance carries 1 ECTS credit, and the duration of each workshop is min. 2 academic hours).	**1**	**4**
9.	Attendance of English Academic Language workshops (each workshop attendance carries 1 ECTS credit, and the duration of each workshop is min. 2 academic hours).	**1**	**4**
10.	Attend workshops on applying for specialised computer programs, programming, and programming languages in science (each workshop attendance carries 1 ECTS credit, and the duration of each workshop is min. 2 academic hours).	**1**	**4**
11.	Participation in science popularisation activities (each activity 1 ECTS credit).	**1**	**3**
12.	Attendance at the postgraduate level of other higher education institutions (each attendance 1 ECTS credit, min. 2 academic hours).	**1**	**4**
13.	Preparation of the Annual Work Plan of a postgraduate university student with the support and consent of the study advisor/mentor and submission on the OB 8-4-6 form (each plan 1 ECTS credit per year).	**1**	**3**

The realisation of elective teaching activities listed in **Table 3** must be proven as follows:

1. *The workshop must be reported to the Head of Postgraduate Studies at the beginning of the academic year as part of the Annual Plan for Professional and Scientific Workshops. After the workshop, it is necessary to submit a report with a list of participants to the Vice-Dean for Science in the case of scientific workshops or to the Vice-Dean for Projects and Institutional Cooperation in the case of a professional workshop.*

2. *It is proved by presenting a certificate from a higher education institution on completed education.*
3. *It is evidenced by a certificate from the Vice-Dean for Education based on the Report on Classes Held in the Academic Year.*
4. *It is evidenced by a printout from the CroRIS profile of the doctoral student, on which authorship, co-authorship, or editorial is visible.*
5. *The course leader defines the teaching units, and the Teaching Committee reviews the materials.*
6. *It is evidenced by a printout from the CroRIS profile of the doctoral student on which the co-mentorship is visible.*
7. *This is evidenced by an issued certificate of attendance at the workshop, which shows the topic, the organiser, and the duration of the workshop (also applies to points 8, 9, 10, and 12).*
11. *This is evidenced by the certificate of the President of the Committee for the Popularization of Science for activities organised by the Faculty; for other activities, it is necessary to attach a certificate showing the activity's topic, type, and organiser.*

Table 4 ECTS credits for extracurricular activities

Other extracurricular activities		ECTS	
		Min	Max
1.	Scientific paper (published or accepted for publication) of A category, as defined following the applicable Ordinance on Amendments to the Ordinance on Conditions for Election to Scientific Titles (NN 111/22).	36	144
2.	A scientific paper (published or accepted for publication) of category B, as defined following the current Ordinance on the Conditions for Election to Scientific Titles (NN 111/22).	18	
3.	Papers from international and domestic scientific conferences **have been published and** exhibited.	12	
4.	Published papers, presented as **posters**, from international scientific conferences.	8	
5.	By staying at other domestic or foreign universities or scientific institutions, a minimum of 2 ECTS (equivalent to 5 working days) and a maximum of 24 ECTS (equivalent to 60 working days, cumulatively) is achieved during the doctoral study.	2	24
6.	Participation or cooperation in a scientific research project.	10	30
7.	Participation in the organising committees of scientific conferences or the editorial board of scientific journals.	2	6
8.	Patented results of scientific research.	36	
9.	Passing vocational exams: professional exam, certified project managers, certified energy certifiers, etc. (2 ECTS credits per passed exam).	6	
10.	Participation in vocational training in civil engineering and basic technical sciences (1 ECTS point per participation).	4	
Extracurricular activities related to doctoral work			
Submission of the topic of the doctoral thesis		5	
Public defence of the topic of the doctoral thesis		10	
Doctoral Thesis and Doctoral Thesis Defence		30	

The realisation of other extracurricular activities listed in **Table 4** must be proven as follows:

1. *The categorisation of journals and the share of contributions of individual authors in papers is determined following the applicable Ordinance on the Conditions for Election to Scientific Titles. The primary authorship is proved through the Proposal for the appointment of the primary authors of the scientific paper (also applies to point 2).*
3. *The categorisation of the conference and the share of contributions of individual authors in the papers is determined following the current Ordinance on the conditions for election to scientific titles. Participation is proved by a certificate from the organiser of the conference or an excerpt from the proceedings (also applies to point 4).*
5. *The certificate of the receiving institution on the realised stay shows the duration.*
6. *Certificate of the project leader on the activities in the academic year.*
7. *Confirmation from the conference's organiser or the scientific journal's editor-in-chief.*
8. *Certificate of patent from the competent institution.*
9. *Certificate of the professional organisation on the passed exam.*
10. *Certificate of participation in training by a professional organisation.*

The papers under points 1, 2, 3 and 4, **Table 4**, refer to papers published by the student during the postgraduate study.

2.5. Conditions and Manner of Obtaining a Doctoral Degree by Enrolling in a Doctoral Study and Writing a Doctoral Thesis without Attending Classes and Taking Exams

2.5.1. Doctoral dissertation by transfer or continuation of studies

Applicants who have passed specific exams in the postgraduate scientific study for the academic degree of Master of Science (MSc) in civil engineering or basic technical sciences can be recognised as equivalent to exams from this study program up to a maximum of 48 ECTS credits. The completed and defended master's thesis is recognised as a published scientific paper with 22 ECTS credits. The rest of the 90 ECTS credits necessary to initiate the procedure for obtaining a doctoral degree, i.e. to apply for the topic of the doctoral thesis, is achieved by the doctoral student through elective teaching and extracurricular activities and by passing two differential exams from the group of elective courses determined by the Committee for Postgraduate Studies. After the public defence of the topic and before the public defence of the doctoral thesis, the doctoral student is obliged to have published or accepted for publication at least one scientific paper of category A, whereby the category of the thesis and the equivalent value for each author is determined following the applicable Ordinance on Amendments to the Ordinance on the Conditions for Election to Scientific Titles (NN 111/22), in which the sole or one of the primary authors is the work and the paper must be in the field of research of the doctoral thesis. The main authorship is proven through the Proposal for appointing the primary authors of the scientific paper form. To initiate the evaluation and public defence of the doctoral thesis, the doctoral student must have a minimum of 150 ECTS credits.

Applicants who have completed a university specialist study (univ. spec. ing. aedif. or spec. tech.) in the field of civil engineering or the field of basic technical sciences, passed exams can be recognised as equivalent to exams from this study program up to a maximum of 40 ECTS credits. The completed and defended specialist thesis is recognised in 20 ECTS credits. The rest of the 90 ECTS credits necessary to initiate the procedure for obtaining a doctoral degree, i.e. the application of the doctoral thesis topic, are achieved by the doctoral student through elective teaching and extracurricular activities, passing two differential exams

from the group of elective courses determined by the Committee for Postgraduate Studies and the compulsory course. After the public defence of the topic and before the public defence of the doctoral thesis, the doctoral student is obliged to have published or accepted for publication at least one scientific paper of category A, whereby the category of the thesis and the equivalent value for each author is determined following the applicable Ordinance on Amendments to the Ordinance on the Conditions for Election to Scientific Titles (NN 111/22), in which the sole or one of the primary authors is the work and the paper must be in the field of research of the doctoral thesis. The main authorship is proven through the Proposal for appointing the primary authors of the scientific paper form. To initiate the evaluation and public defence of the doctoral thesis, the doctoral student must have a minimum of 150 ECTS credits.

Acquiring a PhD without enrolment in a doctoral study programme is regulated by Article 24 of the Act. of the Ordinance on Postgraduate Studies of the University.

2.5.2. Doctoral dissertation as a scientific work based on a set of published scientific articles

Following the Ordinance on Postgraduate Studies of the University, Article 39, the possibilities of designing a doctoral thesis as a scientific monograph or a set of published scientific papers are defined. According to this article, a set of published scientific papers is accompanied by a critical review chapter consisting of an introduction, discussion, conclusion, and review of relevant literature. The papers must fully correspond to the selected topic of the doctoral thesis so that the hypotheses, methodology, and scientific contribution from the accepted topic can be referred to in the proposed papers unambiguously. This form of a doctoral dissertation is possible only within the framework of research work in the doctoral study. Scientific papers combined into a doctoral thesis must consist of at least three original scientific papers in indexed journals in databases relevant to the scientific field of the doctoral dissertation in which the doctoral student is the sole author or one of the primary authors. At least one of the published papers must be in the journal Q1 quartile following the applicable Ordinance on Amendments to the Ordinance on the Conditions for Election to Scientific Titles (NN 111/22), in which the sole or one of the primary authors is the paper. The paper must be in the field of research of the doctoral thesis. The primary authorship is proved through the form of a Proposal for the appointment of the primary authors of the scientific paper and other papers, according to **Table 5**.

When the doctoral thesis is in the form of a scientific work based on published articles, it must be equivalent to the doctoral dissertation in scope and significance, and it should show the independence and creativity of the doctoral student, as well as the originality of the research. All published papers (articles) equivalent to a doctoral thesis should be a related thematic unit, confirmed by the Committee for the Evaluation of the Doctoral Thesis appointed by the Faculty Council.

The doctoral student and the mentor, or co-mentor, should be the primary authors of the published papers together, and the primary authorship is proven through the Proposal for the Appointment of the Main Authors of the Scientific Paper form. The Doctoral Thesis Evaluation Committee or the Faculty Council may request a written statement on the contribution of each co-author according to the applicable regulations.

After defending the topic and before submitting the Mentor's Certificate of completion and submission of the doctoral thesis, the doctoral student and the mentor decide on the model according to which they will structure the doctoral dissertation as a scientific monograph or as a set of published scientific articles.

Regardless of the chosen model, doctoral students take exams in the study, at least six subjects and other obligations prescribed by this study program.

By selecting a doctoral thesis as a scientific work based on a set of published scientific articles, the following must be met:

1. The doctoral student must be the main author of all papers.
2. The maximum number of authors in a published paper may be four (4),
3. Results in scientific papers must not be part of a previously defended qualification thesis (final, graduate or master's thesis),
4. All scientific papers must be published after enrolment in doctoral studies,
5. The doctoral thesis is written in Croatian or, with the consent of the Faculty Council, can be written in English, and the attached papers published during the study must be in their original form,
6. Each paper can only qualify one doctoral student.
7. The doctoral thesis consists of the following chapters:

I. **TITLE PAGES** prescribed by the University and the Faculty,
II. **TITLE, ABSTRACT AND KEYWORDS** in Croatian and English,
III. **THANK YOU** or dedication at the request of the doctoral student – not necessary,
IV. **INTRODUCTION** - an exhaustive review of findings from the narrower field of work, which is the result of a thorough search of the literature in the field, which was published in an international journal in English, **Table 5**. This part may also contain an unpublished overview of findings from a narrower field of research. Still, in this case, one more published paper is needed in the category of scientific papers. In addition to the literature search results, the introduction should contain working hypotheses, research goals, a description of the research methodology and the expected scientific contributions accepted by the Faculty Council in the Decision to accept the doctoral thesis topic.
V. **SCIENTIFIC PAPERS** - instead of the experimental part and results, separate scientific papers should be submitted which correspond to the submitted topic and which were published in an international journal(s) in English, **Table 5**. Suppose the published papers are not in open-access journals. In that case, obtaining a certificate from the publisher is necessary to approve the public publication of the complete thesis in the doctoral dissertation. Suppose the doctoral student is one of the co-authors of the thesis. In that case, it is necessary to indicate the roles of the individual authors of the thesis and ask the other authors for permission to include the thesis in question in the doctoral dissertation.
VI. **DISCUSSION** - which is common to all published papers, which explains in an argumentative way how the consolidated papers give a new scientific contribution concerning individual papers and which ultimately leads to a conclusion,
VII. **CONCLUSIONS** - a concise recapitulation of the most important findings resulting from the conducted research, in which the new scientific contribution concerning all individual papers is explained,
VIII. **LIST OF PUBLICATIONS,**
IX. **APPENDICES** - methodological data and results that are relevant to the doctoral thesis and are not part of the attached published papers,
X. **CURRICULUM VITAE OF THE PHD STUDENT,**

Table 5 Required number and type of papers for a doctoral thesis as a scientific work based on a set of published scientific articles

Chapter of the doctoral thesis	Required number of published papers	Type of work required	Quartile to which the journal belongs*
IV. INTRODUCTION	1**	Complete work	from Q1 to Q4
V. SCIENTIFIC PAPERS	min. 2		Q1 or Q2
	min. 1		from Q1 to Q4***

** The quartiles of the journal are determined according to the classification in the corresponding categories, the Journal Citation Report (JCR) based on the Web of Science Core Collection and/or the Scimago Journal & Country Rank (SJR) based on the Scopus database. Quartiles are determined according to the paper's publication year or the last year for which the data on the journal's quartile is known, using a more favourable choice for the applicant.*

*** If the paper in Chapter IV is not published, then the number of required published scientific papers in Chapter V is increased by 1 and amounts to 4.*

**** If the journal in which the paper was published is indexed in the WoSCC and/or Scopus database but has not yet been assigned a quartile and/or impact factor, it will be considered to be classified in the fourth quartile (Q4).*

3. ANTICIPATED LEARNING OUTCOMES THAT ARE ACQUIRED BY FULFILLING INDIVIDUAL STUDY OBLIGATIONS, STUDY MODULES AND THE OVERALL STUDY PROGRAMME, AS WELL AS THE ANTICIPATED NUMBER OF HOURS FOR EACH STUDY OBLIGATION THAT ENSURES THE ACQUISITION OF THE ENVISAGED LEARNING OUTCOMES

The doctoral study ensures the acquisition of top scientific education in civil engineering based on scientific research by mastering the study program and participating in organised scientific research activities. By writing a doctoral thesis, in which the doctoral student makes his original scientific contribution and proves himself as a scientist in his field of research.

Declared work qualifications of completed participants of the study program:

A doctor of technical sciences in the scientific field of civil engineering or basic technical sciences is qualified to conduct top scientific work in the profession independently, possesses and independently uses cutting-edge knowledge in construction and basic technical sciences, and makes scientific contributions in the field of civil engineering or basic technical sciences with their inventive work.

During the study, knowledge and skills in applying research methods are systematically developed, as well as the ability to formulate a research problem by evaluating existing and creating new facts in the field of research, whereby doctoral students use the acquired highly specialised knowledge and skills. During their studies, they focused on the development of new research methods.

3.1. The study program enables the acquisition of project planning and management skills

In addition to acquiring specialised knowledge, students develop competencies in project management – organising and conducting scientific research in conditions of limited time and material and financial resources. Study participants are expected to create an annual research plan that determines the schedule of research activities and the necessary resources and forms a research team in which doctoral students demonstrate the ability to design, plan, implement, and adapt to a research problem. The Research Plan defines the scope of the research, the connection of the planned activities with the defined scope, key events in the research, potential risks and measures to mitigate them. By completing their studies and obtaining the Doctor of Science degree, doctoral students confirm that they have acquired these skills, aware that they need to be expanded and deepened. PhD students are also focused on cooperation with other researchers and scientists in the country and the world, and in this way, organisational skills are developed.

3.2. The study program provides knowledge of research methodology

During the study and implementation of research in the preparation of a doctoral thesis, doctoral students can demonstrate the ability to detect a research problem, identify and analyse the relevant literature in the field of research, determine the method of data collection, select appropriate and particular theoretical and analytical techniques, and apply and draw research conclusions. They can consider their findings and the success of their achievement.

3.3. The study program allows you to acquire writing and reporting skills

The development of writing and reporting skills is carried out through the requirement that the doctoral thesis be written following the highest academic standards. During the study, postgraduate students present their seminar papers in front of professors and colleagues and, at the end of the study, in front of the committee for the defence of the doctoral thesis. PhD students of the Faculty of Civil Engineering and Architecture Osijek regularly present their research topics at a gathering of young researchers in the field of civil engineering and related technical sciences – Zajednički temelji.

3.4. The study program enables the development of teaching skills and the monitoring and evaluation of doctoral students

According to Article 52 of the Statute of the Faculty of Civil Engineering and Architecture Osijek (June 2023), doctoral students can participate in teaching. Engagement in teaching is aligned with the time required for scientific research. In teaching, they participate in the process of monitoring and evaluating students. In this

way, students are strengthened in developing time management competencies, focus on achieving educational goals, and discipline.

3.5. The study program enables the development of the skill of expressing personal and professional authority

3.6. The study program enables the assumption of ethical and social responsibility

Given the expectations that students are ready and able to take on the most complex tasks in the work environment upon completion of the doctoral study – to initiate, organise and participate in various projects that require coordinated work and a combination of associates who have different competencies during the study, the study program is focused on developing the ability to accept and promote technological, social and cultural achievements. In their expertise, they are trained to communicate with the broader academic and social community.

3.7. Upon completion of the doctoral study of Civil Engineering at the Faculty of Civil Engineering and Architecture in Osijek, students will be able to:

- **Identify, define and formulate a research problem.**
- **Critically analyse, evaluate, and synthesise new and complex research ideas.**
- **Demonstrate a systematic understanding of the field of study and a high degree of knowledge in the speciality.**
- **Conduct scientific research independently.**
- **Independently construct an experimental model and a measuring instrument.**
- **Apply specific knowledge to generate new knowledge and research projects.**
- **Publish scientific papers.**
- **Take responsibility for the implementation of research and the social usefulness of research results.**
- **Take on the most complex tasks in your work environment.**
- **Apply ethical principles in research.**

The acquisition of highly specialised knowledge and the research potential of the Faculty are emphasised in the field of scientific branches of load-bearing structures, organisation and technologies of construction, hydraulic engineering, roads and geotechnics. The strategic documents of the Faculty formalised and supported this direction of scientific activities, investment in infrastructural development and the creation of conditions for the consolidation of research groups. Within the study program, the aspiration is to achieve a synergistic effect between learning, research and innovation. The study program enables and encourages work on constructing experimental models and measuring instruments.

3.8. Students of the doctoral study of Civil Engineering, depending on the chosen subjects and field of research, acquire the following competencies:

3.8.1. Load-bearing structure module

The postgraduate university study on the module Load-bearing Structures expands and deepens the knowledge that students have acquired in their previous education at undergraduate and graduate studies related to structures made of concrete, masonry, steel and wood, and the building materials themselves. More detailed research of the behaviour of materials and structures exposed to different effects of action and the ways of ensuring their usability and durability acquire the skills necessary for the reproduction of existing scientific knowledge, as well as the recognition and solution of new scientific problems in the subject area. Students are also allowed to cooperate with other modules, and applying advanced methods of modelling and calculating the behaviour of structures and materials provides the necessary knowledge and skills to work in a modern, competitive scientific research and economic environment.

3.8.2. Organization, Technology and Management Module

Postgraduate university studies in the Organization, Technology and Management module expand and deepen the knowledge of masters of civil engineering related to the organisation, planning, optimisation of technological and economic aspects, technology development, sustainable development, management and control of construction projects and business operations. The study provides an exhaustive survey of methods, techniques, and systems related to these issues and advanced scientific methods for planning, construction, analysis, management, protection, and maintenance of buildings.

3.8.3. Engineering Mechanics Module

The postgraduate university study on the module Engineering Mechanics is the basis of basic technical sciences within the field of civil engineering, upon completion of which students acquire knowledge of nonlinear dynamic calculation, assessment of the behaviour of historical buildings, inverse, numerical and experimental models and the application of new materials. The module provides an exhaustive study of these topics with advanced scientific methods of experimental and numerical modelling.

3.8.4. Module Hydraulic Engineering

Students of the Postgraduate University Study of Civil Engineering, Module Hydraulic Engineering deepen their knowledge of masters of civil engineering and, depending on the chosen subjects and field of research, acquire competencies related to a broader understanding of hydro-technical problems and research work in hydraulic engineering. The emphasis is on competencies in applying modern scientific methods and the connection between hydraulic engineering and environmental protection.

3.8.5. Road and Geotechnics Module

The postgraduate university study in the module Roads and Geotechnics enables students to critically analyse, evaluate and synthesise new and complex concepts, apply modern and develop new methodological procedures in the scientific branches of Roads and Geotechnics through the examination of materials and structures and the professional and scientific application of relevant knowledge in their conception and analysis. The student is also qualified for independent advanced scientific research work in testing, modelling, calculation, analysis and design of systems and interventions in these scientific branches.

3.9. List of courses and modules

The list of courses and/or modules with the number of hours of active teaching required for their implementation and the number of ECTS credits for the doctoral study of Civil Engineering is presented in **Table 6**, and the **Annex** provides a description and general information on all courses.

Table 6 List of compulsory and elective courses and/or modules with the number of hours of active teaching required for their performance and the number of ECTS credits

LIST OF MODULES/COURSES							
Year of study: 1							
Semester: 1							
MODULE	COURSES	COURSE TEACHER	P	V	S	ECTS	STATUS*
COMPULSORY SUBJECT	Theoretical Postulates and Principles of Scientific Research	prof. dr. sc. Davorin Penava	30	0	30	6	C
ELECTIVE COURSES GENERAL	Numerical Mathematics	prof. dr. sc. Ninoslav Truhar	30	0	30	6	E
	Application of Expert Systems	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	izv. prof. dr. sc. Ivana Šandrk Nukić	30	0	30	6	E

LIST OF MODULES/COURSES							
Year of study: 1							
Semester: I, II							
MODULE	COURSES	COURSE TEACHER	P	V	S	ECTS	STATUS*
LOAD-BEARING STRUCTURES	Reliability Engineering	izv. prof. dr. sc. Tihomir Dokšanović prof. dr. sc. Damir Markulak	30	0	30	6	E
	Serviceability Limit States of Reinforced Concrete Structures	izv. prof. dr. sc. Ivan Kraus	30	0	30	6	E
	Earthquake Engineering II	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 Structures Modelling	prof. dr. sc. Damir Markulak	30	0	30	6	E
	Theory of Structure Durability	izv. prof. dr. sc. Ivana Miličević	30	0	30	6	E
	Fatigue of Steel Structures	prof. dr. sc. Ivan Radić	30	0	30	6	E
	Blast Load Effects on Structures	izv. prof. 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

POPIS MODULA/PREDMETA							
Year of study: 1							
Semester: I, II							
MODUL	COURSES	COURSE TEACHER	P	V	S	ECTS	STATUS*
ORGANIZATION, 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. Hrvoje Krstić	30	20	10	6	E
	Planning, Modelling and Simulating the Construction Process	izv. prof. dr. sc. Mario Galić	30	0	30	6	E
	Optimisation of Construction Processes	prof. dr. sc. Uroš Klanšek	30	0	30	6	E
	Sustainable Construction Technologies	prof. dr. sc. Hrvoje Krstić	30	0	30	6	E
	Strategic Management	izv. prof. dr. sc. Ivana Šandrk Nukić dr.sc. Barbara Medanić, prof. emer.	30	0	30	6	E
	Quality Management in Construction Projects	prof. dr. sc. Zlata Dolaček-Alduk	30	0	30	6	E
	Comprehensive Energy Modelling of Buildings	prof. dr. sc. Hrvoje Krstić	30	0	30	6	E
	Technologies for the Automation of Construction, Monitoring, and Control Processes	prof. dr. sc. Zlata Dolaček-Alduk izv. prof. dr. sc. Mario Galić	30	0	30	6	E

POPIS MODULA/PREDMETA							
Year of study: 1							
Semester: I, II							
MODUL	COURSES	COURSE TEACHER	P	V	S	ECTS	STATUS*
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	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	izv. prof. 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
	River Hydraulics	prof. dr. sc. Lidija Tadić	30	0	30	6	E

POPIS MODULA/PREDMETA							
Year of study: 1							
Semester: I, II							
MODUL	COURSES	COURSE TEACHER	P	V	S	ECTS	STATUS*
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	prof. dr. sc. Silva Lozančić	30	20	10	6	E
	Theory and Principles of Assessment and Retrofit of Historic Buildings	prof. dr. sc. Davorin Penava prof. dr. sc. 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	izv. prof. 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	izv. prof. dr. sc. Ivana Miličević	30	0	30	6	E

POPIS MODULA/PREDMETA							
Year of study: 1							
Semester: I, II							
MODUL	COURSES	COURSE TEACHER	P	V	S	ECTS	STATUS*
ROADS AND GEOTECHNICS	Flexible Pavement Structures	prof. dr. sc. Sanja Dimter	30	0	30	6	E
	Analysis of Asphalt Mixtures	prof. dr. sc. Aleksandra Deluka-Tibljaš	30	30	0	6	E
	Rigid Pavements	prof. dr. sc. Ivana Barišić	30	20	10	6	E
	Management of Modern Roadways	izv. prof. dr. sc. Miroslav Šimun	30	0	30	6	E
	Transport Modelling	prof. dr. sc. Irena Ištoka Otković	30	10	20	6	E
	Computer Modelling in Geotechnics	prof. dr. sc. Krunoslav Minažek	30	0	30	6	E
	Earth Structures and Dynamic Soil Compaction	prof. dr. sc. Dietmar Adam	30	0	30	6	E
	Efficiency Mechanisms of Geosynthetics	prof. dr. sc. Krunoslav Minažek doc. dr. sc. Stanislav Lenart	30	0	30	6	E
	Laboratory and In-Situ Soil Tests	prof. dr. sc. Krunoslav Minažek	30	0	30	6	E
	Soil Dynamics and Foundations	doc. dr. sc. Igor Sokolić	30	0	30	6	E

**Note: If the course is compulsory, C is entered, and the elective is E.*

4. AN APPROPRIATE NUMBER OF ECTS CREDITS BASED ON THE AVERAGE TOTAL AMOUNT OF WORK THAT THE DOCTORAL STUDENT MUST PUT IN TO ACQUIRE THE ANTICIPATED LEARNING OUTCOMES AS PART OF THE OBLIGATIONS

In addition to the data on ECTS credits listed in Tables 1 to 4 and 6, this chapter provides a scheme of ECTS credits for the doctoral study of Civil Engineering.

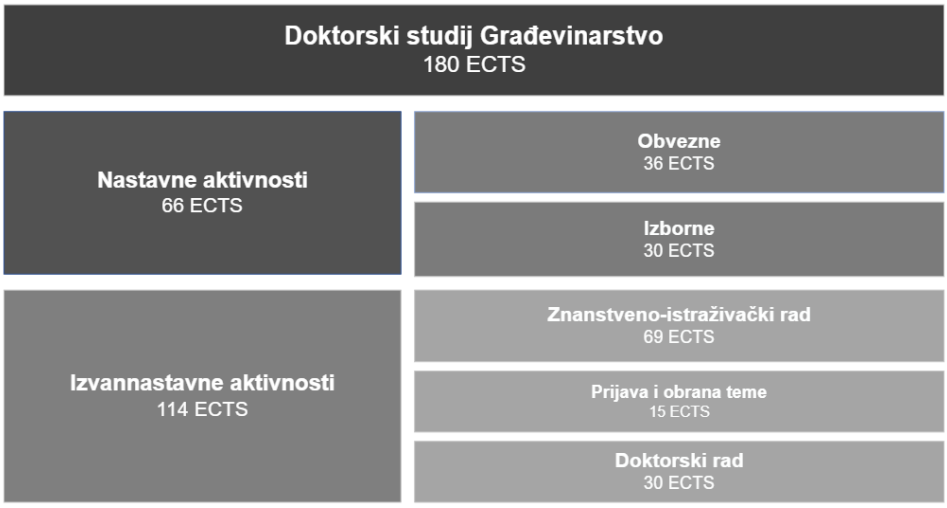

Figure 1 Scheme of ECTS credits for the doctoral study of Civil Engineering

4.1. Form of Teaching and Method of Verification of Acquired Learning Outcomes for Each Study Obligation

Teaching activities are carried out through elective courses and direct forms of teaching consisting of lectures, research seminars, exercises, workshops, laboratory work, etc. Direct forms of teaching are compulsory and elective teaching activities, and indirect forms of teaching are extracurricular activities.

The form of teaching and the method of verifying the acquired learning outcomes for each study obligation, as well as the list of compulsory and elective courses and/or modules with the number of hours of active teaching required for their implementation and the number of ECTS credits for the doctoral study of Civil Engineering is presented in detail in the Annex.

By passing the exam and completing compulsory teaching activities, the doctoral student acquires 36 ECTS credits. Through elective teaching activities, the student acquires a maximum of 30 ECTS credits, meaning that direct teaching has a share of 37% of the total obligations envisaged by the study program, i.e., 66 ECTS credits.

Extracurricular activities include the implementation of scientific research work under the guidance and supervision of a study advisor or mentor/commentator, as well as the dissemination of research, laboratory work and other forms of research work whose final goal is the preparation of a doctoral thesis. Extracurricular activities account for 63% of the total obligations envisaged by the study programme, i.e. 114 ECTS credits.

4.2. Popis drugih studijskih programa na kojima se mogu steći ECTS bodovi

In the case of a doctoral student's transfer from another university's postgraduate study, the Committee for Postgraduate Studies determines the number of ECTS recognised by the student and the obligations that the student must complete in the doctoral study of Civil Engineering until the completion of the study.

5. MONITORING THE PROGRESS OF DOCTORAL STUDENTS

A doctoral student acquires the right to enrol in a higher year of study if, by the enrolment deadline, he/she has duly fulfilled all the envisaged study obligations prescribed by the study programme, decisions of the Senate and other general acts of the university constituent, i.e. Faculty.

At the beginning of the academic year, at the invitation of the Head of Postgraduate Studies, the doctoral student, with a study advisor (mentor), is obliged to submit the Doctoral Student's Annual Work Plan to the Committee for Postgraduate Studies, which analyses and accepts or rejects the plan. Based on the Annual Plan, the doctoral student and the study advisor (mentor) submit a report on the doctoral student's progress at the end of the academic year. PhD students who do not submit the Annual Plan or the Committee for Postgraduate Studies have rejected their plan cannot submit the annual report, which is mandatory for enrollment in the next academic year.

During the doctoral study, the doctoral student is entitled to obtain a certificate of fulfilment of individual study obligations and acquire ECTS credits following the doctoral study program.

The Strategic Program of Scientific Research combines the faculty's scientific research resources, the market's needs, the application of new technologies, sustainability and environmental protection. The construction industry is one of the key sectors for economic development, but at the same time, it can significantly impact the environment and nature. Therefore, the research must apply the latest technologies and innovative solutions that will enable the construction of environmentally friendly and energy-efficient buildings and infrastructure. At the same time, it is essential to understand the market's needs and adapt research to them to enable the development of products and services that will meet the requirements of clients. Sustainability and environmental protection require the development of materials and construction processes that reduce the negative environmental impact, reduce energy and resource consumption, and promote the circular economy.

6. PROCEDURE FOR APPLICATION, EVALUATION AND DEFENSE OF THE TOPIC OF THE DOCTORAL THESIS

After acquiring a **minimum of 90 ECTS** credits, 36 ECTS by passing exams, 30 ECTS by elective teaching activities and a minimum of 24 ECTS through scientific research, the student initiates the procedure of obtaining a PhD by submitting a proposal for the topic of the doctoral thesis to the Faculty Council.

The application initiating the procedure is submitted on a unique application form for the topic of the doctoral thesis prescribed by the Faculty, i.e. the head of the study.

The fulfilment of the conditions for initiating the procedure for acceptance of the doctoral thesis topic is determined by the Committee for Postgraduate Studies.

In the Committee for Postgraduate Studies proposal, the Faculty Council appoints the Committee to accept the doctoral thesis topic and the minutes.

The committee for the acceptance of the topic of the doctoral thesis has a minimum of three members and a maximum of five members, of which at least one member is from outside the institution of the holder of the doctoral study.

Committee members for the acceptance of the topic of the doctoral thesis may be teachers in the scientific-teaching field or scientists in a scientific position in the scientific field of the doctoral dissertation. The mentor cannot be the president or a committee member for accepting the doctoral thesis topic.

The defence of the doctoral thesis topic is made public before the Committee for the acceptance of the doctoral thesis topic, other postgraduate students, and interested persons.

At the Committee for Postgraduate Studies proposal, the Faculty Council determines the date and place of the public defence of the doctoral thesis topic, which is then advertised on the notice board and the website of the University or the Faculty.

By submitting the topic of the doctoral thesis, 5 ECTS credits are acquired, and by the public presentation and defence of the doctoral thesis topic before the Committee for the acceptance of the doctoral thesis topic, 10 ECTS credits are acquired.

The public defence of the topic must be within the ninety (90) day deadline set by the University Statute for submitting the committee report for the acceptance of the doctoral thesis topic to the Faculty Council.

The public defence of the doctoral thesis topic is an integral part of the Report and the proposal of the Committee for the acceptance of the doctoral thesis topic. The Committee for the Acceptance of the Doctoral Thesis Topic submits a Report and adopts a final proposal to evaluate the proposed doctoral thesis topic.

The procedure for applying, evaluating and defending the topic of the doctoral thesis is prescribed by Articles 40 to 45 of the Act. of the Ordinance on Postgraduate Studies of the Josip Juraj Strossmayer University of Osijek, Articles 151 to 153 of the Statute of the Josip Juraj Strossmayer University of Osijek and the procedure of the Faculty, PO-7-8 Application, Evaluation and Defence of the Doctoral Thesis.

The purpose of the public defence of the topic of the doctoral thesis is

- provide the public and the Committee for the acceptance of the doctoral thesis topic with an insight into the main elements of the research and prove that the research is dissertable and represents the original work of the applicant;
- to provide the doctoral student with the opportunity for public discussion to clarify ambiguities in the topic proposal and to take into account suggestions for further improvement of research;
- To enable the Committee to accept the doctoral thesis topic, clarify further and discuss with the doctoral student the main elements of the field of research to which the topic belongs.

The minutes of the public defence of the doctoral thesis topic with attachments (list of persons present and questions from those present and members of the Committee) is an integral part of the Report on the acceptance of the doctoral thesis topic of the Committee for the acceptance of the doctoral thesis topic.

The Science Committee considers the report of the Committee for the acceptance of the doctoral thesis topic. It adopts a written opinion and reports to the Faculty Council.

On the basis of the reasoned report and the proposal of the Committee for the acceptance of the topic of the doctoral thesis, the form for the selection of mentors and the opinion of the Science Committee, the Faculty Council makes the final decision on acceptance, amendment or rejection of the proposed topic of the doctoral thesis within 60 days of receipt of the report (according to Articles 44 and 45 of the Act). of the Ordinance on Postgraduate Studies of the Josip Juraj Strossmayer University of Osijek), informs the doctoral student and appoints a mentor, or the first and second mentor, and a co-mentor.

7. METHOD OF COMPLETING STUDIES

The study ended with the successful passing of six exams, satisfaction with all other obligations of the postgraduate university study, and the successful preparation and public defence of the doctoral thesis in front of the committee, which amounts to 180 ECTS credits. The procedure for the application, evaluation and defence of the doctoral dissertation, as the rights and obligations of the student, mentor, co-mentor and committees for the evaluation and defence of the doctoral thesis, is regulated by Articles 151 to 162 of the Act. of the Statute of the Josip Juraj Strossmayer University of Osijek, Articles 40 to 55 of the Statute of the Josip Juraj Strossmayer University of Osijek. of the Ordinance on Postgraduate Studies of the Josip Juraj Strossmayer University of Osijek and the procedure of application, evaluation and defence of the doctoral thesis. All postgraduate students, mentors and committees apply this procedure.

7.1. Procedure for applying, evaluating and defending a doctoral thesis

Before submitting the completed doctoral thesis to the mentor, the doctoral student, mentor (s), and co-mentor(s) decide according to which model they will submit the doctoral dissertation, as a scientific monograph or a set of published scientific papers.

The doctoral thesis is written in Croatian, and with the consent of the expert council of the study holder (the Committee for Postgraduate Studies), it can also be written in English. The doctoral thesis's title, abstract and keywords must be written in Croatian and English. The abstract should enable an understanding of the goal of the doctoral dissertation, research methods, results and conclusions.

After fulfilling all study obligations in the doctoral study, the doctoral student submits a request to evaluate the doctoral thesis. The application is submitted on the prescribed form of the doctoral study holder, and the application is accompanied by:

1) CV of the doctoral student,
2) Certificate of fulfilment of all study obligations at the doctoral study following the study programme of the doctoral study holder,
3) a written statement from the mentor that the doctoral thesis meets the criteria of the doctoral dissertation,
4) doctoral dissertation in electronic form,
5) a short doctoral thesis summary (one page of the author's text).

The candidate must submit the doctoral thesis electronically (doc(x) or pdf format) to the mentor before the final submission. The mentor checks for authenticity in the Turnitin IT system. Upon verifying the doctoral

thesis's authenticity, the mentor fills out a written report according to the form. If, in the mentor's opinion, the work meets the conditions of originality, the opinion is positive. If, in the mentor's opinion, the work does not meet the conditions of originality, the mentor may return the candidate for refinement until the conditions are met or undertake other legal activities following the acts of the Faculty of Civil Engineering and Architecture in Osijek and the University.

The mentor submits to the Faculty a Certificate of completion and submission of the doctoral thesis and a certificate of satisfaction with the condition of the originality of the doctoral dissertation, which is considered by the Faculty Council, which then appoints the Committee for the Evaluation of the Doctoral Thesis, at the proposal of the Committee for Postgraduate Studies.

The doctoral thesis evaluation committee shall consist of at least three members. Members of the doctoral thesis evaluation committee may be teachers in a scientific-teaching or artistic-teaching position or scientists in a scientific position in the scientific field of the doctoral thesis. The mentor cannot be a member of the Doctoral Thesis Evaluation Committee.

According to Article 47. of the Ordinance on Postgraduate Studies of the Josip Juraj Strossmayer University of Osijek, the Committee for the Evaluation of the Doctoral Thesis submits a report to the Faculty Council within 90 days of receiving the doctoral thesis. Within the set deadline, the Faculty must make the doctoral dissertation available to the public on its website at least 30 days before the day of the public defence of the doctoral thesis. If, in the process of public publication of the doctoral dissertation, comments and comments of the public are received, which the Doctoral Thesis Evaluation Committee determines should be taken into account, it will request the doctoral student to revise the doctoral thesis no later than 30 days before the expiry of the deadline for submitting the report of the Doctoral Thesis Evaluation Committee.

Based on the reasoned report and the proposal of the Committee for the Evaluation of the Doctoral Thesis, the Faculty Council decides regarding the doctoral thesis. After accepting a positive evaluation of the doctoral dissertation, as a rule at the same session, the Faculty Council appoints the Committee for the Defence of the Doctoral Thesis of at least three members, two deputies, and a recorder. It determines the defence's date and place at the Committee for Postgraduate Studies proposal. The Statute and the Ordinance of the University regulate the committee's composition.

The doctoral thesis includes the following items:

1) Outer and inner sheet of the front cover;
2) Blank sheet or, if necessary, a dedication sheet;
3) Title page in Croatian;
4) Title page in English or German;
5) A title page in another world language, if necessary;
6) Judging committees and bibliographic data;

7) Author's statements;
8) Blank sheet;
9) Preface;
10) Summary and keywords in Croatian;
11) Summary and keywords in English or German;
12) Summary and keywords in another world language (optional);
13) Blank sheet;
14) Content;
15) Blank sheet;
16) List of illustrations;
17) List of tables;
18) List of abbreviations and symbols;
19) Blank sheet;
20) Main text: appropriately divided into chapters, sub-chapters, etc.;
21) Appendices (appendices);
22) Bibliography;
23) Blank sheet;
24) The author's short biography with a photo;
25) Blank sheet;
26) Inner and outer sheets of back covers.

Instructions for the preparation of the doctoral thesis are prepared by HRN ISO 7144:2004 Documentation -- Design of dissertations and similar documents (ISO 7144:1986) and HRN ISO 6357:2001 Documentation -- Spine titles of books and other publications (ISO 6357:1985).

The Protocol regulates the public defence of the doctoral thesis for the defence of the doctoral dissertation.

The public defence of the doctoral thesis is held in the premises of the doctoral study holder in the language in which the doctoral dissertation was written.

Based on the decision of the authorised council of the doctoral study holder, exceptionally, the public defence of the doctoral thesis may be organised in a hybrid way through online means of communication, whereby at least one member of the committee physically attends the public defence of the doctoral thesis. A link must be available to the public to follow the defence of the doctoral dissertation.

If a doctoral student fails to participate in the public defence of the doctoral thesis according to the established date and place of the doctoral thesis defence without a justified reason, the authorised council of the doctoral study holder will decide to suspend the procedure for obtaining a doctoral degree or a doctorate of arts and inform the doctoral student and mentor thereof.

During the defence of the doctoral thesis, minutes are kept and signed by the members of the Committee and the recorder. The decision of the Committee for the Defence of the Doctoral Thesis shall be entered in the minutes, which may be:

- defended by a unanimous decision of the Commission
- defended by a majority of votes of the Commission

- did not defend it.

A doctoral student who has not defended the doctoral thesis has the right to re-submit the preparation and defence of the doctoral dissertation after ninety (90) days, but not on the same topic.

A doctoral thesis that has not been defended within five years from the date of acceptance of the doctoral thesis topic is subject to a new procedure for approval of the topic.

After successfully defending the doctoral thesis, within 25 days from the day of the defence, the doctoral student submits the bound doctoral dissertation and the electronic version in at least 5 copies to the secretariat and signs a statement on the storage of the doctoral thesis in the institutional, university and national digital repository, regardless of the chosen form of the doctoral dissertation (scientific monograph or a set of published scientific papers).

After the defence of the doctoral thesis, the Dean of the Faculty submits to the Rector of the University a report on the taking of the doctoral dissertation and attaches to the decision of the Committee for the Defence of the Doctoral Thesis and one copy of the thesis.

The Josip Juraj Strossmayer University of Osijek issues the diploma. The Rector presents the diplomas at the graduation ceremony.

By writing and successfully defending the doctoral thesis, the student acquires an additional 30 ECTS credits and completes the study with 180 ECTS credits.

8. TERMINATION OF THE STATUS OF A DOCTORAL STUDENT

A doctoral student who has enrolled in a doctoral study programme in regular and part-time status shall have the status of a doctoral student terminated:

- if they fail to complete their doctoral studies within twice the duration of the study,
- if the public defence of the topic of the doctoral thesis or the doctoral thesis has been negatively evaluated for the second time,
- if the authorised counsel of doctoral study holders decides on the suspension of the procedure for obtaining a doctoral degree following the Statute of the University and this Ordinance,
- upon completion of doctoral studies,
- if they are leaving the doctoral program,
- expulsion from doctoral studies in the procedure and under the conditions determined by the general act of the University.

9. CONTINUATION OF INTERRUPTED STUDIES IN DOCTORAL STUDIES

A doctoral student whose status as a doctoral student has ceased due to the interruption of postgraduate studies may continue doctoral studies provided that no more than three years have passed since the date of interruption of studies and that the study program has not been significantly changed (20%) from the one enrolled by the doctoral student.

The application for the continuation of the interrupted study is submitted to the authorised body of the doctoral study holder with the appropriate documentation prescribed by the study holder.

The authorised body of the doctoral study holder issues the decision to approve the continuation of the interrupted study. It contains the approval of the continuation of the study, the recognition of the exam with grades and ECTS credits earned during the study, and the amount of study costs or tuition fees.

10. DESCRIPTION AND GENERAL INFORMATION OF EACH 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	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 ☒ 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	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. građ.**	
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

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

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 ☒ seminars and	☒ independent tasks ☒ 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

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

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

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	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	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 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

Continuous knowledge testing	2	1,2,3	Independent tasks	Reviewing research progress reports	0	40
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 ☐ exercises ☐ remote education ☐ field classes	☐ 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	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							

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) **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	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

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.

1.7. Students' obligations

Regular class attendance, creating and defending the seminar paper as the final exam, preparing the seminar paper topic for an article.

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	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

-

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

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

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 ☒ seminars and workshops ☐ exercises ☐ remote education ☒ field classes	☐ independent tasks ☐ multimedia and web ☒ laboratory ☒ mentorship ☐ other _____
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 liquefication; 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	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	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.