Course catalogue

GRADUATE STUDY PROGRAMME

TABLE OF CONTENT

GEOTECHNICAL ENGINEERING PROGRAMME

I. SEMESTER

Module name:	**Mathematics 3**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	21802
Subtitle, if applicable	
Courses, if applicable	I class (84 students) 1 lecture, 2 auditory groups
Semester(s) in which the module is taught	I (Winter)
Person responsible for the module	Tomislav Došlić, Alan Filipin
Lecturer	Nikola Adžaga, Rafael Mrđen
Language	Croatian
Relation to curriculum	Master's degree programme for all engineering programmes. Compulsory elective. Semester I.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 45 • Exercises (auditory): 30
Workload	Lecture hours 45 Hours of exercise 15 Other contact hours 30 Self study hours 135
Credit points	7,5 ECTS
Requirements according to the examination regulations	• Regular attendance in lectures and exercises, • Minimum 25 % score in the pre-exam.
Recommended prerequisites	• Understanding the calculus of one and several variables, including ordinary differential equations, and basic linear algebra.
Module objectives/intended learning outcomes	• Understanding the conditions and limits of applicability of linear models, • Ability to recognize and choose a correct model, • Ability to solve (analytically and/or numerically) simple linear models.
Content	• Lectures: 1. Ordinary differential equations [3] 2. Fourier series [3] 3. Partial differential equations and linear models of mathematical physics [20] 4. Numerical methods for solutions of ordinary and partial differential equations [16] • Exercises (auditory) follow the lectures.
Study and examination requirements and forms of examination	• Minimum 50% score in the written exam, • Students passing the pre-exam take only the second part, • Oral exam.
Media employed	Whiteboard, projector .
Reading list	Required literature: 1. T. Došlić, D. Pokaz: Matematika 3, available on the course web-page.

	2. T. Slijepčević-Manger: Zbirka zadataka iz Matematike 3, available on the course web-page. Optional literature: 1. E. Kreyszig: Advanced Engineering Mathematics, John Wiley and Sons Ltd., 1999, 2. F. Scheid: Numerical Analysis, Schaum's Outline Series in Mathematics, McGraw-Hill

Module name:	**Stochastic Processes**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	I (Winter)
Person responsible for the module	Tomislav Došlić, Alan Filipin
Lecturer	Rafael Mrđen, Kristina Ana Škreb
Language	Croatian
Relation to curriculum	Master degree programme for all engineering programmes. Compulsore elective. Semester I.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 45 • Exercises (auditory): 30
Workload	Lecture hours 45, hours of exercise 30, other contact hours 30, self study hours 120.
Credit points	7.5 ECTS
Requirements according to the examination regulations	• Regular attendance • Minimum 25 % score in the pre-exam.
Recommended prerequisites	
Module objectives/intended learning outcomes	• Understanding conditions and limits of applicability of stochastic models, • Ability to recognize and choose correct model. • Ability to formulate and solve simple problems in terms of Markov chains and processes.
Content	• Lectures: 1. Basic characteristics and examples of stochastic processes [3], 2. Markov chains with discrete time and finite and countable set of states [27], 3. Markov processes [6], 4. Poisson processes and the theory of queues [6], • Exercises (auditory: follow the lectures.
Study and examination requirements and forms of examination	• Eliminatory written exam - minimum 50 % score, • Students who pass the pre-exam take only the second part, • Oral exam.
Media employed	Blackboard, whiteboard, projector .
Reading list	Required literature: 1. N. Berglund, Processus aleatoires et applications, available as Croatian translation on the course web-page and originally at ArXiv.org. Optional literature: 1. R. Durrett: Essentials of Stochastic Processes, Springer Texts in Statistics, Springer, New York, 1999, 2. D. P. Bertsekas, J. N. Tsitsiklis: Introduction to Probability, On line lecture notes, M.I.T., 2000.

Module name:	**Research methods**
Module level, if applicable	Master's Degree Programme
Code, if applicable	21822
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	I.(Winter)
Person responsible for the module	Anita Cerić
Lecturer	
Language	Croatian
Relation to curriculum	Master's degree programme. Compulsory for all subject areas at Graduation studies. Semestar I.
Type of teaching, contact hours	• Lectures: 15 • Seminars: Students are obliged to write a seminar paper on an assigned topic.
Workload	Lecture hours 15 Other contact hours 10 Self study hours 20
Credit points	1.5 ECTS
Requirements according to the examination regulations	Writing a seminar paper or a positively graded test.
Recommended prerequisites	
Module objectives/intended learning outcomes	• Collecting literature from different sources, • Defining the hypothesis, • Choosing an appropriate research method and methodology, • Using different techniques in data collection, • Writing essays, papers and reviews, • Presenting and discussing research findings.
Content	• Lectures: 1. Collecting literature and information 1 (2) 2. Role of hypothesis and general structure of the thesis 1 (1) 3. Writing papers, critiques and essays 2 (2) 4. Data collection 1 (1) 5. Research methodology 2 (1) 6. Research methods 3 (2) 7. Reporting the results 1 (2) 8. Citing references 2 (3) 9. Bibliography 1 (2) 10. Presentation skills 1 (1)
Study and examination requirements and forms of examination	• Written paper, • Written exam
Media employed	Whiteboard, projector .
Reading list	Required literature: 1. Zelenika, R. Metodologija i tehnologija izrade znanstvenog i stručnog djela, Rijeka: Ekonomski fakultet Sveučiliša u Rijeci, 1999 (in Croatian) 2. Cerić, A., Textbook for Civil Engineering Students, 2012, (in Croatian) Optional literature: 1. Fellows, R. And Liu, A., Research Methods for Construction, Oxford: The Blackwell Science, 1997 2. 2.Naoum, S.G., Dissertation Research and Writing for Construction Students, Oxford: ButterworthHeinemann, 2007

Module name:	**Geotechnical Engineering**
Module level, if applicable	Master's Degree Programme
Code, if applicable	93211
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	I (Winter)
Person responsible for the module	Tomislav ivšić
Lecturer	
Language	Croatian
Relation to curriculum	Master's degree programme, Geotechnical Engineering. Compulsory. Semester I.
Type of teaching, contact hours	Number of hours (in semester): • Lectures:30 • Exercises: 30
Workload	Lecture hours 30 Exercise hours 30 Consultation hours 30 Self study hours 90
Credit points	6 ECTS
Requirements according to the examination regulations	• Minimum 10 points in all programs by the end of semester.
Recommended prerequisites	• Knowledge in basic physical and mechanical properties of soil and rock mass (stiffness, strength), • Application of the basic concepts of soil mechanics (soil classification, index indicators, principle of effective stress, soil consolidation, settlement and bearing capacity of shallow foundations, soil pressures on the retaining structures, groundwater lookpage, slope stability).
Module objectives/intended learning outcomes	• Ability to identify design situation related to basic geotechnical structures (shallow and deep foundations, retaining structures, slopes, embankments), • Ability to conduct bearing capacity analysis for shallow and deep foundations in different types of soil and rock, • Ability to conduct stability analysis of natural and man-made slopes, • Ability to estimate earth pressures on the various types of retaining structures, • Ability to conduct stability analysis of various retaining structures, • Ability to conduct simple seismic analysis of geotechnical structures.
Content	• Lectures: 1. Introduction to Geotechnical Engineering [2] 2. Principles of Eurocode 7 [2] 3. Types and bearing capacity of shallow foundations in different types of soil and rock [2] 4. Settlement of shallow foundations [2] 5. Calculation methods for stability of natural and man-made slopes [2] 6. Actions on slopes and stabilization procedures [2] 7. Types of retaining structures and the determination of earth pressure [2] 8. Actions on retaining structures and calculation of the stability of retaining structures[2] 9. Application and bearing capacity of deep foundations[2] 10. Performance and transfer of forces in group of pilots[2] 11. Types of embankments and the basics of soil compaction[2] 12. Construction of embankments and stability analysis[2]

	13. Introduction to the soil dynamics and the basics of the cyclic behavior of soil[2] 14. Typical problems of seismic geotechnical engineering[2] 15. Simplified seismic geotechnical calculations[2] • Exercises: 1. Introduction - review, exercise plan, 'rules of the game' (auditory)[2] 2. EC7 - review (design situations, design values, partial coefficients) examples for various structures (auditory)[2] 3. Foundation pad (capacity + settlement) –an example of the bearing capacity calculation for eccentric loaded foundation pad and settlement calculation (Kany, Steinbrenner, M & P), 1st program - task (auditory and construction)[2] 4. 1st program - solving task (construction)[2] 5. Slopes - stability analysis in the program GEO - SLOPE, 2nd program - task (auditory and construction)[2] 6. 2nd program – solving task (construction)[2] 7. Retaining wall –an example of calculation for gravity and L-typewall (pressures according to Rankine), 3rd program - task (auditory and construction)[2] 8. 3rd program - solving task (construction)[2] 9. Retaining structures - an example of calculation of anchored structure, 4th program – task (auditory and construction)[2] 10. 4th program - solving a task (construction)[2] 11. Deep pile foundations - an example of calculation of the pile bearing capacity (API and DIN) and pile settlement (DIN), 5th program - task (auditory and construction)[2] 12. 5th program - solving task (construction)[2] 13. Seismic analysis - simple examples of seismic calculations for geotechnical structures from previous programs, 6th program - task (auditory and construction)[2] 14. 6th program - solving a task (construction)[2] 15. Review of all programs (construction)[2]
Study and examination requirements and forms of examination	Written part with maximum 70 points.
Media employed	Whiteboard, projector.
Reading list	Required literature: 2. Teaching material: Tomislav Ivšić (lectures, powerpoint presentation - available on the web) 3. Mimeographed lecture notes: Antun Szavits-Nossan Optional literature: 1. Any domestic or international book on geotechnical engineering and foundations.

Module name:	**Flow processes in soil and rock**
Module level, if applicable	Master's Degree Programme
Code, if applicable	21747
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	I (Winter)
Person responsible for the module	Mario Bačić
Lecturer	
Language	Croatian
Relation to curriculum	Master's degree programme, Geotechnical Engineering. Compulsory. Semester I.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises: 30
Workload	Lecture hours 30 Exercise hours 30 Consultation hours 30 Self study hours 90
Credit points	6 ECTS
Requirements according to the examination regulations	• Attendance in lectures (7 points), • Attendance in exercises (7 points), • Doing 2 homework assignments (14 points), • Pre-exams (22 points), • Final exam (50 points).
Recommended prerequisites	
Module objectives/intended learning outcomes	• Learning about flow processes and associated deformations in saturated and unsaturated soils and rocks (theoretical and factual). Learning about the general behavior of saturated soils (theoretical and factual). Learning to use numerical modeling of flow processes in saturated and unsaturated soils and rocks, • Ability to solve related problems in geotechnical practice, also by-numerical modeling, • Ability to integrate the acquired knowledge to the behavior of unsaturated soils with the previously covered behavior of saturated soils with the particular emphasis on flow processes. Ability to incorporate the acquired knowledge in solving practical geotechnical problems.
Content	• Lectures: 1. Introduction [2] 2. Water in soil: calm water and water flow through homogeneous isotropic soil [4] 3. Water flow through anisotropic and non homogeneous soil [2] 4. Soil consolidation [4] 5. Embankment construction on un-drained and drained foundation soil [4] 6. Pre-exam [2] 7. Unsaturated soil: introduction [2] 8. Unsaturated soil: basic definitions [2] 9. Changes in soil depending on capillary suction [2] 10. Characteristic curve of soil-water [2] 11. Shear strength of unsaturated soil [2] 12. Water flow through unsaturated soil [2] • Auditory exercises in the computer room: 1. Learning about SEEP/W software [2]

	2. Solving simple examples with SEEP/W software for homogeneous, isotropic soil [2] 3. Solving more complex examples with SEEP/W and SIGMA/W for homogeneous, isotropic soil [2] 4. Water flow through anisotropic and non homogeneous soil [2] 5. Soil consolidation [4] 6. Pre-exam[2] 7. An example of embankment construction on foundation soil in un-drained conditions; an example of embankment construction on coarse grained soil [4] 8. An example of gradual construction of an embankment with the consolidation of foundation soil [4] 9. Functions of permeability coefficient for unsaturated soil; Characteristic curve of soil-water[2] 10. Shear strength of unsaturated soil: application to the slope stability [2] 11. Water flow through unsaturated soil [2] 12. Application of the water flow through unsaturated soil to the slope stability [2].
Study and examination requirements and forms of examination	• According to the above stated points, students should acquire a minimum of 50 points (including the final exam) for a passing grade.
Media employed	Whiteboard, projector, SEEP/W computer programme
Reading list	Required literature: 1. Fredlund, D.G., Rahardjo, H. (1993): Soil Mechanics for UnsaturatedSoils, John Wiley & Sons, New York. Optional literature: 1. Cedergren, H.R. (1989): Seepage, Drainage and Flow Nets. JohnWiley & Sons, New York.

Module name:	**Applied Soil Mechanics**
Module level, if applicable	Master's Degree Programme
Code, if applicable	93213
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	I (Winter)
Person responsible for the module	Meho-Saša Kovačević, Lovorka Librić
Lecturer	Gordana Ivoš
Language	Croatian
Relation to curriculum	Master's degree programme, Geotechnical Engineering. Compulsory. Semester I.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 45 • Exercises (design): 28 • Seminars: 2
Workload	Lecture hours 30 Exercise hours 30 Consultation hours 45 Self study hours 120
Credit points	7,5 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, two homework assingments and a pre-exam (see grading bellow)
Recommended prerequisites	• Basic soil mechanics and geotechnical engineering.
Module objectives/intended learning outcomes	• Understanding the complex soil behaviour: influence of drained and un-drained conditions, similarities and differences between fine and coarse grained soils, influence of initial density and confining pressure on stiffness, strength and influence of drainage conditions on soil behaviour; soil permeability as the primary reason for differences between sand and clay behaviour, • Ability to apply knowledge in soil behaviour to solving typical simple geotechnical problems by numerical modeling with commercially available software, • Ability to estimate soil model properties from field and laboratory tests.
Content	• Lectures: 1. Laboratory equipment for soil stress-strain testing (oedometer, triaxial apparatus)[6]] 2. Behaviour of dry sand (influence of density and confining pressure)[3] 3. Strength, stiffness, dilatancy, critical state of sands[3] 4. Behaviour of water saturated sands under undrained conditions[3] 5. Behaviour of clays in oedometer tests, influence of pre-consolidation[3] 6. Behaviour of normally and over consolidated clays in undrained triaxial tests[3] 7. Similarities and differences between sand and clay behaviour; drained and undrained conditions; undrained shear strength[3] 8. Soil models in geotechnical practice: linear elastic model[3] 9. Soil models in geotechnical practice: linear elastic ideally plastic model, drained and undrained analysis[3] 10. Soil model parameter determination from laboratory and in situ tests[3] 11. Pre-exam[3] 12. Developments of normally consolidated and over, consolidated soil profiles and initial state of stresses[3] 13. Principles of stress and strain analyses in soils, drained and undrained conditions[3]

	14. fi = 0 analysis[3] • Exercises (design – work on a PC with commercial software): 1. Introduction to numerical modelling in geotechnical engineering; GEOSTUDIO program suite[4] 2. Finite element mesh generation, limit and initial conditions)[2] 3. Program SIGMA/W (stress-strain analysis: solving various examples)[2] 4. Program SIGMA/W (stress-strain analysis: solving various examples)[2] 5. Program SIGMA/W (stress-strain analysis: solving various examples - drained and undrained analysis)[2] 6. Program SEEP/W (seepage analysis: solving various examples)[2] 7. Program SEEP/W (seepage analysis: solving various examples) [2] 8. Program SEEP/W (seepage analysis: solving various examples) [2] 9. Program SLOPE/W (slope stability and limit equilibrium) [2] 10. Program SLOPE/W (slope stability and limit equilibrium: various examples) [2], 11. Program SLOPE/W (slope stability and limit equilibrium: various examples) [2] 12. Program SLOPE/W (slope stability and limit equilibrium: various examples)[2] 13. Solving several practical geotechnical problems employing numerical modelling[2]
Study and examination requirements and forms of examination	• Students with 25 points are entitled to taking the final exam.
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. Course material available on the course web site Optional literature: 1. Wood, D. M. (1990): Soil Behaviour and Critical states Soil Mechanics, CUP, Cambridge; 2. Wood, D. M. (2004): Geotechnical Modelling, Spon Press, London; 3. Mayne, P. W., Christopher, B. R., DeJong, J. (2001). Manual on Subsurface Investigation. National Highway Institute., Publication No. FHWA NHI-01-031, Federal Highway Administration, Washington, DC.

II. SEMESTER

Module name:	**Structures**
Module level, if applicable	Master’s Degree Programme
Code, if applicable	21801
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	II (Summer)
Person responsible for the module	Jelena Bleiziffer, Dalibor Carević, Neven Kuspilić
Lecturer	Nicola Rossi, Jelena Bleiziffer
Language	Croatian
Relation to curriculum	Master’s degree programme, Hydraulic Engineering Programme and Geotechnical Engineering Programme. Compulsory. Semestar II.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises (auditory, design, laboratory): 30
Workload	Lecture hours 30 Exercise hours 30 Self study hours 85 Hours of skills 30 Other contact hours 5
Credit points	6 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, • Executing all individual exercise calculation tasks, • Minimum 25% score in each pre-exam.
Recommended prerequisites	• Knowledge and understanding materials and resistance of materials, understanding basic geotechnical, hydro technical, concrete, steel, masonry and timber structures, base knowledge of various static system analysis.
Module objectives/intended learning outcomes	• Students gain an understanding of the basic principles and problems in constructing structures, students gain the basic knowledge and skills in observation and analysis of the effects on the structures, students gain the basic knowledge and skills for calculations of structural elements, students are familiar with design principles and have the skills to apply them to certain structural elements.
Content	• Lectures: 1. Introduction – the main principles of bearing structures [4] 2. Structure elements, models and structure modeling [2] 3. Basics of design and calculation [2] 4. Actions on structures and structure calculus [2] 5. Concrete structures [2] 6. Pre-stressed concrete structures [2] 7. Steel structures [2] 8. Foundations [2] 9. Sustaining walls [2] 10. Building structures [2] 11. Bridge structures [2] 12. Water towers [2] 13. Floating structures [2] 14. Field examples [2] • Auditory exercises:

	Calculation and sizing of 6 different structures: 1. Ship lock [2] 2. Inspection chamber [2] 3. Retaining wall [2] 4. Quay [2] 5. Diaphragm [2] 6. Pile [2] • Construction exercises: 1. Ship lock [2] 2. Inspection chamber [2] 3. Retaining wall [2] 4. Quay [2] 5. Diaphragm [2] 6. Pile [2]
Study and examination requirements and forms of examination	• Pre-exam score or written exam60-70%, • Oral exam 30-40%
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. Tomičić, I.: Concrete structures, DHGK Zagreb, Zagreb 1996, 2. Radić, J.: Concrete structures–examples with a key, Zagreb, 2006 3. Mimeographed lecture and exercises notes. Optional literature: 1. Norms EN 199i ; i = 0,1,2,3,4,7,8.

Module name:	**Foundation Engineering**
Module level, if applicable	Master's Degree Programme
Code, if applicable	93215
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	II (Summer)
Person responsible for the module	Mario Bačić
Lecturer	
Language	Croatian
Relation to curriculum	Master's degree programme.Geotechnical Engineering Compulsory. Semester II.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 45 • Exercises (design): 30
Workload	Lecture hours 42 Numerical exercises hours 28 Midterm written examination hours 3 Presentation of individual students design exercise 2 Self study hours 147 Final written examination hours 3
Credit points	7.5 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, two homework reports and a pre-exam.
• Basic soil mechanics and geotechnical engineering.	• Basic soil mechanics and geotechnical engineering.
Module objectives/intended learning outcomes	• Knowledge about types, methods of analysis, codes, construction, acceptance criteria of typical structural foundations, • Ability to design typical structural foundations employing currently acceptable methods and procedures (footings, slabs, bored, CFA and driven piles • Knowledge and skills required to understand, design and monitor typical foundations on various soils under circumstances common in current geotechnical practice.
Content	• Lectures: 1. Introduction to Foundation Engineering [3] 2. Foundation design environment (codes and local law) [3] 3. Design according to Eurocode 7 [3] 4. Shallow foundations: types, design situations, ultimate and serviceability limit states, design criteria [3] 5. Various methods of settlement and bearing capacity calculation (immediate – drained and undrained conditions, long term, creep) [3] 6. Effects of soil structure-interaction (differential settlements, load redistribution) [3] 7. Soil-structure interaction – axially and laterally loaded piles (t-z and p-y curves) [3] 8. Influence of pile type and pile installation (bored, CFA, driven, vibrated), negative skin friction [3] 9. Pile testing (load tests, integrity tests, dynamic bearing capacity tests, monitoring of piles) [3] 10. Pile foundation construction, pile drivability [3] 11. Design of pile foundations according to Eurocode 7 [3] 12. Structural design of foundations (Eurocode 2 and Eurocode 3 [3]

	13. Other deep foundations (pile rafts, caissons) [3] 14. Foundation design and ground investigation [3] 15. Dynamically loaded foundations [3] • Exercises (design – work on a PC with commercial software): 1. Introduction: Design of simple footings, Eurocode 7 [2] 2. Design of simple footings [2] 3. Design(settlement) of a single footing by computer program SETTLE [2] 4. Design(settlement) of a single footing by computer program SETTLE [2] 5. Soil-structure interaction (total and differential settlements): footings of a frame Structure [2] 6. (program SETTLE) [2] 7. Soil-structure interaction: footings of a frame structure (program SETTLE) [2] 8. Soil-structure interaction (contact pressure redistribution): slab foundation (program SLAB) [2] 9. Soil-structure interaction: slab foundation (program SLAB) [2] 10. Axially loaded piles (program AXPILE) [2] 11. Axially loaded piles (program AXPILE) [2] 12. Soil-structure interaction: computation of internal forces of a complex structure Foundedon shallow foundations (programs SETTLE and SAP) [2]
Study and examination requirements and forms of examination	• At the end of semester students are required to complete seven exercises to apply for the exam.
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. Course material available from the course web site Optional literature: 1. Bond, A., Harris, A. (2008). Decoding Eurocode 7, Taylor & Francis, London.; 2. Rees, L. C., Isenhower, W. M., Wang, S.-T. (2006). Analysis and Design of Shallow and Deep Foundations, John Wiley & Sons, New Jersey. 2. Tomlinson, M. J. (2000),Foundation design and construction, Prentice Hall; 3. Bowles, J. E. (1997). Foundation analysis and design, McGraw-Hill; 4. Canadian Geotechnical Society (2006). Foundation Engineering Manual, Canadian Geotechnical Society.

Module name:	**Numerical modelling in geotechnics**
Module level, if applicable	Master's Degree Programme
Code, if applicable	93216
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	II (Summer)
Person responsible for the module	Mario Bačić
Lecturer	
Language	Croatian
Relation to curriculum	Master's degree programme. Geotechnical Engineering. Compulsory. Semester II.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises (design):45
Workload	Lecture hours 30 Exercise hours 45 Consultation hours 30 Self study hours 30 Self practice hours 90
Credit points	7.5 ECTS
Requirements according to the examination regulations	• Attendance in lectures (7 points), • Attendance in exercises (10.5points), • 2 homework assignments (6points), • Pre-exams (20.5points), • Final exam (50 points).
Recommended prerequisites	
Module objectives/intended learning outcomes	• Learning about the Finite element method(theoretical), the importance of engineering judgement in numerical modeling, issues related to numerical modeling in geotechnical engineering (factual), meshing (theoretical and factual), drained and und rained analyses (theoretical and factual), different constitutive equations for soils (theoretical). By solving examples of complex geotechnical problems, learning how to use numerical modeling in practice, • Ability to solve complex geotechnical problems in practice by correct numerical modeling • Ability to integrate the acquired knowledge on numerical modeling with all the facts previously learned about geotechnical engineering covered behavior of saturated soils with the particular emphasis on flow processes. Ability to incorporate the acquired knowledge in solving complex practical geotechnical problems.
Content	• Lectures: 1. Introduction [2] 2. Revision of modelling from 1st semester [2] 3. The importance of final elements network [2] 4. The importance of limit conditions [2] 5. The importance of soil parameters [2] 6. Modeling in geotechnics: engineering judgment, parameter analyses, feedback analyses [2] 7. Excavation of the foundation pit reinforced by diaphragm and geotechnical anchors [2] 8. Stability of slopes [2] 9. Reinforcement of slopes[2] 10. Sudden lowering of water in artificial lakes [2]

	11. Stability of soil under shallow foundations [2] 12. Stability of backfill behind retaining structures [2]. • Auditory exercises in the computer room: 1. Simple examples of modelling from 1st semester [2] 2. The importance of finite elements network [2] 3. The importance of limit conditions [2] 4. Parameter analyses; feedback analyses [2] 5. Tunnel excavation [2] 6. Excavation of foundation pit reinforced with diaphragm and braces [2] 7. Excavation of foundation pit reinforced with diaphragm and geotechnical anchors [3] 8. Stability of slopes [3] 9. Stability of infinite slopes [3] 10. Reinforcement of slopes with anchors and spikes [3] 11. Reinforcement of slopes with geotextile [3] 12. Soil stability under shallow foundations and backfills behind supporting structures [3]. Design exercises: • During exercises students use numerical modeling tosimulate complex geotechnical problems.
Study and examination requirements and forms of examination	• According to the above stated points, students should earn a minimum of 50 points (including the final examin) for a passing grade.
Media employed	Whiteboard, projector, SEEP/W, SIGMA/W and SLOPE/W computer programmes
Reading list	Required literature: 1. Potts, D.M., Zdravkovic, L. (1999): Finite Element Analysis in Geotechnical Engineering: Application. Thomas Telford, London, Great Britain. Optional literature: 1. Potts, D.M., Zdravkovic, L. (1999): Finite Element Analysis in Geotechnical Engineering: Theory. Thomas Telford, London, Great Britain, 1999

Module name:	**Applied Geology**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	21717
Subtitle, if applicable	
Courses, if applicable	1. Applied Geology, 2. Hydrogeology and Engineering Geology
Semester(s) in which the module is taught	II (Summer)
Person responsible for the module	Meho-Saša Kovačević
Lecturer	
Language	Croatian, English
Relation to curriculum	Master's degree programme. Compulsory elective. Semestar II.
Type of teaching, contact hours	Number of hours (in semester): • Lectures:30
Workload	Lecture hours 30 Other contact hours 10 Self study hours 50
Credit points	3 ECTS
Requirements according to the examination regulations	• Attendance in 75% lectures, • Minimum 25% score in the pre-exam.
Recommended prerequisites	• Kowledge of basic chemical elements and compounds.
Module objectives/intended learning outcomes	• Ability to distinguish between igneous, metamorphic and sedimentary rocks, • Ability to identify layers, faults and overthrust, • Knowledge about the process of the formation of karst and various karst formations and learning about the problems which constructors encounter during construction of tunnels in karst, • The ability to use geological maps – recognition of geological symbols, determination of the geological age of rocks, their composition and other important geological phenomena of a terrain, • Knowledge of basic engineering-geological rock mass classification.
Content	• Lectures: 1. Introduction [2] 2. General information about the geosciences, Geology general, stratigraphic; Constitution of Earth; Geoid; Mineralogy; Mineral; Crystal [2] 3. Isotropic and anisotropic minerals; pyrogenic, pneumatogenic, hydrothermal, hydatogenic; Axis, center plane of symmetry; crystal systems; properties of crystals, crystal connection; tetrahedral coordination, coordination number; Polymorphism; Isomorphism [2] 4. The properties of minerals, Mineral groups; oxides and hydroxides, carbonates, sulfates, silicates [2] 5. Introduction to Petrology; Rock phenocrysts, Monomineral; igneous rocks; types of igneous rocks, structure and texture of igneous rocks; Acidity of magma; Bowen series of crystallization; Table of igneous rocks [2] 6. Sedimentary rocks, sediment transport, mineral composition of sedimentary rocks , structures and textures of sedimentary rocks; General overview of sedimentary rocks, metamorphic rocks, metamorphic zones; types of metamorphic rocks [2] 7. Tectonics, rock exposures, outcrops, thickness of layers, anticlines and synclines, faults, over thrust, types of cracks [2] 8. Pre-exam [2]

	9. Egzodynamic processes; insolation, hydrogeology, water, the hydrologic cycle, porosity, permeability, laminar and turbulent flow; types of aquifers; Ghyben Herzberg law; Ice and Snow, Wind, organisms [2] 10. Pre-exam [2] 11. Karst; external karst formations; interior karst formations [2] 12. Types of caves, speleothems, groundwater [2] 13. Landslides; Endodynamics; orogeny, epirogensis [2] 14. Volcanoes, Earthquakes; Earthquake scales, seismicity [2] 15. Geological maps, RMR and Q classification of rocks in the construction domain; determining the age of rocks [2]
Study and examination requirements and forms of examination	Written and oral exam.
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. Herak, M., Geology, 1990 2. Šestanović, S., Basics of Geology and Petrology, 2001 Optional literature: 1. West, T.,Geology Applied to Engineering, 1994 2. Monroe, J. & Wicander, R., Physical geology, 2006 3. Plummer,C., McGeary,D. & Carlson, C., Physical Geology, 2010

Module name:	**Environmental Protection**
Module level, if applicable	Master's Degree Programme
Code, if applicable	
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	II (Summer)
Person responsible for the module	Živko Vuković
Lecturer	
Language	Croatian
Relation to curriculum	Master's degree programme. Compulsory elective. Semester II..
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30
Workload	Lecture hours 30 Consultation hours 30 Self study hours 30
Credit points	3 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, • Two pre-exams.
Recommended prerequisites	• Basic knowledge in physics, biology, chemistry and civil engineering.
Module objectives/intended learning outcomes	• Understanding basic ecological processes, • Recognising and explaining basic ecological principles, • Explaining basic technological procedures of wastewater treatment, • Understanding waste management, • Understanding the concept of "sustainable development".
Content	• Lectures: 1. Introduction [2] 2. Basic ecological concepts (ecology, biotop, biocenose, ecosystem, biodiversity) [3] 3. Global changes in biosphere –changes in atmosphere [2] 4. Pedosphere pollution [2] 5. Hydrosphere pollution [3] 6. The impact of cities [3] 7. The impact of landfills [3] 8. Impact of hydraulic structures [3] 9. Transportation facilities impact [3] 10. Environmental sustainability and sustainable development [3] 11. Measures and environmental protection procedure (political and sociological approach, legal measures, environment planning, economic and financial measures, scientific approach and technological measures, institutional measures [3]
Study and examination requirements and forms of examination	Students with minimum 60 % score in each pre-exam are exempt from the final oral exam.
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. Vuković, Ž.: Environment Protection, Manuscript, 2014, Zagreb (in Croatian). Optional literature: 1. Raven, P. H., Berg, L. R., Hassenzahl, D. M.: Environment, 7th Edition, Wiley, 2010. 2. Miller, G. T.: Living in the Environment: Principles, Connections, and Solutions, 15th Edition, Thomson Books, 2007.

Module name:	**Dynamics of Structures and Earthquake Engineering**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	93347
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	II (Summer)
Person responsible for the module	Damir Lazarević
Lecturer	Marija Demšić, Marta Šavor Novak
Language	Croatian
Relation to curriculum	Master's Degree Programme. Theory and Modeling Structures. Compulsory. Semester II.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 45 • Exercises: 30 (auditory - 15, construction – 6, design - 9)
Workload	Lecture hours 45 Hours of exercise 30 Other contact hours 45 Self study hours 105
Credit points	7,5 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, • Soving 3 program assignments, • 1 pre-exam, minimum 25% score, or a make up exam.
Recommended prerequisites	• Competence in basic differential equation solving procedures, • Competence in the basics of computer engineering (Sage program software or the like), • Understanding the calculation procedures for statically determinate and indeterminate structures.
Module objectives/intended learning outcomes	• Recognizing and understanding the problems related to various dynamic actions on buildings, • Applying knowledge on selection procedures of mathematical models for dynamic calculus of a structure: selection of degrees of freedom in dynamic systems, analysis of mass, rigidity and flexibility, • Applying knowledge on maths in solving problems of own a shapes and frequencies, • Applying the calculus of system response with more degrees of freed on to the effect of the known dynamic load, • Understanding and application of spectrum calculus for frameworks and buildings related to earthquake effects, • Applying software to calculate response to structure action.
Content	• Lectures: 1. Simple harmonic oscillator, an overview of theory for free and forced vibration response with and without damping. Types of dynamic loadings in structural engineering: earthquake, wind, waves, explosions, machine operation [3] 2. Occurrence and effect of resonance. Duhamel integral. Response spectrum function [2] 3. Generalized system with one degree of freedom. Energy approach [2] 4. Finite degrees of freedom systems vibration. Definition of coordinates (discrete, generalized), static condensation of system, matrix formulation of motion equations, influence of axial forces on dynamical characteristics of system (use of computer software)[4] 5. Generalized coordinates and Hamilton's principle in forming Lagrange's equations of motion[3]

	6. Free-vibration systems with finite degree of freedom, solution of eigenvalue problem, eigenvectors orthogonality and normal coordinates. Matrix iteration methods[6] 7. Dynamic response of finite degree of freedom system using modal superposition method. Buildings with symmetric and irregular plan disposition[2] 8. Dynamic response of finite degree of freedom system using step by step methods, use of accelogrammes for determining earthquake load[4] 9. Spectral analysis of buildings[2] 10. Dynamics of engineering objects. Application of finite element method[2] 11. Dynamic response of distributed mass systems (bending and axial deformations of a beam). Free-vibrations of plates, beams, console and a frame[4] 12. Nonlinear vibrations. Sources of system nonlinearity. Mathematical modeling and determination of numerical solution using Runge-Kutta method (simple pendulum, Duffing equation). Parametric vibration[3] 13. Earthquake phenomenon, seismic zones and fundamentals of earthquake load, response spectrum functions, equivalent static load[2] 14. Basic rules and principles of earthquake building design in seismically active area[2] 15. Wind and earthquake: corresponding regulations and the application of design rules [3]. • Exercises (auditory): 1. One degree of freedom systems, definition of system mass, rigidly and flexibility[2] 2. Free-vibration response of one degree of freedom system with and without damping[2] 3. Forced-vibration response of one degree of freedom systems. Force transmission and vibration Isolation[2] 4. Rayleigh method. Symmetry in multidegree of freedom systems[2] 5. Free-vibration response of multi degree of freedom systems. Analysis of vibration mode shapes and vibration frequencies[3] 6. Forced vibrations of multi degree of freedom systems[2] 7. Distributed parameter systems response [2]. • Exercises (construction): 1. Multi degree of freedom system in plane examples of modeling [2] 2. Multi degree of freedom system in plane modeling by computer applications [4] • Exercises (design): 1. Response spectrum creating. Response spectrum analysis of plane frame[4] 2. Modeling and response spectrum analysis of multi story buildings with symmetric and unsymmetrical plan [5].
Study and examination requirements and forms of examination	• Seminar paper, • Written exam, • Oral exam.
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. A.Mihanović, Dinamika konstrukcija, Građevinski fakultet Sveučilišta u Splitu (Faculty of Civil Engineering, Split), 2. V.Raduka: Lecture notes, accessible online.

	Optional literature: 1. A.K.Chopra, Dynamics of Structures, Theory and Application to Earthquake Engineering, Prentice Hall, 1995, 2. W. Clough, J. Penzien: Dynamics of Structures, McGraw-Hill, 1993

Module name:	**Theory of Elasticity and Plasticity**
Module level, if applicable	Master's Degree Programme
Code, if applicable	21864
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	II (Summer)
Person responsible for the module	Ivan Duvnjak, Domagoj Damjanović
Lecturer	Marina Frančić Smrkić
Language	Croatian
Relation to curriculum	Master's degree programme. Geotechnical Engineering. Elective. Semestar II.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 45 • Exercises (auditory): 30
Workload	Lecture hours 45 Exercise 30 Other contact hours 10 Self study hours 140
Credit points	7,5 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, • Writing a seminar paper.
Recommended prerequisites	• Knowledge about differential and integral mathematics, partial differential equations, vectors and tensors analysis, • Good knowledge on general theoretical mechanics and numerical mathematics, • Knowledge about static, dynamic and strength of materials theory.
Module objectives/intended learning outcomes	• Recognizing appropriate boundary value problems of the theory of elasticity and plasticity, • Explaining differential equations of equilibrium and compatibility in stress and strain analysis, • Adequate formulation of boundary value problem. Solving problems using displacements or stress components, • Choosing the optimal method for solving appropriate boundary value problems, • Understanding the methods for solving boundary value problems in 2D and 3D region. • Understanding the behavior law of materials in elastic and plastic region.
Content	• Lectures: 1. Vector and tensor analysis[6] 2. Deforming models of material continuum [3] 3. Finite deformation tensors and infinitesimal deformation tensors [6] 4. External and internal forces on solids, stress tensor and its properties [6] 5. Thermodynamics of real solids, constitutive equations – general Hooke's low [3] 6. Definition, formulation and solution of boundary value problems using displacement or stress components[3] 7. Virtual work equations and energy principles[3] 8. Analitical and numerical methods for solving problem in theory of elasticity [3] 9. Plane problems, Airy's function, harmonic and biharmonic functions [3] 10. 3D problems of the theory of elasticity (torsion, thin plates, infinite solid and semi-infinite solid) [3] 11. Introduction to plasticity, yield criteria, plasticity parameters [3]

	12. Viscoelastic and viscoplastic models of materials, creep and relaxation [3]. Exercises (auditory): 1. Transformations of vectors and tensors, principal stress and principal strains [4] 2. Analitical and numerical methods for solving boundary value problems (Ritz method, Galerkin's, finite elements, finite differences, Fourier's series and complex-variable methods [12] 3. Solving plane problems, Airy's function, polynoms and infinite series [4] 4. Solving 3D problems (torsion of beams, thin plates and semi-infinite solid) [4] 5. Solving plastic problems, creep and relaxations [4].
Study and examination requirements and forms of examination	• Seminar paper, written and oral exam.
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. M. Rak,Teorija elastičnosti i plastičnosti (http://www.grad.unizg.hr) Optional literature: 2. T. Herman,Teorija elastičnosti iplastičnosti, Element, Zagreb, 2008 3. Z Kostrenčić,Teorija elastičnosti, Školska knjiga, Zagreb, 1982 4. S Timošenko, J.Gudier,Teorija elastičnosti, Građevinska knjiga, Beograd, 1962 5. I. Alfirević,Uvod u tenzore i mehaniku kontinuuma, Golden marketing, Zagreb, 2006 6. J. Brnić,Elastomehanika i plastomehanika, Školska knjiga, Zagreb, 1996 7. G.E. Mase,Theory and Problems of Continuum Mechanics, McGrow-Hill Company, 1970 8. Y.A. Amanzade,Theory of Elasticity, MIR, Publishers Moscow, 1979

Module name:	**Numerical Mathematics**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	21805
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	II (Summer)
Person responsible for the module	Tomislav Došlić, Alan Filipin
Lecturer	
Language	Croatian
Relation to curriculum	Master's degree programme.Elective.Semestar II.
Type of teaching, contact hours	Number of hours (in semester): 60 • Lectures: 30 • Exercises (auditory): 30
Workload	Lecture hours 28 Exercises hours 30 Other contact hours 2 Self study hours 60
Credit points	6 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises.
Recommended prerequisites	• Familiarity with the calculus, including ordinary differential equations, and basic linear algebra.
Module objectives/intended learning outcomes	• Understanding the conditions and limits of applicability of particular numerical methods, • Ability to choose and successfully apply correct methods.
Content	• Lectures: 1. Sources and types of errors (5) 2. Methods for solving non-linear equations (5) 3. Interpolation and approximation (5) 4. Numerical integration (5) 5. Numerical methods for solutions of ordinary differential equations (5) 6. Numerical linear algebra (5) • Exercises (auditory): follow the lectures.
Study and examination requirements and forms of examination	• Correct solution of a pre-assigned problem, • Oral exam.
Media employed	Blackboard, whiteboard, projector.
Reading list	Required literature: 1. T. Došlić, Numerička matematika, available at the course web-page. Optional literature: 1. E. Kreyszig: Advanced Engineering Mathematics, John Wiley and Sons Ltd., 1999,. 2. F. Scheid: Numerical Analysis, Schaum's Outline Series in Mathematics, McGraw-Hill

Module name:	**Perspective**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	21806
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	II (Summer)
Person responsible for the module	Sonja Gorjanc
Lecturer	Iva Kodrnja, Helena Koncul, Dora Pokaz
Language	Croatian
Relation to curriculum	Master's Degree Programmes. Elective. Semester II.
Type of teaching, contact hours	Number of hours (in semester): 60 • Lectures:30 • Exercises (auditory, design, laboratory): 30
Workload	Lecture hours 30 Hours of laboratories or skills 30 Other contact hours 30 Self study hours 90
Credit points	6 ECTS
Requirements according to the examination regulations	• 100% attendance in lectures and exercises, • 4 projects, • 1 seminar paper, • 1 pre-exam.
Recommended prerequisites	• Familiarity with the methods of parallel projection.
Module objectives/intended learning outcomes	• Mastering basic constructive procedures in perspective, • Acquiring knowledge on methods of construction of perspective image of an object, • Acquiring knowledge on geometric properties of algebraic surfaces of higher order, • Ability to construct perspective image of objects from civil engineering.
Content	• Lectures: 1. Central projection [8] 2. Quadric surfaces [4] 3. Ruled surfaces [6] 4. Computer modeling of surfaces [8] 5. Terrains in perspective [4] • Exercises (constructive, in computer classroom): 1. Central projection [8] 2. Quadric surfaces [4] 3. Ruled surfaces [6] 4. Computer modeling of surfaces [8] 5. Terrains in perspective [4]
Study and examination requirements and forms of examination	• Written exam - minimum 60% score, • Oral exam, • Students who have achieved a positive grade in projects, seminar paper and pre-exam are exempt from the written and oral exam.
Media employed	Whiteboard, projector
Reading list	Required literature: 1. P. Kurilj, N. Sudeta, M. Šimić, Perspektiva (Perspective), Arhitektonski fakultet, Zagreb, 2005 Optional literature: 1. V. Niče, Perspektiva (Perspective), Školska knjiga, Zagreb, 1978,

	2. B. Kučinić et al., Oble forme u graditeljstvu, Građevinar, Zagreb, 1992, 3. H. Brauner, W. Kickinger, Geometrija u graditeljstvu, Školska knjiga, Zagreb,1980

Module name:	**Basics of Differential Geometry**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	21804
Subtitle, if applicable	
Courses, if applicable	1 class for lectures 1 class for exercises
Semester(s) in which the module is taught	II (Summer)
Person responsible for the module	
Lecturer	Iva Kodrnja, Sonja Gorjanc
Language	Croatian
Relation to curriculum	Master's degree programme.Elective.Semestar II.
Type of teaching, contact hours	Number of hours (in semester): 60 • Lectures:30 • Exercises (auditory, design, laboratory): 30
Workload	Lecture hours 30 Hours of exercise 30 Other contact hours 30 Self study hours 90
Credit points	6 ECTS
Requirements according to the examination regulations	• 100% attendance in lectures and exercises, • 2 projects, • 1 seminar paper, • 2 pre-exams.
Recommended prerequisites	• Familiarity with the basics of differential calculus and linear algebra.
Module objectives/intended learning outcomes	• Acquiring basic knowledge about differential geometry of curves and surfaces in Euclidean space, • Ability to solve tasks in differential geometry by using program Mathematica, • Knowledge about the properties of minimal surfaces, • The ability to apply the methods and content of differential geometry in civil engineering.
Content	• Lectures: 1. Curves in Euclidean space [8] 2. Surfaces in Euclidean space [10] 3. Curvatures of surfaces [6] 4. Mapping of surfaces [4] 5. Minimal surfaces [4]. • Exercises (constructive, in computer classroom): 1. Curves in Euclidean space [8] 2. Surfaces in Euclidean space [10] 3. Curvatures of surfaces [6] 4. Mapping of surfaces [4] 5. Minimal surfaces [4].
Study and examination requirements and forms of examination	• Written exam - minimum 60% score, • Oral exam, • Students who have achieved a positive grade in projects, seminar paper and pre-exam are exempt from written and oral exam.
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. I. Kamenarović, Diferencijalna geometrija, Sveučilište u Rijeci, Pedagoški fakultet, Rijeka, 1990,

	2. J. Beban-Brkić: web-scrip:http://www.grad.hr/itproject_math/Links/jelena/index.html Optional literature: 1. Gray, A.: Modern Differential Geometry of Curves and Surfaces With Mathematica, CRS Press, Boston, London, 1998, 2. On-line Encyclopedia of mathematical concepts: MathWorldWolfram

Module name:	**Waves and Oscillations**
Module level, if applicable	Master's Degree Programme
Code, if applicable	21807
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	II (Summer)
Person responsible for the module	Dario Jukić
Lecturer	
Language	Croatian and/or English
Relation to curriculum	Master degree programme, Physics. Elective. II Semester.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises: 30 (auditory - 15, laboratory - 15)
Workload	Lecture hours 30 Hours of laboratories 15 Hours of practical exercies 15
Credit points	6 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, • Three pre-exams – minimum 35% score in each, • One make up exam.
Recommended prerequisites	• Undergraduate course mathematics, including differential equations, • Basics of programming and use of Mathematics software.
Module objectives/intended learning outcomes	• Mastering equations on given problems: free vibrations of simple systems – wires, slabs; waves and wire extension in one, two or three dimensions, deformations, • Understanding the physical background of the equations taught in professional and mathematical courses, • Ability to find equations through physical properties of a problem – coupled oscillations and vibrations, acoustic wave spreading, acoustic insulation, • Modeling by applying a harmonic oscillator, • Computer modelling of individual physical models of the problems dealt with in professional and mathematical courses, • Understanding physical properties of forced oscillation and interference, • Understanding the physical basis for measurements in civil engineering.
Content	• Lectures: 1. Basics of deriving equations from given problems (4) 2. Waves and wave propagation in one, two or three dimensions, deformations (5) 3. Physical background for the equations mastered in professional and mathematical courses (5) 4. Finding solutions for the equations through physical properties of problems (5) 5. Modeling by harmonic oscillator (2) 6. Computer modeling of physical models for problems dealt with in professional and mathematical courses (3) 7. Physical properties of forced oscillations, interferences (5) 8. Physical basis of measurements in civil engineering (2). • Exercises (auditory, laboratory): 1. Free vibrations of simple systems – wires, slabs (4) 2. Coupled oscillations and vibrations, acoustic wave spreading, acoustic insulation (9)

	3. Coupled oscillations and vibrations, acoustic wave spreading, acoustic insulation (7) 4. Modeling: physical models (3) 5. Forced oscillations, interferences (5) 6. Physical measurements (2). • Seminars: included in exercises.
Study and examination requirements and forms of examination	• Pre-exam – students with a minimum 60% score are exempt from a part of the final exam (only final test is mandatory) End of semester grading: • The final test is the requirement for the final exam.
Media employed	Whiteboard, projector, experiments integrated with the lecture presentation.
Reading list	Required literature: 1. F. S. Crawford, Waves: Berkeley physics course v.3, McGraw-Hill college, 1968 Optional literature: 1. A. P. French, Vibrations and Waves, W.W. Norton & Company, New York, 1971

III. SEMESTER

Module name:	**Improvement of Soil and Rock**
Module level, if applicable	Master's Degree Programme
Code, if applicable	
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	III (Summer)
Person responsible for the module	Meho Saša Kovačević, Lovorka Librić
Lecturer	Nicola Rossi, Stjepan Matić
Language	Croatian
Relation to curriculum	Master's degree programme. Geotechnical Engineering. Elective. Semestar III.
Type of teaching, contact hours	Number of hours (in semester): • Lectures:30 • Exercises (auditory):24 • Exercises (field and laboratory):6
Workload	Lecture hours 30 Hours of laboratories 30 Other contact hours 30 Self study hours 90
Credit points	6,0 ECTS
Requirements according to the examination regulations	• Attendance in 75% of lectures, in 100% of exercises, • Minimum 25% score in the pre-exam.
Recommended prerequisites	• Understanding the terms of stiffness and strength of soils and rocks, • Understanding the principles of soil consolidation and pore pressure, • Knowledge of the methods of determining the settlement of structure, as well as the capacity of the foundation soil/rock.
Module objectives/intended learning outcomes	• Ability to identify problems and to select an optimal method for soil improvement, depending on the problem considered, • Ability to determine the degree of soil improvement and calculation of improved soil stiffness if limitation of settlements is considered, as well as the calculation of improved soil strength parameters if improvement of bearing capacity is considered, • Ability to determine the velocity of consolidation and the time required for the overall consolidation if the reduction of pore pressure and acceleration of consolidation are considered, • Ability to perform simple laboratory and field experiments in order to control the quality of the soil improvement works (device for uniaxial pressure, SASW)
Content	• Lectures: 1. Principles of soil and rock improvement: an increase in bearing capacity, control of total and differential settlements, reducing the time required to achieve deformations of soil, reducing liquefaction potential, reducing the permeability of the soil, removing water from the soil, increasing the shear strength and slope stability, increased erosion stability, execution of internal drainage system [2] 2. Replacement of the soil, displacement of the soil, reducing load[2] 3. Vertical drains [2] 4. Deep vibration techniques [2] 5. Vibro stone columns [2] 6. Consolidation and jet grouting [2]

	7. Adding load [2] 8. Inundation [2] 9. Pressure berms [2] 10. Anchored structures [2] 11. Soil reinforcement [2] 12. Chemical methods of soil improvement [2] 13. Freezing, heating, vegetation [2] 14. Quality control of soil and rock improvement: laboratory investigations, field investigations [2] 15. Methods of measurements and observations of improved soil and rock [2]. • Exercises 16. Vertical drains[auditory] [2] 17. Deep vibration techniques [auditory] [2] 18. Vibro stone columns[auditory] [2] 19. Vibro stone columns[auditory] [2] 20. Consolidation grouting[auditory] [2] 21. Jet grouting [auditory] [2] 22. Jet grouting[auditory] [2] 23. Adding of load [auditory] [2] 24. Anchored structures[auditory] [2] 25. Pre-exam[2] 26. Soil reinforcement [auditory] [2] 27. Soil reinforcement [auditory] [2] 28. Quality control of soil and rock improvement [laboratory][2] 29. Quality control of soil and rock improvement [field][2] 30. Methods of measurements and observations of improved soil and rock [field][2].
Study and examination requirements and forms of examination	Written and oral exam.
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. Meho Saša Kovačević - lecture notes - powerpoint presentation. Optional literature: 1. Mitchell, J. M., Jardine, F.M. A Guide to Ground Treatment, CIRIA publication C573, London, UK, 2002, 2. Bell, F.G. Engineering Treatment of Soils, Spon Press, London, UK, 1993, 3. Moseley, M.P. Ground Improvement., CRC Pres, Boca Raton, Florida, USA, 1993.

Module name:	**Earthfill and Retaining Structures**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	133593
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	III (Winter)
Person responsible for the module	Tomislav Ivšić
Lecturer	Lovorka Librić
Language	Croatian
Relation to curriculum	Master's degree programme.Geotechnical Engineering; Compulsory; III semester
Type of teaching, contact hours	Number of hours (in semester): • Lectures:30 • Exercises: 30
Workload	Lecture hours 30 Design and numerical exercises hours 30 Midterm written examination hours 2 Final written and oral examination hours 3 Self study hours 115
Credit points	6 ECTS
Requirements according to the examination regulations	• 75% attendance in lectures, • Submission of the program.
Recommended prerequisites	• Knowledge of basic physical and mechanical properties of the soil (strength, stiffness), • Understanding of groundwater seepage in the soil, knowledge of the concepts of flow, critical hydraulic gradient, the permeability coefficient, • Knowledge of soil classification and selection of parameters depending on the type of soil, • Knowledge of the basic principles of numerical modeling.
Module objectives/intended learning outcomes	• Selection of design situations related to different types of earth dams (embankments), • Conduction of seepage and stability analysis for different types of earth dams(embankments), • Understanding the basic problems related to the stability of earth dams and understanding of remedial works for earth structures, • Understanding earth pressures on retaining structures and understanding of procedures for their determination, • Determination of all the actions on the retainingstructure including earth pressures, its own weight, earthquake and other actions, • Ability to calculate stability of earth and retaining structures.
Content	• Lectures: 1. Types of earth structures (dams and flood protection embankments, road embankments, landfills)[2] 2. Selection of earth materials, field and laboratory investigation works, methods of construction[2] 3. Theory of soil compaction, properties of compacted material[2] 4. Geotechnical calculations of earth structures 1 (seepage, limit equilibrium methods, FEM analyzes using simple soil models)[2] 5. Geotechnical calculations of earth structures 2 (seismic stability, selection of parameters)[2] 6. Selection of embankments, zoned embankments, solution variations, presentation of major dams[2]

	7. Monitoring of earth structures, instabilities, damage and destruction of the dam, the impact of construction on stability and deformation[2] 8. The application and types of retaining structures[2] 9. Basis of earth pressure calculation 1 (concepts of earth pressure, strength parameters)[2] 10. Basis of earth pressure calculation 2 (Rankine states, Coulomb method and accuracy)[2] 11. Basis of earth pressure calculation 3 (additional load on the surface, seismic load)[2] 12. Retaining walls, reinforced earth structures[2] 13. Embedded retaining walls, anchored retaining structures, geotechnical anchors calculation[2] 14. Analysis of embedded retaining walls (design and theoretical requirements)[2] 15. Analysis of embedded retaining walls (calculatio00n procedures)[2]. • Exercises: 1. Examples of geotechnical calculation of embankment - seepage (auditory)[2] 2. Examples of geotechnical calculation of embankment - slope stability (auditory)[2] 3. Geotechnical calculations of flood protection embankment (computer work)[6] 4. Geotechnical calculations and preparation of report (computer work)[2] 5. Geotechnical calculations and preparation of report, submission of report (computer work)[2] 6. Examples of geotechnical calculations of retaining structures - soil pressures (auditory)[2] 7. Examples of geotechnical calculations of retaining structures - a retaining wall (auditory)[2] 8. Examples of geotechnical calculations of retaining structures - Embedded retaining walls (auditory)[2] 9. Working on task - solving retaining structure example (construction)[8] 10. Submission of the program[2].
Study and examination requirements and forms of examination	Written and oral exam.
Media employed	Blackboard, whiteboard, projector.
Reading list	Required literature: 1. Tomislav Ivšić , Lectures, powerpoint presentation - available on the web, 2. Nonveiller, E. (1981): Mehanika tla i temeljenje građevina, 2nd edition, Školska knjiga, Zagreb 3. Nonveiller, E.: Nasute brane - projektiranje i građenje, Školska knjiga, Zagreb, 1983, 359 pp. Optional literature: 1. Nonveiller, E.: Klizenje i stabilizacija kosina, Školska knjiga, Zagreb, 1987, 204 pp. 2. Embankment Dam Engineering - Casagrande Volume, Eds. R.C. Hirschfeld and S.J. Poulos, John Wiley & Sons, New York, 1973, 454 pp. 3. US Dept. of Interior, Bureau of Reclamation: Design of small dams, 3rd ed, 1987 4. Dembicki,E.: Tlak, otpor i nosivost tla, Sveučilišna naklada Liber, Zagreb, 1982

	5. Gaba, A.R., Simpson, B.,Powrie, W., Beadman, D.R: Embedded retaining walls-guidance for economic design, Report CIRIA C580, London, 2003

Module name:	**Hydrogeology and Engineering Geology**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	
Subtitle, if applicable	
Courses, if applicable	1. Applied Geology, 2. Hydrogeology and Engineering Geology
Semester(s) in which the module is taught	III (Winter)
Person responsible for the module	
Lecturer	Meho-Saša Kovačević
Language	Croatian, English
Relation to curriculum	Master's degree programme. Geotechnical Engineering. Compulsory. Semester III.
Type of teaching, contact hours	Number of hours (in semester): • Lectures:30
Workload	Lecture hours 30 Other contact hours 10 Self study hours 50
Credit points	3 ECTS
Requirements according to the examination regulations	• Attendance in 75% of lectures, • Minimum 25% score in the pre-exam.
Recommended prerequisites	• Knowledge of basic geological terms.
Module objectives/intended learning outcomes	• Understanding the impact of groundwater regime on construction works in the karst, • Introduction to methods of determining water-protected areas, • Understandingthe impact of geological structures on bearing capacity under foundations and on the stability of slopes in rock mass, • Understandingthe impact of geological structures on the stability of underground openings in rock mass, • Ability to determine the geological parameters necessary for rock mass classifications.
Content	• Lectures: 1. Introduction, hydrogeology [2] 2. The role of hydrogeology in civil engineering [2] 3. Classification of groundwater [2] 4. Groundwater regime[2] 5. Research methods [2] 6. Water in Karst [2] 7. Karst [2] 8. Pre-exam [2] 9. Determination of protection zones, interpretation of hydrogeological investigations [2] 10. Pre-exam (make up) [2] 11. Engineering geology and its role in civil engineering [2] 12. Engineering geology and its role in civil engineering [2] 13. Engineering geology and its role in civil engineering, landslides [2] 14. EG classification of rocks [2] 15. Investigation methods for determination of rock properties needed for the civil engineering [2].
Study and examination requirements and forms of examination	Written and oral exam.
Media employed	Whiteboard, projector.
Reading list	Required literature:

	1. Herak, M., Geologija, 1990 2. Šestanović, S., Osnove geologije i petrologije, 2001 3. West, T., Geology Applied to Engineering, 1994 4. Monroe, J. & Wicander, R. , Physical geology, 2006 5. Plummer,C., McGeary,D. & Carlson, C., Physical Geology, 2006 Optional literature: 1. Weight, W. & Sonderregger,J. , Manual of Applied Field Hydrogeology, 2004 2. Weight, W. , Hydrogeology Field Manual, 2008 3. Waltham, T., Foundations of Engineering Geology, 2002 4. Poehls, D. J. & Smith, G. J., Encyclopedic Dictionary of Hydrogeology, 2009 5. Fetter, C. W., Applied Hydrogeology, 2000 6. Rahn, P., Engineering geology: An Environmental Approach, 1996

Module name:	**Geotechnical Laboratory**
Module level, if applicable	Master's Degree Programme
Code, if applicable	104008
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	III (Winter)
Person responsible for the module	Danijela Jurić Kačunić
Lecturer	Gordana Ivoš, Krešimir Kašner, Luka Pušić
Language	Croatian
Relation to curriculum	Master's degree programme. Geotechnical Engineering. Compulsory. Semestar III.
Type of teaching, contact hours	Number of hours (in semester): • Lectures:30 • Exercises (laboratory):45
Workload	Lecture hours 30 Hours of laboratories 45 Other contact hours 45 Self study hours 105
Credit points	7,5 ECTS
Requirements according to the examination regulations	• 75% attendance in lectures, • 100% attendance in exercises.
Recommended prerequisites	• Knowledge of basic physical and mechanical properties of soil and rock needed for designing, • Skills in Microsoft Office-in (Word, Excel).
Module objectives/intended learning outcomes	• Acquired knowledge and understanding of the essential role of laboratory experimental methods in geotechnical engineering, • Ability to conduct laboratory experiments on coherent and non-coherent soil samples, and the intact rock samples, • Ability to analyze and interpret the results of laboratory tests, • Drawing borehole logs and engineering-geological soil profile, • Ability to write final reports on laboratory tests.
Content	• Lectures: 1. The role of the laboratory in geotechnical engineering[2] 2. The program of laboratory investigation activities [2] 3. Basic concepts in measuring : accuracy, precision, resolution, sensitivity, linearity, hysteresis, noise, measurement error[2] 4. Determination of natural moisture and particle density[2] 5. Classification tests: sieving, aerometry, liquid limit, plastic limit[2] 6. Determining the coefficient of permeability: the test with constant fall and the test with changing fall[2] 7. Determination of soil compaction: standard and modified Proctor test[2] 8. Determination of stiffness and strength of soils and rocks: oedometer tests[2] 9. Determination of stiffness and strength of soils and rocks: direct shear tests[2] 10. Determination of stiffness and strength of soils and rocks: uniaxial and triaxial tests[2] 11. Determination of the point strength of rock monoliths: PLT test[2] 12. Determination of parameters of weathered rock mass: slake durability test[2] 13. Determination of calcium carbonate content in the rock samples[2] 14. Geophysical methods: measuring the velocity of propagation of longitudinal and shear waves in soil and rock samples[2]

	15. A report on the results of laboratory tests[2] • Exercises (laboratory): 1. Determination of natural moisture and particle density[2] 2. Classification tests: sieving, aerometry[2] 3. Classification tests: liquid limit, plastic limit[2] 4. Determination of coefficient of permeability: test with constant fall and test with changing fall[2], 5. Determination of soil compaction: standard and modified Proctor test[2] 6. Determination of stiffness and strength of soils and rocks: oedometer tests[2] 7. Determination of stiffness and strength of soils and rocks: direct shear tests[2] 8. Determination of stiffness and strength of soils and rocks: uniaxial and triaxial tests[2] 9. Determination of the point strength of rock monoliths: PLT test[2] 10. Determination of parameters of weathered rock mass: slake durability test[2] 11. Determination of calcium carbonate content in the rock samples[2] 12. Geophysical methods: measuring the velocity of propagation of longitudinal and shear waves in soil and rock samples[2] 13. A report on the results of laboratory tests[6]
Study and examination requirements and forms of examination	Written and oral exam.
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. Danijela Marčić, lectures –powerpointpresentation. Optional literature: 3. Head, K.H., Manual of Soil Laboratory Testing, Volume 1, 2 i 3, John Wiley & Sons, West, Sussex, UK, 1998, 4. Bardet, J.P., Experimental Soil Mechanics, Prentice Hall, New Jersey, USA, 1997.

Module name:	**Underground Structures**
Module level, if applicable	Master’s Degree Programme
Code, if applicable	104009
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	III (Winter)
Person responsible for the module	Meho Saša Kovačević, Lovorka Librić
Lecturer	Nicola Rossi
Language	Croatian
Relation to curriculum	Master’s degree programme. Geotechnical Engineering. Elective. Semestar III.
Type of teaching, contact hours	Number of hours (in semester): • Lectures:30 • Exercises (auditory):10 • Exercises (design):20
Workload	Lecture hours 30 Hours of laboratories 30 Other contact hours 30 Self study hours 90
Credit points	6,0 ECTS
Requirements according to the examination regulations	• Attendance in 75% lectures, in 100% exercises, • Minimum 25% score in the pre-exam.
Recommended prerequisites	• Knowledge of basic physical and mechanical properties of soil and rock mass (stiffness, strength...), • Knowledge of the rock mass classifications, • Understanding the basic principles of numerical modelling.
Module objectives/intended learning outcomes	• Ability to calculate the relevant parameters of the soil/rock required for numerical modeling based on the results of laboratory and field tests and on the basis of the classification of rock masses, • Ability to choose the system to ensure stability of underground structures, depending on the environment in which it is located, • Ability to conduct a complex two-dimensional and three-dimensional stress-strain analysis in order to assess the stability of an underground structure, • Knowledge of the principles of interactive design in underground construction using observations and measurements during construction.
Content	• Lectures: 1. Basic concepts and development of underground structures [2] 2. Investigation works for design and construction of underground structures [2] 3. Design process of underground structures [2] 4. Elements of the primary support system [2] 5. Elements of secondary support system [2] 6. Loading on support system: Theories of self-supporting arch, Elastically supported ring, 2D and 3D models [2] 7. Stress-strain analysis of underground structures [2] 8. Division of tunnel profile (cross section), Time for installing support system [2] 9. Characteristic curves of rock mass and support system [2] 10. Designing of support system based on RMR classification [2] 11. Designing of support system based on Q classification [2]

	12. Improving the rock mass for the excavation of underground structures and methods of excavation [2] 13. New Austrian Tunneling Method: main and specific principles [2] 14. Observations and measurements of underground structures [2] 15. Long-term deformations of underground structures [2]. • Exercises 1. Elements of the primary support system[4] 2. Elements of secondary support system[4] 3. Loading on support system: Theories of self-supporting arch [2] 4. Loading on support system: Elastically supported ring[2] 5. Designing of support system based on RMR classification[2] 6. Designing of support system based on Q classification[2] 7. Characteristic curves of rock mass and support system[4] 8. Stress-strain analysis of underground structures[6] 9. Long-term deformations of underground structures[4]
Study and examination requirements and forms of examination	Written and oral exam.
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. Meho Sasa Kovačević, lectures – powerpoint presentation. Optional literature: 1. Hoek, E., Brown, E. T. , Underground excavations in rock,The Institution of Mining and Metallurgy, London, England, 1980, 2. ITA, Guidelines for the design of tunnels, ITA Working Group on General Approaches to the Design of Tunnels, Tunnelling and Underground Space Technology, Vol. 3, No. 3, 1988.

Module name:	**Geotechnics and Environmental Protection**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	104010
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	III (Winter)
Person responsible for the module	Tomislav Ivšić
Lecturer	
Language	Croatian
Relation to curriculum	Master's degree programme. Geotechnical Engineering; Elective. III Semestar.
Type of teaching, contact hours	Number of hours (in semester): • Lectures:30 • Exercises: 15
Workload	Lecture hours 30 Numerical exercises 10 hours Seminar 5hours Written and oral examination 3 hours Self study hours 87
Credit points	4.5 ECTS
Requirements according to the examination regulations	Criteria for completing the module Short presentation of selected relevant literature Written and oral examination
Recommended prerequisites	• Knowledge of flow process in soil (terms of flow, hydraulic gradients, etc.), • Knowledge of slope stability analysis of earth materials.
Module objectives/intended learning outcomes	• Knowledge on calculation of seepage of contamination through soil, • Knowledge on calculation of stability of slopes in landfills in static and seismic conditions, • Understanding the role of geosynthetics to protect the ground from contamination (geomembrane) and to ensure the stability of the slope (geotextiles, geogrids, etc.), • Exploring the possibilities of using waste materials as building materials, • Theoretical knowledge about long-term monitoring of behavior of landfill parameters which are essential from geotechnical standpoint.
Content	• Lectures: 1. Basic principles of environmental protection 1 (environmental science, the environment of the earth, the concept and the origin of soil, water and air contamination)[2] 2. Basic principles of environmental protection 2 (current trends in solving environmental problems, the concept of sustainable development, regulations)[2] 3. Waste and waste management - the concept of a closed landfill[2] 4. Waste and waste disposal - integral parts of the landfill, harmful products[2] 5. Geotechnical aspects of landfill[2] 6. Properties of waste as construction material[2] 7. Stability of landfill slope 1 (static and seismic conditions), geosynthetics, the impact of eluates[2] 8. Stability of landfill slope 2, geosynthetics interfaces, the impact of eluates[2] 9. Properties of natural and synthetic materials as sealing and drainage layers[2]

	10. Landfill construction types, the use of geosynthetics[2] 11. Monitoring of the landfill and the environment, examples of instability of landfills[2] 12. Transfer of contamination through soil and water[2], 13. Preventing pollution and remedial works on contaminated soil[2] 14. Presentation of seminar papers and discussions[2] 15. Presentation of seminar papers and discussions[2]. • Exercises: 1. Examples of landfill stability calculations (auditory)[2] 2. Examples of calculation of pollution transfer through soil and the impact of remedial measures (auditory)[2] 3. Analysis of stability of landfill - the landfill body and cover (computer work)[4] 4. Presentation of seminar papers and discussions[7]
Study and examination requirements and forms of examination	Oral exam
Media employed	Blackboard, whiteboard, projector.
Reading list	Required literature: 1. Teaching material: Tomislav Ivšić - lectures, powerpoint presentation - available on the web 2. Znidarčić, D., Kovačić, D., Kvasnička, P., Mulabdić, M.,Geotehnologija pri odlaganju komunalnog otpada, Hrvatsko društvo građevinskih inženjera, Građevni godišnjak, 1996 3. Z. Milanović, Deponij – trajno odlaganje otpada, ZGO-Zagreb, 1992 4. Z. Milanović, S.Radović, V.Vučić, Otpad nije smeće, Gospodarstvo i okoliš, V.Gorica, 2002 Optional literature: 1. M.L.McKinney, R.M.Schoch,Environmental Science (Systems and Solutions), 3rd ed., Jones and Bartlett Publishers, Boston, 2003 2. ISSMFE Technical Committee TC 5,Environmental Geotechnics, Report, Bochum, 1997 3. R.M.Koerner,D.E.Daniel,Final Covers for Solid Waste Landfills and Abandoned Dumps, ASCE Press & Thomas Telford, 1997 4. R.M.Koerner,Designing with Geosynthetics, 4th edition, Prentice Hall, 1998 5. R.K.Rowe,R.M.Quigley,J.R.Booker, Clayey Barrier Systems for Waste Disposal Facilities, E&FN

Module name:	**Soil Dynamics**
Module level, if applicable	Master's Degree Programme
Code, if applicable	104011
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	III (Winter)
Person responsible for the module	Tomislav Ivšić
Lecturer	
Language	Croatian
Relation to curriculum	Master's degree programme. Geotechnical Engineering. Elective. Semestar III.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises: 30 (auditory – 16, design - 14)
Workload	(Estimated) workload, divided into contact hours (lecture, exercise, laboratory session, etc.) and private study, including examination preparation, specified in hours,13 and in total.
Credit points	6 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, • Program submission.
Recommended prerequisites	• Knowledge about basics of free and forced oscillations, structure diynamics, • Knowledge about the basics of soil mechanics and physical-mechanical properties of soil (strength, stiffness).
Module objectives/intended learning outcomes	• Understanding the expansion of seismic waves in a half-space, • Understanding complex relationships between strain and deformations in cyclic load on soil materials, • Calculating dynamic loads on foundations, • Determining the potential liquefaction of water saturated soil, • Analyses and verification of the stability of slopes, earth and retaining structures subjected to earthquake action.
Content	• Lectures: 1. Introduction: basics of oscillations (free and forced oscillations of an undamped and damped simple oscillator), oscillation measuring instruments [4] 2. Waves in elastic media: longitudinal and transverse waves in rods, reflection, waves in infinite media (longitudinal, transverse, reflection and refraction), waves at boundaries (Raylegh and Lowe's waves, attenuation, dispersion [2] 3. Properties of cyclic loads on soils: hysteresis, stiffness, attenuation, strength, cyclic volume deformations and pore pressures, laboratory experiments, field experiments [4] 4. Foundation oscillations: vertical, lateral, torsion, rocking and related oscillations of shallow foundations, theory and measuring, oscillations of foundations on piles, vibration defence [4] 5. Bearing capacity of soil in dynamic conditions[2] 6. Geotechnical earthquake engineering: impact of earthquakes on soil and structure, examples from practice [2] 7. Earthquake load: definition of terms, characteristics of ground motion during earthquakes, propagation of seismic waves: vertical propagation in a stratified medium, non-linear behaviour of soil, amplification [2]

	8. Behavior of walls and slopes in earthquakes: Mononobe-Okabe theory for walls, sliding block method, dimensioning walls to limited lateral displacements, permanent displacements in slopes and embankments 9. Liquefaction: liquefaction in laboratory and in the field, laboratory and field experiments, improving liquefaction prone soil [4] • Auditory exercises: 1. Calculus of dynamic loads on foundations[4] 2. Determining the liquefaction potential of soil [4] 3. Calculus of seismic stability of slopes and earth structures [4] 4. Seismic calculus of supporting structures [4]. • Design exercises: 1. Calculus of dynamic loads on foundations [4] 2. Determining the liquefaction potential of soil [4] 3. Calculus of seismic stability of slopes and earth structures [4] 4. Seismic calculus of supporting structures [4].
Study and examination requirements and forms of examination	Written and oral exam.
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. Das, B. M.: Principles of Soil Dynamics. Brooks/Cole, Pacific Growe, CA, 1993, 2. Lecture notes – power point presentation. Optional literature: 1. Kramer, S. L.: Geotechnical Earthquake Engineering. Prentice Hall, NJ, 1996, 2. Prakash, S.: Soil Dynamics. McGraw-Hill, NY, 1981

Module name:	**English Language in Civil Engineering 2**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	93234
Subtitle, if applicable	
Courses, if applicable	Master's's programme 7 classes
Semester(s) in which the module is taught	III (Winter)
Person responsible for the module	Alemka Kralj Štih
Lecturer	
Language	English
Relation to curriculum	Master's Degree Programmes. Elective. Semester III.
Type of teaching, contact hours	Number of hours (in semester): • Exercises: 45
Workload	Lecture hours 45 Other contact hours 10 Self study hours 80
Credit points	4,5 ECTS
Requirements according to the examination regulations	• 75% attendance in lectures, • Making a presentation, • 3 pre-exams.
Recommended prerequisites	• Intermediate level, B 1.
Module objectives/intended learning outcomes	• Developing language competences which include professional terminology in the field of transport facilities and geotechnical engineering, • Independent user – ability to read technical literature independently, • Revision of basic grammar categories in professional language – passive, past tenses, modal verbs, • Confident use of sentences in professional language, developing presentation skills and skills in writing professional papers.
Content	• Exercises: 1. A Career in Transportation Engineering [2] 2. Road Structure [2] 3. Construction of a Road [2] 4. A Career in Geotechnical Engineering [3] 5. Tunnels and Tunneling Tools [2] 6. How to write a CV? [3] 7. The CV and Job Interview Questions [3] 8. Preparing for the Interview Skills – Techniques, Tips and Advice [3] 9. Single presentations on Transportation Issues [3] 10. Transportation System Issues and Challenges [3] 11. The Light at the End of the Tunnel – Revision of vocabulary [4] 12. What's so Special About Geotechnical Engineering? [3] 13. General Considerations in Foundation Design [2] 14. Special Foundation Problems [2] 15. Deep Foundations [3] 16. Presentations [3]
Study and examination requirements and forms of examination	• The credits earned through all the testing and pre-exams make up the final grade. The grades are based as follows: pre-exam results, points earned during semester - active participation in class, grammar checks, translations into a foreign language, translations from a foreign language, professional vocabulary checks. Maximum number of points that can be earned in the pre-exam is 20 – the grade is multiplied by four. Students who have not earned enough points are required to take the final exam. • Grading is as follows - 50-62% score = sufficient (2),

	- 63-75% score = good (3), - 76-88% score = very good (4), - 89-100% score = excellent (5).
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. A. Kralj Štih: English in Transportation and Geotechnical Engineering, course materials. Optional literature: 1. D. Bonamy: Technical English 4, Pearson Longman, 2011 2. The Internet pages, program Building Big, Brantacan, ASCE. 3. Z. Vulelija: Ilustrirani rječnik arhitekture i građe inar t a – hrvatsko engleski i englesko hrvatski, Masmedia, Zagreb, 2010 4. A. Prager: Trojezični građevinski rječnik, Masmedia, Zagreb, 2002

Module name:	**German Language in Civil Engineering 2**
Module level, if applicable	Master's Degree Programm
Code, if applicable	93235
Subtitle, if applicable	
Courses, if applicable	Master's Programmes 1 class
Semester(s) in which the module is taught	III (Winter)
Person responsible for the module	Alemka Kralj Štih
Lecturer	
Language	German
Relation to curriculum	Master's Degree Programmes. Elective. Semester III.
Type of teaching, contact hours	Number of hours (in semester): 45 • Exercises (auditory):45
Workload	Lecture hours 45 Other contact hours 10 Self study hours 80
Credit points	4,5 ECTS
Requirements according to the examination regulations	• 75% attendance in exercised, • Preparing one presentation, • 3 pre-exams.
Recommended prerequisites	• German language competence at B1, B2 level.
Module objectives/intended learning outcomes	• Understanding and interpreting technical texts, • Independent oral skills in technical field, ability to explain professional terms, • Writing a CV and job applications.
Content	• Auditory exercises: 1. Die Geschichte des Kuppelbaus [3] 2. Wie schreibt man einen Lebenslauf? [3] 3. Bewerbungsschreiben [3] 4. Wie man sich auf ein Interview vorbereitet [3] 5. Die größte Drehbrücke der Welt [3] 6. Bewerbungsschreiben [3] 7. Die Geschichte der Tunnelkonstruktion [3] 8. Kräfte und Gegenkräfte [3] 9. Einige Festigkeitsarten [3] 10. Elastizität und Verformung [3] 11. Der Straßenbau [3] 12. Gebäude im Erdbeben [3] 13. Der Flughafen [3]
Study and examination requirements and forms of examination	• The credits earned through all the testing and pre-exams make up the final grade. The grades are based as follows: pre-exam results, points earned during semester - active participation in class, grammar checks, translations into a foreign language, translations from a foreign language, professional vocabulary checks. Maximum number of points that can be earned in the pre-exam is 20 – the grade is multiplied by four. Students who have not earned enough points are required to take the final exam. • Grading is as follows - 50-62% score = sufficient (2), - 63-75% score = good (3), - 76-88% score = very good (4), - 89-100% score = excellent (5).
Media employed	Whiteboard, projector.
Reading list	Required literature:

	1. A. Kralj Štih: Deutsch für Konstruktionen, Geotechnik, Verkehr un Theorie un M ellierung der Konstruktionen, Kursunterlagen, 2011 Optional literature: 1. A. Prager: Trojezični građevinski rječnik, Masmedia, Zagreb, 2002

IV. SEMESTER

Module name:	**Geotechnical design**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	104097
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	IV (Summer)
Person responsible for the module	Tomislav Ivšić
Lecturer	
Language	Croatian
Relation to curriculum	Master's degree programme. Geotechnical Engineering; Compulsory; IV semester
Type of teaching, contact hours	Number of hours (in semester): • Lectures:30 • Exercises: 30
Workload	Lecture hours 20 Practical work on project hours 35 Presentation and discussion on design problems hours 5 Midterm written examination hours 2 Final written and oral examination hours 3 Self study hours 115
Credit points	6 ECTS
Requirements according to the examination regulations	working on geotechnical design
Recommended prerequisites	• Knowledge about programs for numerical modeling in geotechnical engineering, • Knowledge about basic physical and mechanical properties of soil and rock needed for designing, • Knowledge about laboratory and field investigation works, • Determining design situations for geotechnical structures.
Module objectives/intended learning outcomes	• Planning geotechnical investigations (laboratory and field), • Analysis and interpretation of geotechnical investigation results, • The characteristic engineering-geological soil profile based on geotechnical investigation results, • Selection of relevant parameters for the calculation, • Selection of appropriate design solution for a particular type of geotechnical problem, • Preparation of the analysis models relevant to a given geotechnical problem, • Analysis and interpretation of the results obtained by numerical modelling, • Selection of construction technology for the specific design solution, • Preparation of bills of quantities of the works based on selected design solution, • Development of the overall design with the accompanying drawings, bill of quantities, technical description, calculations and technical requirements for the execution of the selected design solution.
Content	• Lectures: 1. General principles and specificity of geotechnical and civil engineering design [2] 2. Overview of the relevant regulations and general principles of Eurocode 7: Geotechnical

	Engineering (procedures for design and procedures for mechanical resistance and stability proof) [2] 3. Eurocode 7: Geotechnical Engineering (limit states, geotechnical data) [2] 4. Eurocode 7: Geotechnical Engineering (typical geotechnical structures) [2] 5. Eurocode 7: Geotechnical Engineering (seismic geotechnical engineering) [2] 6. Quality management and quality assurance in geotechnical design and construction[2] 7. Planning of field and laboratory investigation works for typical cases (selection of method, depth, sampling density) [2] 8. Presentation of investigation works results, geotechnical models of foundation soil, selection of relevant geotechnical parameters [4] 9. Variations of technical solutions, selection of materials and characteristics of construction technology [4] 10. Presentation of complex geotechnical structures from practice [6] 11. Discussion about projects[2]. • Exercises: 1. Geotechnical design of typical geotechnical structures (construction) [2] 2. Work on geotechnical design - preparation of geotechnical data, geotechnical model of the ground (construction) [4], 3. Work on geotechnical design - preparation of geotechnical data, selection of relevant parameters (construction) [2] 4. Work on geotechnical design – selection of technical solutions (construction) [4] 5. Work on geotechnical design – geotechnical calculations (construction, work on computer) [8] 6. Work on geotechnical design – graphical part, technical terms of execution and costs (construction, work on computer)[8] 7. Submission of geotechnical design (construction)[2]
Study and examination requirements and forms of examination	A design presentation is the requirement for taking the oral exam.
Media employed	Blackboard, whiteboard, projector.
Reading list	Required literature: 1. Tomislav Ivšić - lectures, powerpoint presentation - available on the web Optional literature: 1. Eurocode 7 – Geotehnika: Geotehničko projektiranje, HRN EN 1997-1: 2004 2. Nonveiller, E. (1981): Mehanika tla i temeljenje građevina, 2nd ed. ,Školska knjiga, Zagreb 3. Tomlinson, M. J. (1995): Foundation Design and Construction, Longman Scientific and Technical, Harlow 4. Bowles, J. E. (1982): Foundation Analysis and Design, McGraw Hill, NY 5. Coduto, D. P. (1994): Foundation Design, Principles and Practices, Prentice Hall, NJ 6. Winterkorn, H.F., Fang, H.-Y. (1982): Foundation Engineering Handbook, Van Nostrand Reinhold Company, New York, 752 str. 7. Geotechnical Engineering Handbook Vol 1-3, Ed. U.Smoltzyck, Ernst&Sohn Verlag, Berlin, 2002 8. Technical engineering and design guides,adapted from the US Army Corps of Engineers, ASCE 9. CIRIA – design reports, London

Module name:	**Field Investigations and Monitoring**
Module level, if applicable	Master's Degree Programme
Code, if applicable	104111
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	IV (Summer)
Person responsible for the module	Meho Saša Kovačević, Danijela Jurić Kaćunić
Lecturer	Marijan Car, Mladen Cvetković, Luka Pušić
Language	Croatian
Relation to curriculum	Master's degree programme. Geotechnics Engineering. Compulsory, Semestar IV.
Type of teaching, contact hours	Number of hours (in semester): • Lectures:30 • Exercises (auditory):14 • Exercises (field):16
Workload	Lecture hours 30 Hours of laboratories 30 Other contact hours 30 Self study hours 90
Credit points	6,0 ECTS
Requirements according to the examination regulations	• Attendance in 75% lectures, in 100% exercises • Minimum 25% score in pre-exam.
Recommended prerequisites	• Knowledge about basic physical and mechanical properties of soil needed for design, • Knowledge of basic physical and mechanical properties of rock needed for design, • Knowledge of concepts of strain, displacement, stress, force, stiffness, necessary for understanding the principles of geotechnical structures monitoring.
Module objectives/intended learning outcomes	• Knowledge about and understanding the essential role of investigation and experimental methods in geotechnical engineering – in design (field investigations) and in verification of executed structures (field measurements and observations), • Ability to conduct simple field tests as part of investigation work, • Ability to use measuring equipment for observation and monitoring, • Ability to analyse and interpret the results of field tests, • Ability to make the final report on field investigations.
Content	• Lectures: 1. Trial pits and borehole drilling[2] 2. Determining the level of groundwater[2] 3. Penetration tests: standard penetration test, static penetration test, light penetration probe[2] 4. Pressuremeter tests: Menard pressuremeter, self-drilled pressuremeter, dilatometer[2] 5. Geophysical investigation: refraction, reflection, cross-hole, down-hole[2] 6. Geophysical investigation: Spectral analysis of surface waves, Multi-channel analysis of surface waves[2], 7. The program of geotechnical structures monitoring[2] 8. Measurement and monitoring of soil and rock deformation: the geodetic measurements[2] 9. Vertical and horizontal inclinometer[2] 10. Sliding deformeter and micrometer, inclinometer[2] 11. Measuring of the cracks[2]

	12. Measurement and monitoring of stress in rock and soil by using pressure cells[2] 13. Methods for testing the integrity and capacity of the piles[2] 14. Interpretation of the results of measurements and observations[2] 15. Numerical back-analysis based on the measurement results[2]. • Exercises 1. Determining the level of groundwater [field][2] 2. Penetration test: static penetration test [auditory][2] 3. Penetration test: static penetration test [field][2] 4. Pressuremeter test: dilatometer[auditory][2] 5. Pressuremeter test: dilatometer[field][2] 6. Refraction and Spectral analysis of surface waves [auditory][2] 7. Refraction and Spectral analysis of surface waves [field][2] 8. Vertical and horizontal inclinometer [auditory][2] 9. Vertical and horizontal inclinometer [field][2] 10. Sliding deformeter and micrometer, inclinometer [auditory][2] 11. Sliding deformeter and micrometer, inclinometer [field][2] 12. Measurement and monitoring of stress in rock and soil by using pressure cells [auditory][2] 13. Measurement and monitoring of stress in rock and soil by using pressure cells [field][2] 14. Methods for testing the integrity and capacity of the piles [auditory][2] 15. Methods for testing the integrity and capacity of the piles [field][2].
Study and examination requirements and forms of examination	Written and oral exam.
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. Meho Saša Kovačević:lectures – powerpoint presentation. Optional literature: 1. Simons, N., Menzies, B.,Matthews, M. A short course in geotechnical site investigation, Thomas Telford, London, UK, 2002, 2. Dunnicliff, J. Geotecnical Instrumentation for Monitoring Field Performance, John Wiley & Sons, New York, USA, 1993, 3. Nicholson, D., Tse, C.-M., Penny, C. The Observational Method in Ground Engineering, CIRIA. Report 185, London, UK, 1999

HYDRAULIC ENGINEERING PROGRAMME

I. SEMESTER

Module name:	**Mathematics 3**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	21802
Subtitle, if applicable	
Courses, if applicable	I class (84 students) 1 lecture, 2 auditory groups
Semester(s) in which the module is taught	I (Winter)
Person responsible for the module	Tomislav Došlić, Alan Filipin
Lecturer	Nikola Adžaga, Rafael mrđen
Language	Croatian
Relation to curriculum	Master's degree programme for all engineering programmes. Compulsory elective. Semester I.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 45 • Exercises (auditory): 30
Workload	Lecture hours 45 Hours of exercise 15 Other contact hours 30 Self study hours 135
Credit points	7,5 ECTS
Requirements according to the examination regulations	• Regular attendance in lectures and exercises, • Minimum 25 % score in the pre-exam.
Recommended prerequisites	• Understanding the calculus of one and several variables, including ordinary differential equations, and basic linear algebra.
Module objectives/intended learning outcomes	• Understanding the conditions and limits of applicability of linear models, • Ability to recognize and choose a correct model, • Ability to solve (analytically and/or numerically) simple linear models.
Content	• Lectures: 1. Ordinary differential equations [3] 2. Fourier series [3] 3. Partial differential equations and linear models of mathematical physics [20] 4. Numerical methods for solutions of ordinary and partial differential equations [16] • Exercises (auditory) follow the lectures.
Study and examination requirements and forms of examination	• Minimum 50% score in the written exam, • Students passing the pre-exam take only the second part, • Oral exam.
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. T. Došlić, D. Pokaz: Matematika 3, available on the course web-page. 2. T. Slijepčević-Manger: Zbirka zadataka iz Matematike 3, available on the course web-page. Optional literature: 1. E. Kreyszig: Advanced Engineering Mathematics, John Wiley and Sons Ltd., 1999,

	2. F. Scheid: Numerical Analysis, Schaum's Outline Series in Mathematics, McGraw-Hill

Module name:	**Stochastic Processes**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	I (Winter)
Person responsible for the module	Tomislav Došlić, Alan Filipin
Lecturer	Rafael Mrđen, Kristina Ana Škreb
Language	Croatian
Relation to curriculum	Master degree programme for all engineering programmes. Compulsore elective. Semester I.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 45 • Exercises (auditory): 30
Workload	Lecture hours 45, hours of exercise 30, other contact hours 30, self study hours 120.
Credit points	7.5 ECTS
Requirements according to the examination regulations	• Regular attendance • Minimum 25 % score in the pre-exam.
Recommended prerequisites	
Module objectives/intended learning outcomes	• Understanding conditions and limits of applicability of stochastic models, • Ability to recognize and choose correct model. • Ability to formulate and solve simple problems in terms of Markov chains and processes.
Content	• Lectures: 1. Basic characteristics and examples of stochastic processes [3], 2. Markov chains with discrete time and finite and countable set of states [27], 3. Markov processes [6], 4. Poisson processes and the theory of queues [6], • Exercises (auditory: follow the lectures.
Study and examination requirements and forms of examination	• Eliminatory written exam - minimum 50 % score, • Students who pass the pre-exam take only the second part, • Oral exam.
Media employed	Blackboard, whiteboard, projector.
Reading list	Required literature: 1. N. Berglund, Processus aleatoires et applications, available as Croatian translation on the course web-page and originally at ArXiv.org. Optional literature: 1. R. Durrett: Essentials of Stochastic Processes, Springer Texts in Statistics, Springer, New York, 1999, 2. D. P. Bertsekas, J. N. Tsitsiklis: Introduction to Probability, On line lecture notes, M.I.T., 2000.

Module name:	**Research methods**
Module level, if applicable	Master's Degree Programme
Code, if applicable	21822
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	I (Winter)
Person responsible for the module	Anita Cerić
Lecturer	
Language	Croatian
Relation to curriculum	Master's degree programme. Compulsory for all subject areas at Graduation studies. Semestar I.
Type of teaching, contact hours	• Lectures: 15 • Seminars: Students are obliged to write a seminar paper on an assigned topic.
Workload	Lecture hours 15 Other contact hours 10 Self study hours 20
Credit points	1.5 ECTS
Requirements according to the examination regulations	Writing a seminar paper or a positively graded test.
Recommended prerequisites	
Module objectives/intended learning outcomes	• Collecting literature from different sources, • Defining the hypothesis, • Choosing an appropriate research method and methodology, • Using different techniques in data collection, • Writing essays, papers and reviews, • Presenting and discussing research findings.
Content	• Lectures: 1. Collecting literature and information 1 (2) 2. Role of hypothesis and general structure of the thesis 1 (1) 3. Writing papers, critiques and essays 2 (2) 4. Data collection 1 (1) 5. Research methodology 2 (1) 6. Research methods 3 (2) 7. Reporting the results 1 (2) 8. Citing references 2 (3) 9. Bibliography 1 (2) 10. Presentation skills 1 (1)
Study and examination requirements and forms of examination	• Written paper, • Written exam
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. Zelenika, R. Metodologija i tehnologija izrade znanstvenog i stručnog djela, Rijeka: Ekonomski fakultet Sveučilиša u Rijeci, 1999 (in Croatian) 2. Cerić, A., Textbook for Civil Engineering Students, 2012, (in Croatian) Optional literature: 1. Fellows, R. And Liu, A., Research Methods for Construction, Oxford: The Blackwell Science, 1997 2. 2.Naoum, S.G., Dissertation Research and Writing for Construction Students, Oxford: ButterworthHeinemann, 2007

Module name:	**Hydraulics 1**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	93214
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	I (Winter)
Person responsible for the module	Goran Gjetvaj
Lecturer	Goran Lončar
Language	Croatian
Relation to curriculum	Master's degree programme. Hydraulic Engineering. Compulsory. Semestar I.
Type of teaching, contact hours	Number of hours (in semester): • Lectures:45 • Exercises (auditory, design, laboratory):30
Workload	Lecture hours 45 Hours of laboratories 30 Other contact hours 10 Self study hours 140
Credit points	7,5 ECTS
Requirements according to the examination regulations	• Attendance in lectures and laboratory exercises, • Making programs.
Recommended prerequisites	• Understanding the elements of fluid mechanics.
Module objectives/intended learning outcomes	• Ability to understand the basics of unsteady fluid flows and understanding the influence of fluid flow on civil engineering constructions and vice versa.
Content	• Lectures: 1. The energy principle of fluid flow, models in hydraulic engineering, non - uniform flow in open channels [3] 2. Unsteady flow in open channels [3] 3. Propagation of a discontinuous surge front[3] 4. Dam failure, short objects (spillway, orifices, stilling basins)[3] 5. Steady flow in pipe networks[3] 6. Non-steady flow with gradual changes – oscillatory motion[3] 7. Non-steady flow with sudden changes – water hammer[3] 8. Pumps and turbines[3] 9. Hydraulics of groundwater[3] 10. Continuum approach[3] 11. Wells (steady and un-steady flow[3] 12. Parameter identification in pumping tests[3] 13. Regional models, groundwater flow in the karstic aquifers[3] 14. Regional pollutant transport models in aquifers[3] 15. Transport in sea, wind impact on structures[3]. • Exercises (auditory, design, laboratory): 1. Non uniform flow in open channel[2] 2. Unsteady flow in open channel[2] 3. Overflow over a weir (laboratory)[2] 4. Discharge thru the orifice (laboratory)[2] 5. Hydraulic jump (laboratory)[2] 6. Hydraulic losses (laboratory)[2] 7. Water distribution system[2], 8. Surge tank[2] 9. Water hammer[2], 10. Groundwater flow [2]

	11. Groundwater flow under the dam[2] 12. Wells (laboratory)[2] 13. Flow and transport processes in the subsurface[2] 14. Erosion processes (laboratory)[2] 15. Drag force (laboratory)[2].
Study and examination requirements and forms of examination	• Oral and written exam.
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. Gjetvaj: Hydraulics - mimeographed lecture notes, 2. Gjetvaj etal.Praktikum- mimeographed lecture notes. Optional literature: 1. W. Kinzelbach; Groundwater modeling, Elsevir; Ven te Chow; OpenChannel Hydraulics, McGraw-Hill Book Company 1986

Module name:	**Hydrology 2**
Module level, if applicable	Master's degree programme
Code, if applicable	21762
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	I (Winter)
Person responsible for the module	Damir Bekić
Lecturer	
Language	Croatian, English
Relation to curriculum	Master's degree programme. Hydraulic Engineering. Compulsory. Semestar I.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises (auditory, design, laboratory):30
Workload	- Lecture: 30 - Practice 30 Other contact hours 30 Self study hours 90
Credit points	6 ECTS
Requirements according to the examination regulations	• Regular attendance in lectures and exercises, • 2 pre-exams: in each pre-exam minimum 10 points should be earned, • Developing 1 design assignment, • At the end of semester: one makeup pre-exam for meeting the requirements for the teacher's signature.
Recommended prerequisites	• Basic knowledge in hydrology, which include water and water motion in the nature, atmospheric processes, hydrometry, processing of hydrometric data, the application of probability and statistics in hydrology, • Knowledge and understanding of the physical properties of substances (phases of matter, density, specific volume and quantity of the substance).
Module objectives/intended learning outcomes	• Understanding the concepts of: hydrological processes on land and enumerate them, analysis of precipitation data, runoff processes in the catchment area - the methods for determining the direct runoff, and mathematical modeling in hydrology, • Applying the acquired theoretical knowledge of hydrology in civil engineering, in the design of structure ability with the objective to solve simple problems and hydrological tasks, • Explaining concepts and applying the basic analysis of meteorological data, hydrological analysis and elaboration of hydrological data, • Students will have knowledge about the meaning and role of water in development of society, the role of the hydraulic structures in the management of water resources, about the division, the purpose and definition of hydrological background and analysis when designing water management structures.
Content	• Lectures: 1. Analysis of data on rainfall, spatial and temporal variability in rainfall intensity. Determination of representative precipitation data. Preparation of IDF curve (intensity, duration, frequency). [2] 2. Hydrological processes on land, interception and evapotranspiration, seepage into the ground and surface water flow. [2] 3. Groundwater, soil moisture, saturated and non-saturated zone, field capacity soil, moisture wilting. [2] 4. Groundwater level measurement. Identification and types of aquifer. Permeability and transmissivity of the aquifer. Darcy's law of filtration. [2]

	5. Groundwater and surface water connection. Base and direct runoff, separation and display of base and direct runoff hydrograph. [2] 6. Methods of determining the direct runoff, unit hydrograph method, synthetic unit hydrograph, instantaneous unit hydrograph. Isochrones, isochrones method. [2] 7. Concentration time of direct runoff from catchment and lead time of hydrograph depending on the rainfall duration. S - hydrograph. The formation of T-hour unit hydrograph. [2] (Pre-exam 1) 8. Srebrenović and Gavrilović method of direct runoff. [2] 9. The formation of the forecast hydrograph with different probabilities of occurrence by using the unit hydrograph. [2] 10. SCS method, SCS unit hydrograph, reduction of the hydrograph of storm rainfalls with shorter duration of concentration time. [2] 11. The retention and retardation characteristics of the basin. The method of linear reservoirs. [2] 12. Hydrological modelling, theoretical, conceptual and systematic models. [2] 13. Application of GIS technology in hydrology. [2] (Pre-exam 2) • Exercises (auditory and design):Exercises accompany lectures 1. Revision of basic concepts: runoff components, the physical characteristics of a basin (auditory) [2] 2. Hydrological and cartographic basis (auditory and design) [2] 3. Modeling in hydrology (auditory and design) [2] 4. Modeling in HEC-HMS (auditory and design) [2] 5. The elements of the model basin in the HEC-HMS (auditory and design) [2] 6. Model of precipitation losses and base flow model (auditory and design) [2] 7. Determination of topographic characteristics, time of concentration and lead time. Division into sub-basins (auditory and design) [2] 8. Model of direct runoff from the catchment area (auditory) [2] 9. Model of direct runoff from the surface (design) [2] 10. Model of transformation of water wave in the stream (auditory and design) [2] 11. IDF curves, design rainfall (auditory) [2] 12. Modeling of rain in HEC-HMS, design rainfall (design) [2] 13. Simulation of runoff in the HEC-HMS (auditory) [2] 14. Simulation of runoff in the HEC-HMS (design) [2] 15. Analysis of the HEC-HMS outputs(auditory and design) [2]
Study and examination requirements and forms of examination	• Written exam: minimum 20 points score. • Oral exam.
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. Husno Hrelja: Inženjerska hidrologija, Univerzitet u Sarajevu – Građevinski fakultet, Sarajevo, 2007, 2. Ranko Žugaj: Hidrologija, Sveučilište u Zagrebu – Rudarsko-geološko-naftni fakultet, Zagreb, 2000, 3. Stevan Prohaska.: Hidrologija I & II deo, Rudarsko geološki fakultet, Beograd, 2003, 4. Dionis Srebrenović: Primijenjena hidrologija, Tehnička knjiga, Zagreb, 1986, 5. Eugen Čavlek: Osnove hidrologije, Geodetski fakultet, Zagreb, 1992,

	6. Ognjen Bonacci: Oborine, glavna ulazna veličina u hidrološki ciklus, Split, 1994 Optional literature: 1. Ven Te Chow: Handbook of Applied Hydrology, McGrow-Hill book Company, New York,1964, 2. Wilson E.M.: Engineering Hydrology, Fourth Edition, Macmillan Press, London, 1990, 3. ViessmanW.Jr. & Lewis. L.G.: Introduction to Hydrology, Harper-Collins-College-Publishers, New York, 1996

Module name:	**River Training**
Module level, if applicable	Master's degree Programmes
Code, if applicable	21763
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	I (Winter)
Person responsible for the module	Neven Kuspilić
Lecturer	Gordon Gilja
Language	Croatian
Relation to curriculum	Master's degree programme. Hydraulic Engineering. Compulsory. Semestar I.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 45 • Exercises (auditory): 30
Workload	Lecture hours 45 Exercises hours 30 Other contact hours 5 Self study hours 145
Credit points	7,5 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, • Developing an individual project assignment, • Minimum 25% score in each pre-exam.
Recommended prerequisites	• Knowledge of linear algebra, differential and integral calculus (including ordinary differential equations), • Knowledge of basic fluid dynamics (momentum equation, general equations for description of the fluid in motion (Saint-Venant and Navier-Stokes equations), the law of conservation of energy, Bernoulli equation for viscous fluid, resistance to flow, determination of local and friction energy losses, pressure and energy grade, measurement of flow velocity, pressure and discharge), • Knowledge of descriptive and differential geometry, drawing in 2D plane, finding line intersections, placement of circles given by their tangent lines, • Computer literacy: drawing with CAD based software.
Module objectives/intended learning outcomes	• Definition of basic laws in riverine environment and their representation through use of mathematical tools, • Understanding dynamics in natural watercourse, • Modeling free surface flow with 1D models and interpretation of results, • Application of engineering approaches to river training, • Placing of horizontal alignment in space and design of river training structures in plane and crosssection, • Estimating the cost-benefit for particular variant solutions with regard to selected river training works type.
Content	• Lectures: 1. Purpose, problems and training tasks, training role in water management [3] 2. Morphology of a riverbed [3] 3. Hydrologic properties of natural watercourses; water, sediment and ice regime [3] 4. Hydraulic calculation methods for natural and artificial watercourses[2] 5. Basic equations for open channel watercourses[3] 6. Sediment transport equations[3] 7. Riverbed stabilityanalyses [3] 8. Training structures at watercourse bed [3]

	9. River training structures on overbanks [3] 10. Revetments[3] 11. Other river training structures [3] 12. Water regime training [3] 13. Training works in the catchment area and water regime altering structures [3] 14. Flood protection, technical defense of an levee[3] 15. Hydraulic structures[3]. • Exercises (auditory): 1. Placing horizontal alignment and regulation lines [4] 2. Hydraulic calculations of mean water flow – manually[4] 3. Hydraulic calculations of high water flow – manually[4] 4. Hydraulic calculations - HEC-RAS [4] 5. Selection and placement of river training works [4] 6. Selection and elaboration of river training structures[4] 7. Stability design of river training structures[4] 8. Graphical design of river training structures [2].
Study and examination requirements and forms of examination	• Written exam: minimum of 50% score, • Oral exam.
Media employed	Whiteboard, projector.
Reading list	Required literature: 4. M. Gjurović: Regulacijerijeka, Optional literature: 6. Ž. Vuković: Osnovehidrotehnike, 7. E. Svetličić: Otvorenivodotoci– regulacije.

II. SEMESTER

Module name:	**Water Supply and Sewerage 1**
Module level, if applicable	Master's Degree Programme
Code, if applicable	93219
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	II (Summer)
Person responsible for the module	Živko Vuković
Lecturer	Ivan Halkijević, Marin Kuspilić
Language	Croatian
Relation to curriculum	Master's degree programme. Hydraulic Engineering. Compulsory elective. Semester II.
Type of teaching, contact hours	Number of hours (in semester): • Lectures:30 • Exercises (auditory):15
Workload	Lecture hours 30 Exercise hours 15 Consultation hours 30 Self study hours 45
Credit points	4 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, • Two pre-exams.
Recommended prerequisites	Familiarity with specific literature, prior knowledge, skills or participation in preparatory modules: No
Module objectives/intended learning outcomes	• Planning, design, construction and operation of water supply and sewerage systems facilities: water intakes, pumping station, water conditioning plants, water tanks, water supply networks, sewerage networks, sewerage facilities, waste water treatment plants, outlets, house water supply and sewerage networks.
Content	• Lectures: 1. Water supply – introduction [2] 2. Water supply systems [2] 3. Water consumption [2] 4. Springs[2] 5. Water intakes [2] 6. Pumping stations [2] 7. Water conditioning [2] 8. Water tanks [2] 9. Water supply networks [2] 10. Home water supply networks 11. Sewerage systems [2] 12. Design waste water quantities [2] 13. Sewerage networks [2] 14. Sewerage facilities [2] 15. Waste water treatment, outlets, house sewerage [2]. • Exercises (auditory): 1. Numerical examples of water consumption [2] 2. Water intakes [2] 3. Pumping stations [2] 4. Water conditioning [1] 5. Water tanks [1]

	6. Water supply networks [2] 7. Design waste water quantities [1] 8. Sewerage networks [2] 9. Waste water treatment [2].
Study and examination requirements and forms of examination	• Written and oral exam.
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. Vuković, Ž.: Water Supply and Sewerage 1, Manuscript, 2014, Zagreb (in Croatian). Optional literature: 1. Ratnayaka, D. D., Brandt, M. J., Johnson, K. M.: Tworts Water Supply, 6th Edition, Elsevier, 2009, 2. Trifunović, N.: Introduction to Urban Water Distribution, Taylor & Francis Group, London, 2008, 3. Margeta, J.: Vodoopskrba naselja: planiranje, projektiranje, upravljanje, obrada vode, AG fakultet, Split, 2010

Module name:	**Water Protection**
Module level, if applicable	Master's Degree Programme
Code, if applicable	21724
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	II (Summer)
Person responsible for the module	Dražen Vouk
Lecturer	Marin Kuspilić
Language	Croatian
Relation to curriculum	Master's degree programme., Hydraulic Engineering. Compulsory elective. Semester II.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises (auditory): 15
Workload	Lecture hours 30 Hours of laboratories or skills 15 Other contact hours 10 Self study hours 65
Credit points	4 ECTS
Requirements according to the examination regulations	• Regular attendance in lectures and exercises, • 100% exercise attendance , • 75% lecture attendance.
Recommended prerequisites	• General secondary school knowledge, • Basics of mathematical modeling.
Module objectives/intended learning outcomes	• Acquiring basic knowledge about natural and wastewater properties, anthropogenic impacts on water quality, legal measures on water protection, water quality modeling and wastewater treatment.
Content	• Lectures: 1. Basic ecological principles: biotic and abiotic factors, biotopes, biocenosis, ecosystems. Water properties: structure, physical, chemical, biological [2] 2. Water quality: physical, chemical and biological indicators. Changes in water quality: pollution sources, wastewater types, water autopurification [2] 3. Water quality models: empirical models, numerical models, QUALL, WASP [2] 4. Aquatic systems degradation: eutrophication, chronic and acute pollution [2] 5. Water quality management: political and sociological issues, legal measures, physical planning, financial and economic measures, scientific and technological measures, institutional measures, water protection plans and programs [2] 6. Wastewater treatment: general principles, mechanical treatment, physico-chemical treatment [2] 7. Wastewater treatment: biological - conventional treatment with active sludge [2] 8. Wastewater treatment: biological – extended aeration, SBR [2] 9. Wastewater treatment: biological – nitrogen and phosphorus removal [2] 10. Wastewater treatment: sludge treatment[2] 11. Wastewater treatment: sludge treatment [2] 12. Wastewater treatment: alternative wastewater treatment [2] 13. Mixing models in lakes and seas: (VISUAL PLUMES, CORMIX) [2] 14. Best Management Practices in runoff treatment [2] 15. Non point pollution control: phenomenon, sources, control technics [2].

	• Exercises (auditory, design, laboratory): 1. Waste water analyses: physical, chemical, biological [2] 2. Streeter-Phelps oxygen sag curve calculation [2] 3. River water quality modeling (QUAL, WASP) [2] 4. River water quality modeling (QUAL, WASP) [2] 5. River water quality modeling (QUAL, WASP) [2] 6. Dynamics of wastewater generation and inflow [2] 7. Mechanical treatment dimensioning [2] 8. Kinetics equations of biological treatment [2] 9. Conventional biological treatment dimensioning [2] 10. Attached microorganisms systems dimensioning [2] 11. Primary and secondary settling dimensioning [2] 12. Facilities for sludge treatment dimensioning [2] 13. Alternative WWTP dimensioning [2] 14. Long sea outfalls dimensioning [2] 15. Mathematical modelling of pollution transport and dilution (VISUAL PLUMES, CORMIX) [2].
Study and examination requirements and forms of examination	• 2 pre-exams, each maximum 100 points,• 1 make up pre-exam the students who earned less than 25% score in one or both pre-exams.
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. Power point presentations of lectures, 2. Tedeschi, S.: Zaštitavoda, a textbook printed by the Zagreb University, 1997, Optional literature: 1. Metcalf & Eddy: Wastewater Engineering, Treatment, Disposal and Reuse, McGraw-Hill International Editions, 2003

Module name:	**Ports and Waterways**
Module level, if applicable	Master's Degree Program
Code, if applicable	93217
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	II (Summer)
Person responsible for the module	Dalibor Carević
Lecturer	
Language	Croatian, English
Relation to curriculum	Master's degree program. Hydraulic engineering.Compulsory, Semester II.
Type of teaching, contact hours	Number of hours (in semester): • Lectures:45 • Exercises (auditory, design):20 • Seminars:25
Workload	- Lecture: 41 hours - Seminars: 40 hours - Hours of laboratories or skills 10 hours - Hours on the Faculty of Science – Geophysics 3 hours - Hours on the Faculty of Mechanical Engineering and Naval Architecture 3 hours - Exam: 1 ECTS 30 hours - Consultations 10 hour - Self study hours 133 hour Total 270 hours
Credit points	9 ECTS
Requirements according to the examination regulations	• 5 pre-exams, • 5 seminar papers, • Written and/or oral examination depending on credits obtained in pre-exams.
Recommended prerequisites	• Prior knowledge in hydraulics, river training, design of concrete structures and foundations.
Module objectives/intended learning outcomes	• Ability to apply the knowledge in structural and geotechnical science to ports and waterways design, • Knowledge in basics of wave mechanics and statistics, • Ability to predict long-term surface gravity waves, • Ability to assess wave forces on coastal structures, • Understanding the basic aspects in design of ports, defence structures, seawalls, rubble mound structures, • Understanding the basic aspects in construction technology of maritime structures.
Content	• Lectures: 1. Introduction [3] 2. Basics of wave mechanics[3] 3. Sea waves[3] 4. Wave theories[3] 5. Wave transformations[3] 6. Long-term wave predictions: spectral description, statistical description[3] 7. Wave generation, short-term predictions[3] 8. Wave forces: Morison equation, diffraction theory, forces on seawalls[3] 9. Construction technology: concrete in sea, subsea works[3] 10. Technology of rubble mound breakwaters[3] 11. Technology of vertical concrete breakwaters[3]

	12. Ports:ships andmanoeuvres in ports, the terms of port and landing stage[3] 13. Transportation functions of port, goods traffic, port types, port layouts, port facilities[3] 14. Inland navigable ways: types and classification[3] 15. Locks and activities on inland water ways[3]. • Exercises (auditory, design): 1. PR 1 – small amplitude wave parameters in deep water, PR2 –small amplitude wave parameters in transitional area, PR3 – wave energy[3] 2. PR4 –diffraction,[2] 3. PR 5 – wave refraction plan [2] 4. PR6 – single diffraction, PE7 – double diffraction [2] 5. PR 8 – height elevations of quay, PR 9 – pressure on a vertical wall, PR 10 – reflection on an inclined slope [3] 6. PR 11 – wave forecasts. [2] 7. PR 12 – general cargo, PR 13 – bulk cargo [2] 8. PR 14 – passengers, PR 15 – containers [2] 9. Internal and external port construction [2]. • Seminars: 1. Presentation of waves by Airy theory[5] 2. Transformations of waves by numerical model (MIKE 21-BW)[5] 3. Long-term wave predictions[5] 4. Wave forces on piles and seawalls[5] 5. Stability of seawalls[5].
Study and examination requirements and forms of examination	• The final grade is based on the seminar pre-exam scores.
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. Pršić, M.,Plovni putevi i luke, web-mimeographed lecture notes, University of Zagreb Faculty of Civil Engineering, 2014 Optional literature: 1. CEM - Coastal Engineering Manual, US Army, Waterways Experimental Station, 2003, 2. EAU - Empfehlungen des Arbeit aus schusses Ufereinfassungen, Ernst und Sohn, 1996, 3. Technical standards and Commentaries for Port and Harbour Facilities in Japan, The Overseas Coastal Area Development Institute of Japan, 2002

Module name:	**Drainage and Irrigation 1**
Module level, if applicable	Master's degree programme
Code, if applicable	93218
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	II (Summer)
Person responsible for the module	Duška Kunštek
Lecturer	
Language	Croatian, English
Relation to curriculum	Master's degree programme. Hydraulic Engineering. Compulsory. Semestar II.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 45 • Exercises: 30 (auditory - 15, design - 15)
Workload	- Lecture: 45 hours - Practice: 30 hours - Exam: 1 ECTS – 30 hours - Other contacts: 50 hours - Self-study: 85 hours
Credit points	8 ECTS (5+2+1); 240 hours
Requirements according to the examination regulations	• Getting familiar with professional literature, off-prints (authorized lecture), participation in field practice, • 75% attendance in lectures, 100% attendance in practical tasks, • 2 pre-exams, minimum 25% score in each, • 100% score in program design.
Recommended prerequisites	• Basics of Hydrology and Hydraulic, • Knowledge of specialised computer software.
Module objectives/intended learning outcomes	• Practical knowledge about surface and ground drainage and irrigation, the significance and purpose of hydro engineering ameliorations, environmental sustainability and environmental characteristics of amelioration, measures and design of hydraulic elements, • Skills for conducting operational tasks, • Ability to implement integrated knowledge and skills with methodological competencies to carry out research and design of facilities and systems for drainage (surface and ground drainage) and irrigation.
Content	• Lectures: 1. Introduction [1] 2. The significance and purpose of hydro engineering ameliorations[2] 3. Preconditions and basic indicators of the construction level of hydro amelioration facilities and systems in Croatia[2] 4. Basic documents for elaboration of plans and project documentation for hydro amelioration facilities and systems[2] 5. Hydro amelioration facilities and systems for surface drainage[2] 6. Influence of environmental characteristics of amelioration domain on the interspaces and other specifications of amelioration canals of IVth and IIIrd order[2] 7. Determination of the appropriate hydro modulus of surface drainage[2] 8. Dimensioning of amelioration canals - hydraulic and geometric elements[2] 9. General map of the canal network and road network with relevant facilities[2] 10. Facilities on amelioration canals:- tube culverts and plate culverts, - stone and concrete cascades,- plugs and automatic plugs, -inverted

	siphons and dams, - protection of canal bottoms and slopes against erosion, - pumping stations[2] 11. Basic technical and financial indicators for the construction and maintenance of amelioration canals - systems of surface drainage[2] 12. Hydro amelioration systems for ground drainage - purpose and preconditions for their construction and functioning[2] 13. Basics of amelioration petrology - basic documents for ground drainage systems[1] 14. Determination of the distance of drainage pipes and their basic elements[1] 15. Determination of the hydromodulus of ground drainage[1] 16. General map of the ground drainage system[1] 17. The influence of precipitation and other characteristics of the amelioration area on relevant elements of the ground drainage system[1] 18. The facilities and the filtering material in ground drainage systems[1] 19. Hydro amelioration facilities and irrigation systems - purpose and preconditions for their construction[1] 20. Facilities for water intake and sedimentation tanks used in irrigation of agricultural areas[1] 21. Determination of standards and the irrigation hydro modulus[1] 22. Facilities of irrigation systems; selection of the method and type of irrigation[1] 23. Fish-ponds - preconditions and facilities for construction[1] 24. Hydro engineering ameliorations in the Law on water resources and the Law on water management financing[2] 25. Field practice - two days[2] 26. Practice: Route design for a drainage canal and location determination for facilities[1] 27. Hydrological calculation of runoff; Hydraulic calculation of flow[2] 28. Selection and elaboration of the canal construction and construction of facilities[2] 29. Deesign and calculation of facilities; Elaboration of textual and graphical sections[2]. • Exercises: 1. Route design for a drainage canal and location determination for facilities[6] 2. Hydrological calculation of runoff[6] 3. Hydraulic calculation of flow[6] 4. Selection and elaboration of the canal construction and construction of facilities [6] 5. Design and calculation of facilities; Elaboration of textual and graphical sections [6]. • (Seminars:) 1. 2 program designs.
Study and examination requirements and forms of examination	• Written exam (if student did not achieve a minimum 25% score in each pre-exam), • Oral exam(minimum 25% score in each pre-exam).
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. Kos, Z.: Hidrotehničke melioracije tla – odvodnjavanje, Školska knjiga, Zagreb, 1989 2. Hidrotehničke melioracije tla – navodnjavanje, Školska knjiga, Zagreb, 1987

	3. Group of authors,Priručnik za hidrotehničke melioracije, I. Kolo, selected paragraphs 4. Volume 2, Podloge za hidrotehničke melioracije, 1984 (Tomić, F.) 5. Volume 2, Osnovna mreža površinskog odvodnjavanja, 1985, projektiranje (Kos, Z.) 6. Volume 4, Detaljna mreža podzemnog odvodnjavanja, 1987, – Projektiranje (Kos, Z.) 7. Volume 5, Građenje sustava površinske i podzemne odvodnje, 1989, (Marušić, J.) 8. Volume 6, Održavanje sustava površinske i podzemne odvodnje, 1991, (Marušić, J.); Društvo za odvodnjavanje i navodnjavanje Hrvatske, Zagreb. 9. Group of authors,Priručnik za hidrotehničke melioracije – navodnjavanje, II. Kolo, selected paragraphs 10. Volume 3, Metode natapanja, 1994, (Kos, Z.); b) Knjiga 4, Sustavi, građevine i oprema za natapanje, 1995, (Kos, Z.) 11. Volume 5, Planiranje, projektiranje i organizacija natapnih sustava, 1996, (Kos, Z.); Građevinski fakultet Rijeka i Hrvatsko društvo za odvodnju i navodnjavanje (HDON), Zagreb 12. Group of authors,Priručnik za hidrotehničke melioracije, III. kolo 13. Volume 1, Suvremeni pristup i metode planiranja i upravljanja hidromelioracijskim sustavima, Rijeka, 2003, (Ožanić, N.) 14. Knjiga 2, Elementi planiranja sustava za navodnjavanje, Rijeka, 2005 (Ožanić, N.); Građevinski fakultet Sveučilišta u Rijeci, HHD i HDON. Vidaček, Ž.: Gospodarenje melioracijskim sustavima odvodnje i natapanja; Agronomski fakultet Sveučilišta u Zagrebu i HDON, Zagreb, 1998.

Module name:	**Structures**
Module level, if applicable	Master's Degree Programme
Code, if applicable	21801
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	II (Summer)
Person responsible for the module	Jelena Bleiziffer, Dalibor Carević, Neven Kuspilić
Lecturer	Nicola Rossi
Language	Croatian
Relation to curriculum	Master's degree programme, Hydraulic Engineering Programme and Geotechnical Engineering Programme. Compulsory. Semestar II.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises: 30 (auditory – 15, design – 15)
Workload	Lecture hours 30 Exercise hours 30 Self study hours 85 Hours of skills 30 Other contact hours 5
Credit points	6 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, • Finishing all individual exercise calculation tasks, • 2 pre-exams (minimum 25% score in each).
Recommended prerequisites	• Knowledge and understanding of materials and resistance of materials, understanding of basic geotechnical, hydro technical, concrete, steel, masonry and timber structures, base knowledge of various static system analysis.
Module objectives/intended learning outcomes	• Understanding the basic principles and problems of constructing structures, • Gaining the basic knowledge and skills in observation and analysis of the effects on the structures, • Gaining the basic knowledge and skills in calculating structural elements, • Understanding the design principles and skills to apply them to certain structural elements.
Content	• Lectures: 1. Introduction – the main principles of bearing structures [4] 2. Structure elements, models and structure modeling [2] 3. Basics of design and calculation [2] 4. Actions on structures and structure calculus [2] 5. Concrete structures [2] 6. Pre-stressed concrete structures [2] 7. Steel structures [2] 8. Foundations [2] 9. Sustaining walls [2] 10. Building structures [2] 11. Bridge structures [2] 12. Water towers [2] 13. Floating structures [2] 14. Field examples [2] • Auditory exercises: Calculation and sizing of 6 different structures: 1. Ship lock [2]

	2. Inspection chamber [2] 3. Retaining wall [2] 4. Quay [2] 5. Diaphragm [2] 6. Pile [2] • Construction exercises: 1. Ship lock [2] 2. Inspection chamber [2] 3. Retaining wall [2] 4. Quay [2] 5. Diaphragm [2] 6. Pile [2]
Study and examination requirements and forms of examination	• Attendance in lectures and exercise, • Timely completion of exercise tasks.
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. Tomičić, I.: Concrete structures, DHGK Zagreb, Zagreb, 1996, 2. Radić, J.: Concrete structures–solved examples, Zagreb, 2006, 3. Mimeographed lecture and exercise notes. Optional literature: 1. Norms EN 199i : i = 0,1,2,3,4,7,8.

Module name:	**Applied Geology**
Module level, if applicable	Master’s Degree Programmes
Code, if applicable	21717
Subtitle, if applicable	
Courses, if applicable	1. Applied Geology, 2. Hydrogeology and Engineering Geology
Semester(s) in which the module is taught	II (Summer)
Person responsible for the module	Meho-Saša Kovačević
Lecturer	
Language	Croatian, English
Relation to curriculum	Master’s degree programme. Compulsory elective. Semestar II.
Type of teaching, contact hours	Number of hours (in semester): • Lectures:30
Workload	Lecture hours 30 Other contact hours 10 Self study hours 50
Credit points	3 ECTS
Requirements according to the examination regulations	• Attendance in 75% lectures, • Minimum 25% score in the pre-exam.
Recommended prerequisites	• Kowledge of basic chemical elements and compounds.
Module objectives/intended learning outcomes	• Ability to distinguish between igneous, metamorphic and sedimentary rocks, • Ability to identify layers, faults and overthrust, • Knowledge about the process of the formation of karst and various karst formations and learning about the problems which constructors encounter during construction of tunnels in karst, • The ability to use geological maps – recognition of geological symbols, determination of the geological age of rocks, their composition and other important geological phenomena of a terrain, • Knowledge of basic engineering-geological rock mass classification.
Content	• Lectures: 1. Introduction [2] 2. General information about the geosciences, Geology general, stratigraphic; Constitution of Earth; Geoid; Mineralogy; Mineral; Crystal [2] 3. Isotropic and anisotropic minerals; pyrogenic, pneumatogenic, hydrothermal, hydatogenic; Axis, center plane of symmetry; crystal systems; properties of crystals, crystal connection; tetrahedral coordination, coordination number; Polymorphism; Isomorphism [2] 4. The properties of minerals, Mineral groups; oxides and hydroxides, carbonates, sulfates, silicates [2] 5. Introduction to Petrology; Rock phenocrysts, Monomineral; igneous rocks; types of igneous rocks, structure and texture of igneous rocks; Acidity of magma; Bowen series of crystallization; Table of igneous rocks [2] 6. Sedimentary rocks, sediment transport, mineral composition of sedimentary rocks , structures and textures of sedimentary rocks; General overview of sedimentary rocks, metamorphic rocks, metamorphic zones; types of metamorphic rocks [2] 7. Tectonics, rock exposures, outcrops, thickness of layers, anticlines and synclines, faults, over thrust, types of cracks [2] 8. Pre-exam [2]

	9. Egzodynamic processes; insolation, hydrogeology, water, the hydrologic cycle, porosity, permeability, laminar and turbulent flow; types of aquifers; Ghyben Herzberg law; Ice and Snow, Wind, organisms [2] 10. Pre-exam [2] 11. Karst; external karst formations; interior karst formations [2] 12. Types of caves, speleothems, groundwater [2] 13. Landslides; Endodynamics; orogeny, epirogensis [2] 14. Volcanoes, Earthquakes; Earthquake scales, seismicity [2] 15. Geological maps, RMR and Q classification of rocks in the construction domain; determining the age of rocks [2]
Study and examination requirements and forms of examination	Written and oral exam.
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. Herak, M., Geology, 1990 2. Šestanović, S., Basics of Geology and Petrology, 2001 Optional literature: 1. West, T.,Geology Applied to Engineering, 1994 2. Monroe, J. & Wicander, R., Physical geology, 2006 3. Plummer,C., McGeary,D. & Carlson, C., Physical Geology, 2010

Module name:	**Environmental Protection**
Module level, if applicable	Master's Degree Programme
Code, if applicable	
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	II (Summer)
Person responsible for the module	Živko Vuković
Lecturer	
Language	Croatian
Relation to curriculum	Master's degree programme. Compulsory elective. Semester II..
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30
Workload	Lecture hours 30 Consultation hours 30 Self study hours 30
Credit points	3 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, • Two pre-exams.
Recommended prerequisites	Familiarity with specific literature, prior knowledge, skills or participation in preparatory modules: No
Module objectives/intended learning outcomes	• Ability to understand and solve some practical problems in field of environmental protection.
Content	• Lectures: 1. Introduction [2] 2. Basic ecological concepts (ecology, biotop, biocenose, ecosystem, biodiversity) [2] 3. Global changes in biosphere (changes in atmosphere) [2] 4. Pedosphere and hydrosphere [2] 5. Changes through energy discharge [2] 6. Reduction of biodiversity [2] 7. Impact of civil engineering on environment (city impact, impact of landfill, transportation facilities impact,) [2] 8. Impact of civil engineering on environment (impact of hydraulic structures) [2] 9. Environmental sustainability and sustainable development [2] 10. Measures and environmental protection procedure (political and sociological approach [2] 11. Legal measures [2] 12. Environment planning [2] 13. Economic and financial measures [2] 14. Scientific approach and technological measures [2] 15. Institutional measures [2].
Study and examination requirements and forms of examination	• Oral exam.
Media employed	Whiteboard, projector.

Reading list	Required literature: 1. Vuković, Ž.: Environment Protection, Manuscript, 2014, Zagreb (in Croatian). Optional literature: 1. Raven, P. H., Berg, L. R., Hassenzahl, D. M.: Environment, 7th Edition, Wiley, 2010, 2. Miller, G. T.: Living in the Environment: Principles, Connections, and Solutions, 15th Edition,Thomson Books, 2007

III. SEMESTER

Module name:	**Water Power Development**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	104047
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	III (Winter)
Person responsible for the module	Eva Ocvirk
Lecturer	Gordon Gilja
Language	Croatian.
Relation to curriculum	Master degree programme, Hydraulic Engineering, Compulsory. Semestar III
Type of teaching, contact hours	Number of hours (in semester): • Lectures:30 • Exercises: 30 (auditory: 4, design : 26)
Workload	Lecture hours 30 Exercisies hours 30 Other contact hours 30 Self study hours 105
Credit points	6 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, • Making programs.
Recommended prerequisites	• Knowledge and understanding of basic hydrological processes, • Knowledge and understanding of basic fluid mechanics and hydraulics principles, • Knowledge and understanding of soil and rock characteristics with basic foundation principles, • Knowledge of concrete structures design.
Module objectives/intended learning outcomes	• Identifying problems related to design of hydro power plants, • Understanding principles of water power use and different types of hydropower plants, • Solving problems related to hydro energetic calculations, • Participation design and construction of hydro power plants.
Content	• Lectures: 1. Energy and water power in the nature. Basic principles of water power use. Basic hydropower plants types. Investigation works related to water power usage. Hydro energetic calculations in variable heads and flows. Size and choice of installed capacity [10] 2. Environmental impact of hydropower plants [2] 3. Low pressure hydropower plants. Medium and heigh-pressure hydropower plants. Major structure groups accompanying hydropower plants [14] 4. Mechanical and electrical equipment [4]. • Exercises: 1. Auditory – hydro energetic calculations [4] 2. Design – hydropower plant design (26)
Study and examination requirements and forms of examination	• Students with a minimum 60% score in the pre-exams are exempt from the written exam, • Oral exam.
Media employed	Whiteboard, projector.
Reading list	Required literature:

	1. Weekly lecture notes - ppt, pdf. Optional literature: 1. Stojić, P.: Hidroenergetika, Građevinski fakultet, Split, 1995, 2. Mosony, E.: Water Power Development, Vol I-II, Budapest, Akademial Kiado, 1987

Module name:	**Water Supply and Sewerage 2**
Module level, if applicable	Master's Degree Programme
Code, if applicable	104053
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	III (Winter)
Person responsible for the module	Živko Vuković, Ivan Halkijević
Lecturer	
Language	Croatian
Relation to curriculum	Master's degree programme. Hydraulic Engineering. Compulsory, Semester III.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises (auditory, design, laboratory): 30 • Seminars: 2
Workload	Lecture hours 30 Hours of laboratories or skills 30 Other contact hours 15 Self study hours 105
Credit points	6 ECTS
Requirements according to the examination regulations	• Attendance in lectures (80 %) and exercises (100 %), • Each student is required to do a 1 seminar paper – theoretical considerations related to the certain objects/facilities or planning, design, operation and maintenance of the water supply and sewer systems, • Each student is required to finish 2 practical assignments – 1 preliminary design project of water supply system, 1 preliminary design project of gravity sewer system, • Each student is required to fulfill the minimum requirements in 2 regular written pre-exams – 1 regular written pre-exam is related to water supply systems (theory and design), 1 regular written pre-exam is related to sewer systems (theory and design). The minimum requirement 25% score, • Students who didn't meetl the minimum requirements in 2 regular written pre-exams are required to fulfill the minimum requirements in a make up pre-exam that is related to the whole course content – water supply and sewer systems (theory and design). The minimum requirement 25% score.
Recommended prerequisites	• Fundamental knowledge about the functionality, design, construction, operation and maintenance of water supply and sewer systems.
Module objectives/intended learning outcomes	• Knowledge about the exact content of project documentation (design projects) for water supply and sewer systems, • Knowledge about defining the relevant input parameters in the design of water supply and sewer systems, • Ability to conduct hydraulic analysis (calculations) in the design of water supply systems by applying modern software tools, • Ability to shape and size the objects in water supply systems (water intake, valve chambers, regulation chamber, measurement chambers, pumping stations, water tanks, etc.), • Ability to conduct hydraulic analysis (calculations)in the design of gravity sewer systems by applying modern software tools, • Ability to shape and size objects in the gravity sewer system (canals, manholes, combined sewer overflows, retention basins, pumping stations, etc.), • Ability to apply the methodology for reduction of water losses in water supply systems,

	• Knowledge about the functionality, design, construction, operation and maintenance of alternative wastewater collection systems, • Knowledge about the functionality, design, construction, operation and maintenance of road runoff collection and disposal systems, • Knowledge about planning, construction, operation and maintenance of water supply and sewer system.
Content	• Lectures: 1. Introduction, preliminary exam, project documentation of water supply systems [2] 2. Water demand and consumption – international trends, Croatian practice, the definition of relevant water demands and patterns [2] 3. Facilities and equipment of water supply systems – pipes, water tanks, pumping stations, valve chambers, valves, fittings, control units, measurement units, etc.[6] 4. Hydrant network for fire fighting – internal and external [2] 5. Water losses – basics, water audit, IWA methodology, zoning the system –DMA zones, the methodology of water losses analysis [2] 6. Project documentation of sewer systems – defining the relevant quantity of wastewater (sanitary and industrial wastewater, rainwater runoff, combined wastewater) [2] 7. Wastewater quantity analysis – international trends, Croatian practice, the definition of relevant waste water flow and patterns [2] 8. Facilities and equipment of sewer systems – canals (pipes), manholes, combined sewer overflows, retention basins, pumping stations, etc.[4] 9. Alternative wastewater collection systems – pressure sewer system, vacuum sewer system, small diameter gravity system [2] 10. Road runoff collection, transport and disposal systems [2] 11. Planning, construction, operation and maintenance of water supply and sewer systems [2] 12. Trenchless technologies in construction and renovation of pipe network in water supply and sewer systems [2] • Exercises (auditory, design, laboratory): 1. Water demand and consumption analysis with the definition of relevant flow regarding the dimensioning of water supply systems [1-auditory, 1–design], 2. Hydraulic analysis of water supply systems – manual calculations and the application of EPANET software tool [2 - auditory, 4 – design], 3. Shaping and dimensioning of water supply facilities – water tanks, pumping stations, valve chambers, etc. [2 - auditory, 1- design], 4. Dimensioning of hydrant network for fire fighting – internal and external [2– design], 5. Water loss analysis – creating the DMA zones, application of IWA methodology, economic analysis [1-auditory, 1-design], 6. Wastewater quantity analysis with the definition of relevant flow regarding the dimensioning sewer systems [1 - auditory, 1–design], 7. Hydraulic analysis of gravity sewer systems – manual calculations and the application of EPASWMM software tool [2 - auditory, 4–design], 8. Shaping and dimensioning of facilities and equipment of gravity sewer systems –manholes, combined sewer overflows, retention basins, pumping stations, etc.[2 - auditory, 1–design], 9. Hydraulic analysis of alternative wastewater collection systems [2–auditory], 10. Hydraulic analysis, shaping, and dimensioning of road runoff collection, transport and disposal systems [2–auditory]. Seminars:

	• 1 seminar paper for each student – theoretical considerations related to the certain objects/facilities or planning, design, operation and maintenance of the water supply and sewer systems, • 2 practical assignments for each student – 1 preliminary design project of water supply system, 1 preliminary design project of gravity sewer system.
Study and examination requirements and forms of examination	• Results in the final written exam(minimum 60% score), • Oral exam.
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. Lecture notes published on the web page of the course Water Supply and Sewerage 1, 2. Lecture notes published on the web page of the course Water Supply and Sewerage2, 3. Margeta, Jure,Vodoopskrba naselja: planiranje, projektiranje, upravljanje, obrada vode,Sveuciliste u Splitu, Gradjevinsko-arhitektonski fakultet, Split, 2010, 4. Margeta, Jure,Kanalizacija naselja: odvodnja i zbrinjavanje otpadnih i oborinskih voda,Sveuciliste u Splitu, Gradjevinsko-arhitektonski fakultet, Split, 2009 Optional literature: 1. Steel, E. W., McGhee, T. J.: Water Supply and Sewerage, Mc Graw Hill Book Company, London, 1991

Module name:	**Urban Hydrology**
Module level, if applicable	Master's degree programme
Code, if applicable	104056
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	III (Winter)
Person responsible for the module	Damir Bekić
Lecturer	Kristina Potočki
Language	Croatian, English
Relation to curriculum	Master's degree programme. Hydraulic Engineering. Elective. Semester III.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises (auditory, design, laboratory):30
Workload	- Lecture: 30 - Practice: 30 Other contact hours 30 Self study hours 90
Credit points	6 ECTS
Requirements according to the examination regulations	• Regular attendance in lectures and exercises, • 2 pre-exams: in each pre-exam minimum 10 point score, • 1 design assignment, • at the end of semester one make up pre-exam for meeting the requirements for the signature.
Recommended prerequisites	• Basic knowledge of the subjects Hydrology and Hydrology 2, which include water and water motion in the nature and in the atmosphere, hydrometry, processing hydrometric data, the application of probability and statistics in hydrology and parametric methods for determining the process, • Basic knowledge about the subject Hydrology 2, which include knowledge and understanding of: hydrological processes, analysis of precipitation data, runoff processes in the catchment area – the methods for determining the direct runoff, and mathematical modelling in hydrology.
Module objectives/intended learning outcomes	• Defining and explaining: hydrological processes in urban catchments, methods of processing data on precipitation and methods for runoff in urban catchments, • Developing IDF-curve and design rainfall on the basis of data on precipitation and associated project hydrograph, • Identifying and selecting the appropriate method for design rainfall and runoff hydrograph, • Applying the acquired theoretical knowledge of urban hydrology in the construction industry, in the design of buildings, ability to solve simple problems and tasks of urban hydrology.
Content	• Lectures: 1. The impact of urbanization on the hydrological processes, differences in urban and natural catchments. Hydrological processes in urban basins [2] 2. Precipitation, interception, infiltration, water retention in depressions, surface flow and retention in the collection gutters, chutes and channels [2] 3. Hydrologic and hydraulic characteristics of the urban system, the characteristics of the elements of rain and mixed sewage, open storm water drainage systems [2] 4. Flat and pitched roofs, paved areas, parks and unpaved surfaces, gutters and gutters, drains and manholes, culverts under roads and other facilities, sewage network, overflow, retention and expansion pools, retractable bottom and outlet structures [2]

	5. Calculation of runoff from heavy rains, the empirical formula and rational method, runoff concentration time and the time lag of maximum runoff of rain shorter than that the concentration time [2] 6. Effective rainfall and runoff coefficient, correlation rainfall - runoff, runoff from melting snow [2] 7. Making and meaning of IDF-curve rain in urban areas, formation of rainfall data sets relevant data to create ITP-curve [2] 8. Methods of determining the runoff hydrograph, unit hydrograph urban catchment [2] 9. Los Angeles hydrograph, Chicago hydrograph, SCS method (Soil Conservation Service Method), other methods [2] 10. Determination of relevant rainfall for urban drainage system, flooding in urban areas, the economic aspects of determining project rain [2] 11. Determination of the project based on the modelling of runoff hydrograph and the implementation of the economic analysis of the cost of drainage systems and urban flood damage caused by rains of high intensity [2] 12. Specifics of the hydrology of roads, highways and airports [2] 13. Modern principles of urban drainage and water quality in urban catchments [2] 14. Collection and use of rainwater, engaging in underground [2] 15. Management of urban drainage system based on the application of mathematical modelling of runoff [2]. • Exercises (auditory and design): 1. The formation of relevant rainfall data sets to calculate the IDF-curve (auditory) [2] 2. The formation of relevant rainfall data sets to calculate the IDF-curve (design) [2] 3. Calculation of the IDF-curve (auditory) [2] 4. Calculation of the IDF-curve (design) [2] 5. Application of unit and in stantaneousunith ydrograph for urban areas (auditory) [2] 6. Application of unit and instant aneousunit hydrograph for urban areas (design) [2] 7. Application of Los Angeles hydrograph (auditory) [2] 8. Application of Los Angeles hydrograph (design) [2] 9. Application of Chicago hydrograph (auditory) [2] 10. Application of Chicago hydrograph (design) [2] 11. Application of HEC-HMS modelling for runoff calculation in urban areas (auditory) [2] 12. Application of HEC-HMS modelling for runoff calculation in urban areas (design) [2] 13. Determination of the relevant rainfall and design hydrograph based on the run off modeling and the implementation of the economic analysis of the cost of drainage systems and urban flood damage caused by rains of high intensity (auditory) [2] 14. Determination of the relevant rainfall and design hydrograph based on the run off modeling and the implementation of the economic analysis of the cost of drainage systems and urban flood damage caused by rains of high intensity (design) [2] 15. Presentation of student program [2].
Study and examination requirements and forms of examination	• Minimum 20 point score in written exam, • Oral exam.
Media employed	Whiteboard, projector.

Reading list	Required literature: 1. Akan A. O., Houghtalen R. J.: Urban Hydrology, Hydraulics, and Stormwater Quality – Engineering Application and Computer Modeling, John Wiley & Sons Ltd. 2003, 2. Maksimović Č., Tejada-Guibert J. A.: Frontiers in Urban Water Management, IWA Publishing, London, 2001, 3. Ven Te Chow: Handbook of Applied Hydrology, McGrow-Hill book Company, New York,1964, 4. Urbana hidrologija - Okrugli stol, Split 25-26 travnja 2002, zbornik radova, Hrvatsko hidrološko društvo i Hrvatske vode, 5. Ognjen Bonacci: Oborine, glavna ulazna veličina u hidrološki ciklus, Split, 1994

Module name:	**Potable and Waste Water Treatment**
Module level, if applicable	Master’s Degree Program
Code, if applicable	104058
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	III (Winter)
Person responsible for the module	Dražen Vouk
Lecturer	
Language	Croatian
Relation to curriculum	Master’s degree programme. Hydraulic Engineering. Elective. Semester III.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises (auditory, design, laboratory): 30
Workload	Lecture hours 30 Hours of laboratories or skills 30 Other contact hours 15 Self study hours 105
Credit points	6 ECTS
Requirements according to the examination regulations	• 100% exercise attendance, • 75% lecture attendance.
Recommended prerequisites	• Basic knowledge about processes in the water bodies, wastewater generation and composition, physical and biological treatment.
Module objectives/intended learning outcomes	• Knowledge about technical and technological aspects of water purification and waste water treatment and procedures in the treatment facilities dimensioning.
Content	• Lectures: 1. Hydraulic and pollution load calculation, determination of data for plant design [2] 2. Purpose and legal aspects of water treatment [2] 3. Mechanical treatment [2] 4. Biological treatment, suspended microbial cultures [6] 5. Biological treatment, attached microbial cultures [2] 6. Biological nutrient removal [2] 7. MBR treatment [2] 8. Lagoons and constructed wetlands [2] 9. Fundamentals of water purification [2] 10. Coagulation, flocculation [2] 11. Clarification and filtration [2] 12. Colors, metals and chemicals removal [2] 13. SCADA, pilot plants, operation and maintenance [2]. • Auditory exercises: 1. Input data analyses by ATV rules [2] 2. Mechanical treatment design [2] 3. Biological reactors’ design [2] 4. Oxygen requirements calculation, and aeration equipment selection [2] 5. Dimensioning and selection of pumping facilities for water and sludge transportation [2] 6. Technological calculation of CAS systems [2] 7. Technological calculations of activate sludge systems [2] 8. Technological calculations of attached microbial cultures systems [2] 9. Biological phosphorus and nitrogen removal calculation and dimensioning [2]

	10. Sludge treatment techniques calculation and dimensioning [2] 11. Sludge dewatering, drying, thermal treatment, and disposal [2] 12. WWTP water and sludge line, layout and vertical arrangement [2] 13. Dimensioning potable water purification processing units [2] 14. Dimensioning potable water purification processing units [2] 15. Pilot plant design [2].
Study and examination requirements and forms of examination	• 2 pre-exams, maximum 100 points, • 1 make up pre-exam the students who earned less than 25% points in one or both pre-exams.
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. Lecture notes power point presentations, 2. Gulić, I.: Water purification, Text book printed by Zagreb University,2003, 3. Metcalf & Eddy: Wastewater Engineering, Treatment, Disposal, Reuse, McGraw-Hill International Editions, 2003

Module name:	**Modeling in Hydraulic Engineering**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	104060
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	III (Winter)
Person responsible for the module	Goran Lončar
Lecturer	
Language	Croatian, English,
Relation to curriculum	Master's degree programme. Hydraulic Engineering. Elective. Semestar III.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises (auditory, design): 30
Workload	Lecture hours 30 Hours of laboratories or skills 30 Exercise oral 10 Seminar work10 Self study hours 100
Credit points	6 ECTS
Requirements according to the examination regulations	• Attendance in75%lectures and 100% exercises.
Recommended prerequisites	• Knowledge about differential and integral calculus (including ordinary differential equations) and linear algebra, • Knowledge about and understanding the particle mechanics(speed, acceleration, Newton's laws, the change of momentum, energy, force, work, power), • Understanding the concepts of initial and boundary conditions, • Knowledge about basic rheology principles, knowledge about the laws of thermodynamics.
Module objectives/intended learning outcomes	• Understanding the concept of "model", • Recognizing the advantages and disadvantages of numerical modeling approach, • Recognizing the consequences of adopted assumptions and imperfections, • Identifying an appropriate description of boundary and initial conditions, • Identifying the appropriate dimensionality of the problem and possible simplification, • Understanding the principles of numerical discretization of partial differential equations, • Ability to apply the results of numerical models to the calculations of pressure and forcesactingon the structure, • Recognising the abilities of modern "free of charge" and "commercial" models.
Content	• Lectures: 1. Description of flow and transport in continuous liquid environment [2] 2. Basic equations of flow and heat transfer (3D mass conservation equation, 3D momentum equations, 3D energy conservation equation)[2] 3. Navier-Stokes equation for Newtonian fluids (conservative form)[2] 4. Differential and integral form of general transport equation[2] 5. Classification according to physical characteristic[2]

	6. Turbulence models (Reynolds averaged Navier-Stokes equations for incompressible fluids, turbulent flow calculation, „mixing length“ and „k-ε“ turbulence models)[2] 7. 2D and 3D open channel flow models with heat exchange component[2] 8. Description of flow and transport in porous environment (groundwater flow)[2] 9. Basic process equations (mass conservation equation, transport components, generalisation of Fick’s law, transport equations, initial and boundary equations)[2] 10. Reactive process (linear decay, mass exchange between liquid-solid phases)[2] 11. Flow and transport model for environment with inter granular porosity[2] 12. Modeling the aquatic eco-system (population dynamics, Michaelis-Menten kinetics)[2] 13. Modeling the aquatic eco-system (eco system with two, three and four state variables, link to convective-dispersion transport)[2] 14. Modeling the wave generation (problem formulation and basic generative process involved)[2] 15. Modeling the non-linear wave interaction (spectral dissipation in deep water region, dissipation due to white capping, non-linear interactions in shallow water region, bottom induced dissipation[2]. • Exercises: (auditory, design, laboratory): 1. Implementation of 2D numerical model for stationary and non-steady open channel flow (model spatial domain, initial and boundary conditions)[2] 2. Implementation of 2D numerical model for stationary and non-steady open channel flow (spatial and temporal discretisation, advantages and disadvantages of various methods)[2] 3. Implementation of 2D numerical model for stationary and non-steady open channel flow (calculation procedure, stability condition, sensitivity analysis)[2] 4. Implementation of 2D numerical model for stationary and non-steady open channel flow (preprocessing and post-processing, handling the input and output files)[2] 5. Implementation of 3D numerical model for stationary and non-steady open channel flow (model spatial domain, initial and boundary conditions)[2] 6. Implementation of 3D numerical model for stationary and non-steady open channel flow (spatial and temporal discretisation, advantages and disadvantages of the various methods)[2] 7. Implementation of 3D numerical model for stationary and non-steady open channel flow (calculation procedure, stability condition, sensitivity analysis)[2] 8. Implementation of 3D numerical model for stationary and non-steady open channel flow (preprocessing and post-processing, handling the input and output files)[2] 9. Implementation of numerical 2D groundwater flow and transport models (model spatial domain, initial and boundary conditions[2] 10. Implementation of numerical 2D groundwater flow and transport models (spatial and temporal discretisation, advantages and disadvantages of the various methods)[2] 11. Implementation of numerical 2D groundwater flow and transport models (calculation procedure, stability condition, sensitivity analysis)[2] 12. Implementation of numerical 2D groundwater flow and transport model (pretprocessing and post-processing, handling the input and output files)[2]

	13. Implementation of Eco-system numerical model (system of governing equations and process variables, initial and boundary condition, stability condition, sensitivity analysis)[2] 14. Implementation of wave generation and deformation numerical model (model spatial domain, initial and boundary conditions)[2] 15. Implementation of wave generation and deformation numerical model (pre-processing and post-processing, handling the input and output files) [2].
Study and examination requirements and forms of examination	• Oral exam.
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. Novak, P.: Hydraulic modelling - an introduction: principles, methods and applications, Spoon Press, London, 2010, 2. Wang, H.F., Anderson, N.P.: Introduction to groundwater modeling, Academic Press, USA, 1985, 3. Versteeg, H.K., Malalasekera, W.: An introduction to computational fluid dynamics, Pearson Educaton Limited, UK, 2007 Optional literature: 1. Abbott, M., Basco, D.: Computational fluid dynamics, Wiley & Sons, New York, USA, 1989, 2. Barnsley, M.J.: Environmental modeling, CRC Press, New York, USA, 2007

Module name:	**Drainage and Irrigation 2**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	104064
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	III (Winter)
Person responsible for the module	Duška Kunštek
Lecturer	
Language	Croatian, English
Relation to curriculum	Master's degree programme. Hydraulic Engineering. Elective. Semestar III.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises: 30 (auditory - 14, design - 14, presentations - 2) • Seminars: 1
Workload	(Evaluated)workload distributed into direct teaching and study in hours. (1ECTS je 30 hours) -Lectures: 3,5 ECTS credits, 105 hours - Practice: 1,5 ECTS credita, 45 hours (seminar paper, colloquium) - Exam: 1 ECTS credit, 30 hours - Other contacts: 100 hours - Study: 200 hours - Field practice: 30 hours - Information on examples from practice: 60 hours - Students get 6 authorized off prints.
Credit points	6 ECTS
Requirements according to the examination regulations	• Getting acquainted with hydroengineering and agro engineering literature, including amelioration and ameliorative pedology, off prints and copies of proceedings' publications, • Participation in field practice.
Recommended prerequisites	• Basic of Hydraulics and Hydrology, • Knowledge of Drainage and Irrigation 1, • Knowledge of specialist software programs, • Knowledge of English language.
Module objectives/intended learning outcomes	• Practical skills in maintenance and use of amelioration systems, • Integrated knowledge in hydro engineering ameliorations 1 and 2: ability to participate in the process of designing, constructing, maintaining and using hydro amelioration systems and facilities (surface and subsurface) drainage, and particularly irrigation of agricultural and other soils
Content	• Lectures: 1. Introduction, relation "plant-soil-water" in hydro engineering ameliorations [2] 2. Basics of ameliorative pedology: soil formation, soil classification, mechanical and physical properties of soil, water in soil, amelioration problems of hydromorphic soils, pedologic investigation[2] 3. The impact of field characteristics of amelioration areas on design and working elements of hydroamelioration facilities and systems for surface and subsurface drainage and irrigation[2] 4. Technical requirements and standards in the maintenance of amelioration system of surface drainage [2] 5. Elements in planning amelioration systems for irrigation [2] 6. Quality of irrigation water [2] 7. Hydraulic dimensioning of pipes for irrigation systems [2]

	8. Establishment and maintenance of water regime of agricultural soils: requirements of optimal development of plant cultures[2] 9. The importance of the maintenance of hydroamelioration facilities and systems for optimal soil water regime and their impact on stable crops of plant cultures[2] 10. Machines and equipment: surface, subsurface drainage and irrigation[2] 11. Technology and costs of construction of hydroamelioration systems[2] 12. Hydroamelioration systems and multipurpose water management facilites. 13. Application of multi criterion analysis in planning hydro systems [2] 14. Control of operation of amelioration systems and technical-financial indicators of construction [2] 15. Hydro engineering amelioration in Water law and Law on financing water management [2]. • Exercises (auditory, design): 1. Analysis of terrain and climatic data for amelioration areas [4] 2. Planning, study and design solutions for construction of facilities and systems for drainage and irrigation of agricultural soils 4) 3. Methods for determining the potential evapotranspiration [4] 4. Calculus of necessary irrigation water for relevant crops by using software CROPWAT [4], 5. Selecting the manner and type of irrigation [6] 6. Organization and construction management of facilities and systems for drainage and irrigation of agricultural soils[6] 7. Organization and maintenance of facilities and systems for drainage of surface and subsurface waters, particularly of the agricultural soils irrigation systems[2]. • Seminars: 1. Students are required to prepare one seminar papershowing practical skills in maintenance and use of amelioration systems.
Study and examination requirements and forms of examination	• Written exam (if student did not succeed earn minimum 25% score in each pre-exam), • Oral exam (the requirement for taking the exam is minimum 25% score in each pre-exam).
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. Group of authors, Priručnici za hidrotehničke melioracije, I. kolo: knjiga 5 i 6, 1989-1991, 2. Group of authors, Priručnici za hidrotehničke melioracije, II. kolo, knjiga 5, 1996, knjiga 7, 1999., odabrana poglavlja, Hrvatsko društvo za odvodnju I navodnjavanje Zagreb, Građevinski fakultet, Rijeka. Optional literature: 1. Vidaček, Ž.: Gospodarenje melioracijskim sustavima odvodnje i natapanja, selected paragraphs, Agronomski fakultet Zagreb i Hrvatsko društvo za odvodnju i navodnjavanje, Zagreb, 1998, 2. Priručnik za hidrotehničke melioracije, II. kolo, knjiga 4, 1995. i knjiga 6, 1997, Hrvatsko društvo za odvodnju i navodnjavanje, Zagreb i Građevinski fakultet Rijeka. 3. Authorised lecture notes and a CD with papers from lifelong learning courses in the field of ameliorations, hydrology, hydro pedology, environment protection and water management.

Module name:	**Flood protection**
Module level, if applicable	Master’s degree Programmes
Code, if applicable	104066
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	III (Winter)
Person responsible for the module	Neven Kuspilić
Lecturer	Gordon Gilja
Language	Croatian
Relation to curriculum	Master’s degree programme. Hydraulic Engineering. Elective. Semestar III.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises (auditory): 30 • Seminars: 1
Workload	Lecture hours 30 Exercises hours 30 Other contact hours 5 Self study hours 115
Credit points	6 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, • Developing individual project assignment, • Minimum 25% score in each pre-exam.
Recommended prerequisites	• Knowledge of linear algebra, differential and integral calculus (including ordinary differential equations), • Knowledge of basic fluid dynamics (momentum equation, general equations for description of the fluid in motion (Saint-Venant and Navier-Stokes equations), the law of conservation of energy, Bernoulli equation for viscous fluid, resistance to flow, determination of local and friction energy losses, pressure and energy grade, measurement of flow velocity, pressure and discharge), • Knowledge of descriptive and differential geometry, drawing in 3D space, finding line intersections with digital elevation model, • Computer literacy: drawing with CAD based software, advanced operations on vectorized background images, • Knowledge of HEC-RAS software.
Module objectives/intended learning outcomes	• Defining flood hazard maps on digital elevation model and estimate material damage and size of potentially endangered population, • Analysis of flood defense system elements, • Design of flood defense structures and their interaction, • Estimate of erosional capacity of flow around submerged structures on watercourses, • Distinguishing the applicability of different approaches in empirical estimates of erosional capacity of flow, • Estimating the extents of flow change influence for constructions in riverine environment.
Content	• Lectures: 1. Introduction, water management longitudinal watercourse profile, watercourses as elements of water management system [2] 2. Estimation of flood risk [2] 3. Development of flood hazard maps [4] 4. Estimate proportions of flood damage and development of flood risk maps [4]

	5. Analysis of floods protection system elements, flood relief channels and lateral channels, frontal and lateral retentions and retention areas in accumulations system [6] 6. Water management facilities, dams, overflows, stoppers investigations. Approaches to protection embankment optimal dimensions specification, their construction and maintenance [2] 7. Investigations on small watercourse regulation with immobile wetted perimeter, approach to riverbed dimensioning by means of permitted flow velocity [2] 8. Approach to optimal dimensions specification of riverbed by using permitted tractive force procedure [2] 9. Scientific approach to riverbed protection modes from fluvial erosion and to the calculation of technical and construction elements [2] 10. Riverbed regime concept, stable bed dimensions in alluvium [2] 11. Approach for calculation of local scour extent [2]. • Exercises (auditory, design): 1. Developing HEC-RAS model geometric data[6] 2. Development of flood hazard maps [8] 3. Local scour model - HEC-RAS [4] 4. Design of detention basin and lateral inlet structure [8] 5. Calculation of seepage through levee and design of drainage system [4]. • Seminars: 1. Calculation of local scour around structures and design of countermeasures
Study and examination requirements and forms of examination	• Written exam: minimum 50 % score, • Oral exam.
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. Chang H. H: Fluvial processes in River Engineering, Krieger publishing company,1998, 2. Jansen, P. Ph. et al: Principles of River Engineering – The non – tidal alluvial river, Pitman Publishing Limited, London, 1979 Optional literature: 1. Water Resources Project Planning, UN Office of Tehnical Cooperation: Water Resources Series No. 41, NY, 1972, 2. Hemphil, R. &Bramley, M. E.: Protection of river and canal banks, CIRIA and Butterworths, London, UK, 1989

Module name:	**Hydraulics 2**
Module level, if applicable	Master's Degree Programme
Code, if applicable	104067
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	III (Winter)
Person responsible for the module	Goran Gjetvaj
Lecturer	
Language	Croatian
Relation to curriculum	Master's degree programme. Hydraulic Engineering. Elective, Semester III.
Type of teaching, contact hours	Number of hours (in semester): • Lectures:30 • Exercises (auditory, design):30
Workload	Lecture hours 30 Hours of laboratories or skills 30 Other contact hours 15 Self study hours 105
Credit points	6 ECTS
Requirements according to the examination regulations	• Attendance in lectures (75%) and exercises (100%), • Pre-exam, • Making their own experiment.
Recommended prerequisites	Knowledge of hydraulics.
Module objectives/intended learning outcomes	• Learning how to organize an experiment and how to understand the operation of a fluid-containing system, • Ability to measure some of the parameters of a flowing fluid. This knowledge can be applied to design improved systems and to predict their future operation
Content	• Lectures: 1. Physical models, methods of investigating fluid flow, short history of hydraulic modeling, basics of physical modeling and similarity criterion, examples of physical modeling, advantages and disadvantages of physical models [2] 2. Hidraulic laboratory - organization and measurement methods[2] 3. Characteristic dimensionless parameters, models with distortion, measurement effect, laboratory effect [2] 4. On fulfilling Reynolds's and other conditions of hydrodynamic similarity [2] 5. Analysis of model concepts [2] 6. Measuring technique- measuring of water level, measurement of velocity and discharge[2] 7. pressure and force measuring, measuring of other parameters (temperature, substance concentration,...)[2] 8. Measuring methods and instrumentations, measurementplanning, optimization of an experiment[2] 9. Measurements in nature: organization and measure methods, measuring the level and flow, measuring sediments [2] 10. Collecting and processing measured data- measuring setting, sensors, signals elaboration[2] 11. Graphic representation and interpretation of results, measurement failure[2] 12. Multiplexors, AD convertors[2] 13. Data presentation and processing, remote data transmission [2]

	14. Presentation of conducted modeling [2] 15. Pre-exam [2]. • Exercises (auditory, design): 1. Introduction about model execution, selection of the problem to be modeled, measuring technique at disposal [2] 2. Selecting the model concept, selection of measuring technique, selection of the scale of the model, locating the model in the laboratory, development of hydraulic scheme and experiment outline [2] 3. Material collection and analysis of measuring equipment and its relevance to the model [2] 4. Verification of the model concept [2] 5. Model development, installation of measuring technique and its calibration [4] 6. Trial operation of the model and identifying defects [2] 7. Elimination of defects on the model [2] 8. Carrying out measurements [4] 9. Measurement data processing [2] 10. Additional measurements (repetition of failed measurements – developing necessary modifications [2] 11. Processing and analysis of new measurements – conclusions and guidelines for the next model [2] 12. Presentation of the developed model and the obtained results [2] 13. Submission of the final report and conservation of the model [2].
Study and examination requirements and forms of examination	• Presentation of the experiment, • Oral exam.
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. Gjetvaj:Lecture notes,Kobus,H.: Hydraulic modeling, Verlag Paul Parey, Hamburg, 1980 Optional literature: 1. Novak P.,Čabelka.J, Models in Hydraulic Engineering, Pitman,1981 2. Tavoularis S., Measurement in Fluid Mechanics, CambridgeuniversityPress, 2005

Module name:	**Earthfill and Rretaining Structures**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	133593
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	III (Winter)
Person responsible for the module	Tomislav Ivšić
Lecturer	Lovorka Librić
Language	Croatian
Relation to curriculum	Master's degree programme.Geotechnical Engineering; Compulsory; III semester
Type of teaching, contact hours	Number of hours (in semester): • Lectures:30 • Exercises: 30
Workload	Lecture hours 30 Design and numerical exercises hours 30 Midterm written examination hours 2 Final written and oral examination hours 3 Self study hours 115
Credit points	6 ECTS
Requirements according to the examination regulations	• 75% attendance in lectures, • Submission of the program.
Recommended prerequisites	• Knowledge of basic physical and mechanical properties of the soil (strength, stiffness), • Understanding of groundwater seepage in the soil, knowledge of the concepts of flow, critical hydraulic gradient, the permeability coefficient, • Knowledge of soil classification and selection of parameters depending on the type of soil, • Knowledge of the basic principles of numerical modeling.
Module objectives/intended learning outcomes	• Selection of design situations related to different types of earth dams (embankments), • Conduction of seepage and stability analysis for different types of earth dams(embankments), • Understanding the basic problems related to the stability of earth dams and understanding of remedial works for earth structures, • Understanding earth pressures on retaining structures and understanding of procedures for their determination, • Determination of all the actions on the retainingstructure including earth pressures, its own weight, earthquake and other actions, • Ability to calculate stability of earth and retaining structures.
Content	• Lectures: 1. Types of earth structures (dams and flood protection embankments, road embankments, landfills)[2] 2. Selection of earth materials, field and laboratory investigation works, methods of construction[2] 3. Theory of soil compaction, properties of compacted material[2] 4. Geotechnical calculations of earth structures 1 (seepage, limit equilibrium methods, FEM analyzes using simple soil models)[2] 5. Geotechnical calculations of earth structures 2 (seismic stability, selection of parameters)[2] 6. Selection of embankments, zoned embankments, solution variations, presentation of major dams[2]

	7. Monitoring of earth structures, instabilities, damage and destruction of the dam, the impact of construction on stability and deformation[2] 8. The application and types of retaining structures[2] 9. Basis of earth pressure calculation 1 (concepts of earth pressure, strength parameters)[2] 10. Basis of earth pressure calculation 2 (Rankine states, Coulomb method and accuracy)[2] 11. Basis of earth pressure calculation 3 (additional load on the surface, seismic load)[2] 12. Retaining walls, reinforced earth structures[2] 13. Embedded retaining walls, anchored retaining structures, geotechnical anchors calculation[2] 14. Analysis of embedded retaining walls (design and theoretical requirements)[2] 15. Analysis of embedded retaining walls (calculatio00n procedures)[2]. • Exercises: 1. Examples of geotechnical calculation of embankment - seepage (auditory)[2] 2. Examples of geotechnical calculation of embankment - slope stability (auditory)[2] 3. Geotechnical calculations of flood protection embankment (computer work)[6] 4. Geotechnical calculations and preparation of report (computer work)[2] 5. Geotechnical calculations and preparation of report, submission of report (computer work)[2] 6. Examples of geotechnical calculations of retaining structures - soil pressures (auditory)[2] 7. Examples of geotechnical calculations of retaining structures - a retaining wall (auditory)[2] 8. Examples of geotechnical calculations of retaining structures - Embedded retaining walls (auditory)[2] 9. Working on task - solving retaining structure example (construction)[8] 10. Submission of the program[2].
Study and examination requirements and forms of examination	Written and oral exam.
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. Tomislav Ivšić , Lectures, powerpoint presentation - available on the web, 2. Nonveiller, E. (1981): Mehanika tla i temeljenje građevina, 2nd edition, Školska knjiga, Zagreb 3. Nonveiller, E.: Nasute brane - projektiranje i građenje, Školska knjiga, Zagreb, 1983, 359 pp. Optional literature: 1. Nonveiller, E.: Klizenje i stabilizacija kosina, Školska knjiga, Zagreb, 1987, 204 pp. 2. Embankment Dam Engineering - Casagrande Volume, Eds. R.C. Hirschfeld and S.J. Poulos, John Wiley & Sons, New York, 1973, 454 pp. 3. US Dept. of Interior, Bureau of Reclamation: Design of small dams, 3rd ed, 1987 4. Dembicki,E.: Tlak, otpor i nosivost tla, Sveučilišna naklada Liber, Zagreb, 1982

	5. Gaba, A.R., Simpson, B.,Powrie, W., Beadman, D.R: Embedded retaining walls-guidance for economic design, Report CIRIA C580, London, 2003

Module name:	**Hydrogeology and Engineering Geology**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	104007
Subtitle, if applicable	
Courses, if applicable	1. Applied Geology, 2. Hydrogeology and Engineering Geology
Semester(s) in which the module is taught	III (Winter)
Person responsible for the module	
Lecturer	Meho-Saša Kovačević
Language	Croatian, English
Relation to curriculum	Master's degree programme. Geotechnical Engineering. Compulsory. Semester III.
Type of teaching, contact hours	Number of hours (in semester): • Lectures:30
Workload	Lecture hours 30 Other contact hours 10 Self study hours 50
Credit points	3 ECTS
Requirements according to the examination regulations	• Attendance in 75% of lectures, • Minimum 25% score in the pre-exam.
Recommended prerequisites	• Knowledge of basic geological terms.
Module objectives/intended learning outcomes	• Understanding the impact of groundwater regime on construction works in the karst, • Introduction to methods of determining water-protected areas, • Understandingthe impact of geological structures on bearing capacity under foundations and on the stability of slopes in rock mass, • Understandingthe impact of geological structures on the stability of underground openings in rock mass, • Ability to determine the geological parameters necessary for rock mass classifications.
Content	• Lectures: 1. Introduction, hydrogeology [2] 2. The role of hydrogeology in civil engineering [2] 3. Classification of groundwater [2] 4. Groundwater regime[2] 5. Research methods [2] 6. Water in Karst [2] 7. Karst [2] 8. Pre-exam [2] 9. Determination of protection zones, interpretation of hydrogeological investigations [2] 10. Pre-exam (make up) [2] 11. Engineering geology and its role in civil engineering [2] 12. Engineering geology and its role in civil engineering [2] 13. Engineering geology and its role in civil engineering, landslides [2] 14. EG classification of rocks [2] 15. Investigation methods for determination of rock properties needed for the civil engineering [2].
Study and examination requirements and forms of examination	Written and oral exam.
Media employed	Whiteboard, projector.
Reading list	Required literature:

	1. Herak, M., Geologija, 1990 2. Šestanović, S., Osnove geologije i petrologije, 2001 3. West, T., Geology Applied to Engineering, 1994 4. Monroe, J. & Wicander, R. , Physical geology, 2006 5. Plummer,C., McGeary,D. & Carlson, C., Physical Geology, 2006 Optional literature: 1. Weight, W. & Sonderregger,J. , Manual of Applied Field Hydrogeology, 2004 2. Weight, W. , Hydrogeology Field Manual, 2008 3. Waltham, T., Foundations of Engineering Geology, 2002 4. Poehls, D. J. & Smith, G. J., Encyclopedic Dictionary of Hydrogeology, 2009 5. Fetter, C. W., Applied Hydrogeology, 2000 6. Rahn, P., Engineering geology: An Environmental Approach, 1996

Module name:	**Hydraulic Concrete**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	104068
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	III (Winter)
Person responsible for the module	Nina Štirmer
Lecturer	Ivan Gabrijel
Language	Croatian
Relation to curriculum	Master's degree programme. Hydraulic Engineering Programme. Electivet. Semester III.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises: 30 (auditory - 18, design - 12)
Workload	Lecture hours 30 Hours of exercises 30 Preparation of independent project 30 Other contact hours 10 Self study hours 80
Credit points	6 ECTS
Requirements according to the examination regulations	• Participation in lectures min. 75 %, • Participation in all exercises, • One program, • Two preliminary exams (min. 25 % on each).
Recommended prerequisites	• Knowledge on concrete composition and properties.
Module objectives/intended learning outcomes	• Ability to estimatethe risk of thermal cracks in mass concrete, • Ability to select appropriate components for mass concrete composition, • Ability to analyse influence of components and environment on the temperature changes in concrete, • Ability to recommend technology of execution for concrete in hydrotechnical structures, • Ability to evaluate results of testing concrete in hydrotechnical structures, • Ability to analyze and evaluate materials for repair of hydrotechnical structures.
Content	• Lectures: 1. Introduction: characteristics and application of concrete for hydrotechnical structures [2] 2. Mass concrete. Heat of hydration: thermal stresses and cracking; volume changes [2] 3. Selection of components for mass concrete and concrete mix design [2] 4. Control of cracks in mass concrete [2] 5. Transport, placement and curing of concrete: dynamics of concreting [2] 6. Concreting at extreme weather conditions [2] 7. Strength and deformations: risk of cracking [2] 8. Cooling systems for mass concrete [2] 9. Special concrete types and technologies for execution of hydrotechnical structures: rollercompacted concrete, preplaced -aggregate concrete, underwater concreting [2] 10. Concrete with improved water impermeability [2] 11. Erosion of concrete in hydraulic structures. Examples of repair [2] 12. Materials for repair of hydrotechnical structures [2] 13. Repair of concrete structures under water [2]

	14. Assessment of concrete condition in existing hydrotechnical structures [2] 15. Regulations and standards for application of concrete in hydrotechnical structures [2] • Auditory exercises: 1. Thermal stress and cracking: cracking risk calculations [2] 2. Control of concrete temperature and temperature gradient [2] 3. Recommendations for selection of aggregate type, cement and concrete additives: influence of components on concrete temperature development [2] 4. Concrete placement and curing methods [2] 5. Calculation of temperature changes in concrete - Schmidt's numerical method [2] 6. Modelling of temperature development in concrete [2] 7. Calculation of temperature flow in mass concrete and cracking risk estimation - examples [2] 8. Protection of concrete elements in hydrotechnical structures [2] 9. Testing methods for relevant concrete properties for hydrotechnical structures [2] • Design exercises: 1. Schmidt's numerical method, risk of thermal cracks in mass concrete [12]
Study and examination requirements and forms of examination	• written examination (min. 60 %), • Oral examination.
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. Štirmer, N.; Gabrijel, I.: Concrete for hydrotechnical structures, course repository, http://www.grad.unizg.hr/predmet/hidbet 2. Advanced Concrete Technology, Processes, ed. Newman, J.; Seng Choo, B., Elsevier, 2003 3. ACI 207.1R-05 Guide to Mass Concrete 4. ACI 207.2R-07 Report on Thermal and Volume Change Effects on Cracking of Mass Concrete 5. ACI 207.3R-94 Practises for Evaluation of Concrete in Existing Massive Structures for Service Conditions 6. ACI 207.4R-05 Cooling and Insulating Systems for Mass Concrete (Reapproved 2012) 7. ACI 207.5R-11 Report on Roller-Compacted Mass Concrete 8. ACI 210R-93 Erosion of Concrete in Hydraulic Structures Optional literature: 1. Prevention of Thermal Cracking in Concrete in Early Ages, RILEM Report, Ed. R. Springenschmid, E & FN Spon, 1998. 2. Monteiro, P. J. M.: Concrete – microstructure, Properties and Materials, McGraw-Hill, 2006

IV. SEMESTER

Module name:	**Water Resources Engineering**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	104069
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	IV (Summer)
Person responsible for the module	Eva Ocvirk
Lecturer	
Language	Croatian
Relation to curriculum	Master's degree programme, Hydraulic Engineering. Compulsory. Semestar III.
Type of teaching, contact hours	Number of hours (in semester): • Lectures:45 • Exercises. 15 (auditory - 3, design - 12)
Workload	Lecture hours 45 Execisies 15 Other contact hours 20 Self study hours 100
Credit points	6 ECTS
Requirements according to the examination regulations	• Attendance in classes and exercises, • Making programs.
Recommended prerequisites	• Knowledge and understanding of basic hydrological processes, • Knowledge and discerning hydraulics structures purposes • Knowledge and understanding technical characteristics of hydraulics structures.
Module objectives/intended learning outcomes	• Identifying problems related towater management, • Knowledge about legislation correlated to water resources, • Understandingthe principles of problem solving technology, • Comparing different water resource projects based on financial analysis, • Participation in water management teams.
Content	• Lectures: 1. Water and water resources[3] 2. Basic terms: system, processes, water management, water research [3] 3. Place and tasks of water management in the state economy [3] 4. Legislation [3] 5. Water development projects: goals and tasks [3] 6. Multipurpose water development projects management [3] 7. Environmental changes in connection with water development projects and hydraulic structures [3] 8. Evaluation goals, criteria and measures [3] 9. Decision making process, optimisation [3] 10. Assessment of water development project systems [3] 11. Water development project benefits and costs [3] 12. Allocation of benefits and costs in multipurpose systems [3] 13. Examples of water development projects (explanation and visit) [6] 14. Water development projects maintenance [3]. Exercises: 1. Water development project analyses [15]

Study and examination requirements and forms of examination	• Minimum 60% score in pre-exams is required to be exempt from the written exam, • Written and oral exam.
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. Weekly lecture notes - ppt, pdf. Optional literature: 1. Water Resources Systems Planning and Management, An Introduction to Methods, Models and applications, Daniel P. Loucks and Eelco van Beek, Studies and Reports in Hydrology, UNESCO PUBLISHING, 2005 2. Vodič za analizu troškova i koristi investicijskih projekata, FOIP biblioteka, 2007 3. Legislation

Module name:	**Design in Hydraulic Engineering**
Module level, if applicable	Master's Degree Program
Code, if applicable	104070
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	IV (Summer)
Person responsible for the module	
Lecturer	Dalibor Carević, Gordon Gilja, Ivan Halkijević, Duška Kunštek, Marin Kuspilić, Neven Kuspilić, Eva Ocvirk, Dražen Vouk, Živko Vuković
Language	Croatian, English
Relation to curriculum	Master's degree programme. Hydraulic engineering. Elective. Semestar IV.
Type of teaching, contact hours	Number of hours (in semester): • Exercises (design):60 • Seminars:1
Workload	- Lecture: 0 hours - Case studies: 60 hours - Consultations 30 hours - Self study hours 90 hours Total 180 hours
Credit points	6 ECTS
Requirements according to the examination regulations	• Creation of seminar (preliminary design) and its presentation.
Recommended prerequisites	• Prior knowledge in Ports and waterways, River training, Water resources engineering, Drainage and irrigation 1, Water protection, Water supply and Sewerage 1
Module objectives/intended learning outcomes	• Ability to structure civil engineering designs (hydraulic engineering), • Practical skills in collecting design supporting documents.
Content	• Exercises (design): 1. Developing a preliminary design of waterrelated structure withmentor supervision: elaboration and presentation of design basics: spatial planning, geodetic, geotechnical, hydrological, climatic, maritime, traffic, demographic [10] 2. Defining the design conditions: relevant design conditions: special planning, ecological, functional and structural [10] 3. Determining functionality: setting the function of the building concept by estimated capacity, estimated section structure and situational solution. Relevant calculi for confirming or changing the assumed concept: hydraulic, agropedological, energetical, tehnological, ecological or traffic [10] 4. Structure calculus: bearing capacity calculus (2D calculus of stability or strength) of the assumed section for one of the structures of the planned water structure [10] 5. Cost estimate, technological or functional solution, design calculations, technicaldescription, bill of quantities, drawings. A design should suit thestandards of EU legal system. (A course project can beselected and agreed on between student and mentor of anyhydraulic engineering professional subject) [10] 6. Drafts: situation, ground plan with the equipment, staking plan, longitudinal sections, typical cross-section [10].
Study and examination requirements and forms of examination	• The final grade is based on seminar and presentation scores.
Media employed	Whiteboard, projector.

Reading list	Required literature: 1. CEM - Coastal Engineering Manual, US Army, Waterways Experimental Station, 2003, 2. Linsley P.K, Franzini J.B: Water-resources Engineering; New York, McGraw Hill Book Com. 1991, 3. Steel, E. W. And Terence, J. McG.,Water Supply and Sewerage, 4. Linsley P.K, Franzini J.B,Water-resources Engineering, New York, McGraw Hill Book Com. 1991 Optional literature: 1. CEM - Coastal Engineering Manual, US Army, Waterways Experimental Station, 2003

Module name:	**Vegetative Water Facilities**
Module level, if applicable	Master's degree programme
Code, if applicable	104074
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	IV (Summer)
Person responsible for the module	Duška Kunštek
Lecturer	
Language	Croatian, English
Relation to curriculum	Master degree programme, Hydraulic Engineering, Elective. Semester IV..
Type of teaching, contact hours	Number of hours (in semester): • Lectures:30 • Exercises: 30 • Seminars:2
Workload	(Estimated) workload divided into face-to-face teaching and independent study, in hours. (1ECTS is 30 hours) Lecture: 30 Practice: 30 Other contact 30 Self study hours 90
Credit points	6 ECTS
Requirements according to the examination regulations	• Attendance in lectures and participation in practical work by discussion, • Seminar paper, • Written and/or oral examin depending on score achieved in pre-exams and seminar work.
Recommended prerequisites	• Hydrology course basic knowledge including hydrologic characteristics of natural water flows, water regime, sediment regime, ice regime. River training course basic knowledge including basic morphological characteristics of water flow, riverbed instability conditions. The interaction of riverbed geometric elements and hydraulic design of natural and artificial water flows.
Module objectives/intended learning outcomes	• Knowledge about the state of the art in specific parts of ecology, ecohydrology and environmental engineering, • Professional skills which can be applied in current ecological and ecohydrological knowledge in professional environmental and river engineering. • Ability to implement integrated ecological, ecohydrological and botanical current knowledge and skills in designing and making environmental and river engineering structures.
Content	• Lectures: 1. Theoretical and practical content of ecology, ecohydrology and biology for solving some environmental and hydro engineering tasks [2] 2. Role of vegetation in hydro and environmental engineering[2] 3. Significance of vegetative water facilities construction[2] 4. Hydraulical effect of ecological regulation of watercourses[2] 5. Water and vegetation, basic aspects of vegetation[2] 6. Water regime impact on vegetation and vice versa[2] 7. Water level duration and vegetation period on open watercourses and lakes[2] 8. Major coastal and littoral vegetation, growth and preparation, watercourse coastal and shoreline protection[2] 9. Vegetation as a constitutive part of river training structures, plant selection, site preparation, seeding, turfing, planting[2]

	10. Slope stabilisation, stabilization of soil slopes[2] 11. Soil erosion and soil conservation[2] 12. Application of reed and willows, live wicker, shrubby vegetation and soft - wood trees[2] 13. Parks and landscape architecture and artificial lakes[2] 14. Use of vegetation in river restoration[2] 15. Vegetative impact on preservation and protection of water [2]. • Exercises (consultations, discussions): 1. The impact of river vegetation on water regime: duration curve of water level. Water regime and vegetation period in open water courses and artificial lakes. Coastal vegetation frames[4] 2. Hydraulic effect of ecological regulation of water courses [4] 3. The influence of vegetation on the erosion and the stability of waterbeds [4] 4. Comparison of vegetative water facilities and massive water facility construction [4] 5. Renaturalization of regulated water courses – solution examples [4] 6. The influence of vegetative water facilities on preservation and protection of water courses – solution examples [6] 7. Presentation of students' seminar papers [4].
Study and examination requirements and forms of examination	• Students must achieve a positive grade in both pre-exams to take the oral exam.
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. Coppin, N. J., Richards, I. G.: Use of vegetation in Civil Enginerind CIRIA(Constructions Industry Research and Information Association), London, 1990, 2. Der biologische Wasserbau – an den Bundeswasserstrassen, Bundesanstalt fur Gewasserkunde Koblenc, Verlag Eugen Uliner, Stuttgart, 1965, 3. Svetličić, E.,Otvoreni vodotoci – pokosi i njihova sigurnost, JVP Hrvatska vodoprivreda Zagreb, 1979, 4. Petraš, J.,Biološke vodogradnje– authorised lectures, Građevinski fakultet Zagreb, 2000 Optional literature: 1. Flusse und Bache erhalten - entwickeln - gestalten, Wasserwirtschaft in Bayern, Oberste Baubehörde im Bayerischen Staatsministerium des Innern, Heft 21, München, 1989. 2. Flusse - Bache - Auen. Pflegen und gestalten, Wasserwirtschaft in Bayern, Oberste Baubehörde im Bayerischen Staatsministerium des Innern, Besonders Publikation, München, 1991.

Module name:	**Special Water Power Projects**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	104076
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	IV (Summer)
Person responsible for the module	Eva Ocvirk
Lecturer	
Language	Croatian
Relation to curriculum	Master degree programme, Hydraulic Engineering, optional. Semestar IV.
Type of teaching, contact hours	Number of hours (in semester): • Lectures:30 • Exercises: 30 (design)
Workload	Lecture hours 30 Exercisies hours 15 Other contact hours 30 Self study hours 105
Credit points	6 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, • Making a program.
Recommended prerequisites	• Knowledge about and understanding basic hydrological processes, • Knowledge about and understanding basic fluid mechanics, hydraulics principles and water use principles, • Knowledge about and understanding soil and rock characteristics with basic foundation principles, • Knowledge about concrete structures design.
Module objectives/intended learning outcomes	• Identifying problems related to design of small and pumped-storage hydro power plants, • Understanding principles of water power use and different (new) types of hydropower plants, • Participation in design and construction of special water power plants.
Content	• Lectures: 1. Small hydropower plants (SHP) [2] 2. Definitions, construction conditions use of SHP and fitting into the energetic system [2] 3. Water intakes, power houses, equipment, management and mainteinance, changes in the environment [2] 4. Background and investigations [2] 5. Interventions, inlets and outlets [2] 6. Power houses and equipment for production and management[2] 7. Management and maintenance [2] 8. Economic role and its profitability, changes in the environment [2] 9. Pumped-storage hydropower plants (PSHP): their role in the electric system [2] 10. Definitions, construction conditions use of PSHP and fitting into the energetic system [2] 11. Reservoirs – construction, maintenance and usage [2] 12. Interventions, inlets and outlets, hydraulic calculations [2] 13. Power houses room and equipment (turbines and pumps) [2] 14. Changes in the environment [2] 15. Other forms of water resourcces usage: the power of the level change (tide), the power of waves, mechanical energy of water (mills) and similar facilities [2].

	• Exercises: 1. Hydraulic calculations [5], 2. Design – small hydropower plant design (25).
Study and examination requirements and forms of examination	According to the results in exercises and discussions about students' project. If it is not enough, written part of exam and oral exam.
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. Weekly lecture notes - ppt, pdf Optional literature: 1. Civil Engineering Guidelines for Planning and Designing Hydroelectric Developments, New York, American Society of Civil Engineering, 1989, Vol.4 Small-scale Hydro; Vol.5 – PumpedStorage and Tidal Power. 2. Stojić P,Hidroenergetika, Split, Građevinski fakultet Sveučilišta u Splitu, 1995 3. Zgradimo majhno hidroelektrarno; Zveza organizacij za tehnično kulturu Slovenije. 1986, Del 1-5 4. Mosony E,Water Power Development, Vol I-II, Budapest, Akademiai Kiado, 1987, Third Ed.

Module name:	**Maritime Structures**
Module level, if applicable	Master's Degree Program
Code, if applicable	104093
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	IV (Summer)
Person responsible for the module	Dalibor Carević
Lecturer	
Language	Croatian, English
Relation to curriculum	Master degree program, Hydraulic engineering.Elective. Semester IV.
Type of teaching, contact hours	Number of hours (in semester): • Lectures:30 • Exercises:10 • Seminars:20
Workload	- Lecture: 30 hours - Exercise: 25 hours - Hours of laboratories or skills 20 hours - Consultations 25 hours - Self study hours 80 hours total 180 hours
Credit points	6 ECTS
Requirements according to the examination regulations	• Participation in seminar paper preparation, • Presentation of seminar papers.
Recommended prerequisites	• Prior knowledge in wave mechanics and statistics, designing of ports, subsea construction technology, strength of materials.
Module objectives/intended learning outcomes	• Knowledge in designing and construction of rubble mound and vertical breakwaters, • Knowledge in designing and setting of submarine pipelines, • Knowledge in designing of marinas (functionality and structures).
Content	• Lectures: 1. Breakwaters: types and detailed design, loads, stability calculations, functionality calculations, construction technology [4] 2. Calculus of lining (Van den Meer), design of details [4] 3. Submarine pipelines: pipe types, setting technology, loads on pipes, stability calculations, resistance calculations [4] 4. Structure calculus (stability on the seabed),design of details [4] 5. Marinas: types, layouts, defence structures, inner structures, nautical fleet, berthing methods, mooring system [4] 6. Introduction to seminars [4] 7. Locks: types, hydraulic calculus [4]. • Exercises : 1. Organising teams. Task distribution among teams. Execution of content and presentation of current know how on the topic of the seminar paper [4], 2. Individual work with teams (30), 3. Presentation of seminar papers [6]. • Seminars: 1. Designing breakwaters, stability of submarine pipelines, setting of pipelines, breakwater types (details), floating breakwaters, breakwaters hazards (disasters)

Study and examination requirements and forms of examination	• The final grade is based on seminar scores.
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. Pršić, M. Pomorskegrađevine, web-lecture notes, University of Zagreb Faculty of Civil Engineering, 2013 Optional literature: 1. CEM - Coastal Engineering Manual, US Army, Waterways Experimental Station, 2003, 2. EAU - Empfehlungen des ArbeitausschussesUfereinfassungen, Ernst und Sohn, 1996, 3. Technical standards and Commentaries for Port and Harbour Facilities in Japan, The Overseas Coastal Area Development Institute of Japan, 2002

STRUCTURAL ENGINEERING PROGRAMME

I. SEMESTER

Module name:	**Mathematics 3**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	21802
Subtitle, if applicable	
Courses, if applicable	I class (84 students) 1 lecture, 2 auditory groups
Semester(s) in which the module is taught	I (Winter)
Person responsible for the module	Tomislav Došlić, Alan Filipin
Lecturer	Nikola Adžaga, Rafael mrđen
Language	Croatian
Relation to curriculum	Master's degree programme for all engineering programmes. Compulsory elective. Semester I.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 45 • Exercises (auditory): 30
Workload	Lecture hours 45 Hours of exercise 15 Other contact hours 30 Self study hours 135
Credit points	7,5 ECTS
Requirements according to the examination regulations	• Regular attendance in lectures and exercises, • Minimum 25 % score in the pre-exam.
Recommended prerequisites	• Understanding the calculus of one and several variables, including ordinary differential equations, and basic linear algebra.
Module objectives/intended learning outcomes	• Understanding the conditions and limits of applicability of linear models, • Ability to recognize and choose a correct model, • Ability to solve (analytically and/or numerically) simple linear models.
Content	• Lectures: 1. Ordinary differential equations [3] 2. Fourier series [3] 3. Partial differential equations and linear models of mathematical physics [20] 4. Numerical methods for solutions of ordinary and partial differential equations [16] • Exercises (auditory) follow the lectures.
Study and examination requirements and forms of examination	• Minimum 50% score in the written exam, • Students passing the pre-exam take only the second part, • Oral exam.
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. T. Došlić, D. Pokaz: Matematika 3, available on the course web-page. 2. T. Slijepčević-Manger: Zbirka zadataka iz Matematike 3, available on the course web-page. Optional literature: 1. E. Kreyszig: Advanced Engineering Mathematics, John Wiley and Sons Ltd., 1999,

	2. F. Scheid: Numerical Analysis, Schaum's Outline Series in Mathematics, McGraw-Hill

Module name:	**Stochastic Processes**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	I (Winter)
Person responsible for the module	Tomislav Došlić, Alan Filipin
Lecturer	Rafael Mrđen, Kristina Ana Škreb
Language	Croatian
Relation to curriculum	Master degree programme for all engineering programmes. Compulsore elective. Semester I.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 45 • Exercises (auditory): 30
Workload	Lecture hours 45, hours of exercise 30, other contact hours 30, self study hours 120.
Credit points	7.5 ECTS
Requirements according to the examination regulations	• Regular attendance • Minimum 25 % score in the pre-exam.
Recommended prerequisites	
Module objectives/intended learning outcomes	• Understanding conditions and limits of applicability of stochastic models, • Ability to recognize and choose correct model. • Ability to formulate and solve simple problems in terms of Markov chains and processes.
Content	• Lectures: 1. Basic characteristics and examples of stochastic processes [3], 2. Markov chains with discrete time and finite and countable set of states [27], 3. Markov processes [6], 4. Poisson processes and the theory of queues [6], • Exercises (auditory: follow the lectures.
Study and examination requirements and forms of examination	• Eliminatory written exam - minimum 50 % score, • Students who pass the pre-exam take only the second part, • Oral exam.
Media employed	Blackboard, whiteboard, projector.
Reading list	Required literature: 1. N. Berglund, Processus aleatoires et applications, available as Croatian translation on the course web-page and originally at ArXiv.org. Optional literature: 1. R. Durrett: Essentials of Stochastic Processes, Springer Texts in Statistics, Springer, New York, 1999, 2. D. P. Bertsekas, J. N. Tsitsiklis: Introduction to Probability, On line lecture notes, M.I.T., 2000.

Module name:	**Research methods**
Module level, if applicable	Master's Degree Programme
Code, if applicable	21822
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	I (Winter)
Person responsible for the module	Anita Cerić
Lecturer	
Language	Croatian
Relation to curriculum	Master's degree programme. Compulsory for all subject areas at Graduation studies. Semestar I.
Type of teaching, contact hours	• Lectures: 15 • Seminars: Students are obliged to write a seminar paper on an assigned topic.
Workload	Lecture hours 15 Other contact hours 10 Self study hours 20
Credit points	1.5 ECTS
Requirements according to the examination regulations	Writing a seminar paper or a positively graded test.
Recommended prerequisites	
Module objectives/intended learning outcomes	• Collecting literature from different sources, • Defining the hypothesis, • Choosing an appropriate research method and methodology, • Using different techniques in data collection, • Writing essays, papers and reviews, • Presenting and discussing research findings.
Content	• Lectures: 1. Collecting literature and information 1 (2) 2. Role of hypothesis and general structure of the thesis 1 (1) 3. Writing papers, critiques and essays 2 (2) 4. Data collection 1 (1) 5. Research methodology 2 (1) 6. Research methods 3 (2) 7. Reporting the results 1 (2) 8. Citing references 2 (3) 9. Bibliography 1 (2) 10. Presentation skills 1 (1)
Study and examination requirements and forms of examination	• Written paper, • Written exam
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. Zelenika, R. Metodologija i tehnologija izrade znanstvenog i stručnog djela, Rijeka: Ekonomski fakultet Sveučilišta u Rijeci, 1999 (in Croatian) 2. Cerić, A., Textbook for Civil Engineering Students, 2012, (in Croatian) Optional literature: 1. Fellows, R. And Liu, A., Research Methods for Construction, Oxford: The Blackwell Science, 1997 2. 2.Naoum, S.G., Dissertation Research and Writing for Construction Students, Oxford: ButterworthHeinemann, 2007

Module name:	**Prestressed concrete**
Module level, if applicable	Master's Degree Programme
Code, if applicable	21783
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	I (Winter)
Person responsible for the module	Ana Mandić Ivanković
Lecturer	Dominik Skokandić
Language	Croatian
Relation to curriculum	Master degree programme, Structural Engineering Programme. Compulsory. Semester I. Master degree programme, Theory and Modelling of Structures Programme. Optional. Semester I.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises: 30 (auditory - 12, design – 18)
Workload	Lecture hours 30 Exercise hours 30 Self study hours 70 Hours of skills 45 Other contact hours 5
Credit points	6 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, • Conceptual design of the assigned structure, • Two pre-exams (25 % score in each is required for the signature).
Recommended prerequisites	Knowledge on reinforced concrete in terms of materials and design of basic elements
Module objectives/intended learning outcomes	• Knowledge and skills needed for designing prestressed structural elements, • Knowledge and ability to select prestressing steel and concrete depending on the condition of the use of prestressed structural element and aggressive environmental conditions in accordance with contemporary methods and criteria of European standards, • Knowledge and skills necessary to analyse the behaviour and to design the prestressed structural elements according to the ultimate limit states using contemporary methods and criteria of European standards, • Knowledge and skills necessary for verification of serviceability limit states using contemporary methods and criteria of European standards, • Ability to shape and design the prestressed structural elements.
Content	• Lectures: 1. The basic principles, Historical development, Types and systems of prestressing [2] 2. Materials, Systems and Technology, and the scope of the prestressing [2] 3. Prestressing force, immediate and time losses [2] 4. Axially prestressed elements [1] 5. Elements subjected to bending [5] 6. Shear and torsion [2] 7. Deflections and cracking, tansfer of prestressing [2] 8. Details and constructive rules for prestressing of concrete construction [3] 9. Cantilever beams [1] 10. Continuous and partially continuous beam [2]

	11. Composite beams [1] 12. Prestressed slabs [3] 13. Elements in compression, Circular prestressing [2] 14. External prestressing [2]. • Exercises (auditory): 8. Layout of the structure [1] 9. Definition of actions, the construction phases and usage [1] 10. Immediate and time losses of prestressing force [2] 11. Structural analysis [2] 12. Designing of prestressed girder for ultimate limit state [2] 13. Verification of serviceability limit states [2] 14. Detailing of structure [1] 15. Crating the plan for a prestressed reinforcement [1] • Exercises (design): 1. Conceptual design of a prestressed structure according to the points explained in the auditory exercises.
Study and examination requirements and forms of examination	• Written final exam: 50% score required for a pass, • Oral final exam: optional.
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. A.Mandić, A.Kindij,Prestressed concrete – lectures published at the web (in Croatian), Zagreb, 2010/2011, 2. Radić, J. et al,Concrete structures – Handbook (in Croatian), Hrvatska sveučilišna naklada: Andris, Zagreb, 2006, 3. Radić, J. et al,Concrete structures – Practical examples (in Croatian), Hrvatska sveučilišna naklada: Andris, Zagreb, 2006 4. Exercise notes published on the web. Optional literature: 1. Rombach, G.,Spannbetonbau, Ernst&Sohn, Berlin, 2010, 2. Zilch, K.,Zehetmaier G.: Bemessung im konstruktiven Betonbau nach DIN 1045-1 und DIN EN 1992-1-1, Springer-Verlag Berlin Heidelberg 2006, 3. Sengupta, A.K.,Menon, D.: Prestressed Concrete Structures, Indian Institute of Technology Madras, 2006, 4. Nawy, E.: Prestressed Concrete: A Fundamental Approach, Pearson Education, New Jersey, 2003, 5. Menn, C.: Bruckenbau 1: Grundzüge des Brückenbaus in Stahlbeton und Spannbeton, Zürich, 1979, 6. Libby, J.R.: Modern Prestressed concrete: Design Principles and Construction Methods, Litton Educational Publishing, 1977, 7. Mehmel, A.: Vorgespannter Beton: Grundlagen der Theorie, Berechnung und Konstruktion, SpringerVerlag, Berlin, Heidelberg, 1973

Module name:	**Bridges II**
Module level, if applicable	Master's Degree Programme
Code, if applicable	21784
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	I (Winter)
Person responsible for the module	Anđelko Vlašić
Lecturer	Gordana Hrelja Kovačević
Language	Croatian
Relation to curriculum	Master degree programme, Structural Engineering Programme. Compulsory. Semester I.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises: 30 (auditory: 15, design: 15)
Workload	Lecture hours 30 Exercise hours 30 Self study hours 75 Hours of skills 40 Other contact hours 5
Credit points	6 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, • Doing an individual bridge design task, • Two pre-exams - minimum 25% score in each.
Recommended prerequisites	• Comprehension and application of the analysis of concrete and steel structures, knowledge about the basic structural systems of bridges, comprehension and knowledge of structural analysis of various statical systems
Module objectives/intended learning outcomes	• Ability to make a conceptual design of various bridge structures, • Ability to perceive and analyze different loads on bridges using contemporary European standards, • Ability to conduct intensive structural analysis of concrete, steel and composite bridges, • Ability to analyze and size individual structural parts of concrete, steel and composite bridges using modern methods and codes according to European standards.
Content	• Lectures: 1. Introduction - greatest world and Croatian bridge achievements[2] 2. Conceptual preliminary design of bridge structural system[2] 3. Slab girder bridges[2] 4. Ribbed girder bridges[2] 5. Box girder bridges[2] 6. Substructure[2] 7. Steel plate bridges[2] 8. Orthotropic decks[2] 9. Composite bridges[2] 10. Truss bridges[2] 11. Frame, braced and integral bridges [2] 12. Cable stayed bridges [2] 13. Suspension bridges [2] 14. Small bridges and overpasses[2] 15. Arch bridges [2]. • Exercises (auditory):

	1. Setting the bridge disposition[2] 2. Cross section forming[2] 3. Substructure forming[2], 4. Load analysis (dead load, permanent load, traffic load, temperature, wind, earthquake, combinations)[3] 5. Transverse influence lines construction[2], 6. Statical analysis by construction stages[2] 7. Sizing and design of cross section elements [2]. • Exercises (design): 1. Doing the program assignment according to the items listed under auditory exercises.
Study and examination requirements and forms of examination	• Grading the completed exercise design task program, • Oral exam in design task program comprehension.
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. Radić, J., Mandić, A.; Puž, G.: Design of bridges, Hrvatska sveučilišna naklada, Jadring, Zagreb, 2005, 2. Radić, J., Concrete bridges, Hrvatska sveučilišna naklada, Andris, Zagreb, 2007, 3. Radić, J.,Introduction to bridge engineering, Hrvatska sveučilišna naklada, Jadring, Zagreb, 2009, 4. Horvatić, D., Šavor, Z.: Steel bridges, Udžbenici Sveučilišta u Zagrebu, HDGK, Zagreb, 1998 Optional literature: 1. Ryall, M. J.; Parke, G. A. R.; Harding, J. E.,Manual of bridge engineering, Thomas Telford, London, 2000, 2. Wiedemann: Brueckenbau, Stahlbeton und Spannbeton Bruecken, Werner-Verlag, Duesseldorf, 1982, 3. Mathivat, J.,The cantilever construction of prestressed concrete bridges, John Wiley and Sons, New York, 1983

Module name:	**Metal Structures 2**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	21785
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	I (Winter)
Person responsible for the module	Darko Dujmović
Lecturer	Ivan Lukačević, Davor Skejić
Language	Croatian
Relation to curriculum	Master degree programme, Structural Engineering, Compulsory. Semester I. Master degree programme, Theory and Modelling of Structures, Compulsory. Semester I. Master degree programme, Construction Materials, Elective. Semester III.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises (design): 30
Workload	(Estimated) workload divided into face-to-face teaching and independent study, in hours. (1ECTS is 30 hours) Lecture hours 30 Numerical exercises hours 30 Midterm written examination hours 2 Self study hours 112 Other contact hours 4 Final written and oral examination hours 2
Credit points	6 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, • Preparation of 9 program assignments, • Written pre-exam.
Recommended prerequisites	Basics of metal structures (undergraduate study).
Module objectives/intended learning outcomes	• Practical knowledge and skills required for the design of structural elements of steel structures and for the application of basic principles of conceptual design, • Analysing the action effects and combination of action for steel structures, • Identifying the advantages of steel in construction and stressing its potentials in thefuture, • Analysing and dimensioning structural elements of steel structures by using modern methods and the European standards criteria (EN).
Content	• Lectures: 1. Introduction [2] 2. Characteristics of steel structures [2] 3. Architecture and steel [2] 4. Economic parameters of steel constructions [2] 5. Basics of design procedure [2] 6. Actions on structures [2] 7. Beams subjected to bending and axial force [2] 8. Uniform built-up compression members [2] 9. Fatigue – dimensioning [2] 10. Basic approaches of plasticity theory [2] 11. Cold-formed thin-walled structures [2] 12. Design of plate elements and welded plate girders [2]

	13. Spatial structural systems [2] 14. Structural systems of multi-storey buildings [2] 15. Details in steel structures [2] • Design exercises: 1. Revision of the examples in design of tension members within the course Metal structures [2] 2. Revision of the examples in design of compression members within the course Metal structures [2] 3. Design examples of beams subjected to axial force and bending [4] 4. Design examples with uniform built-up compression members [4] 5. Fatigue design of steel members[4] 6. Examples of application of plastic theory [2] 7. Design examples with thin-walled structures [4] 8. Design examples with plate elements and girders [4] 9. Preliminary design of spatial structures[4].
Study and examination requirements and forms of examination	• Final written exam: numerical and theoretical tasks (minimum 50% score), • Oral exam.
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. Androić, B., Dujmović, D., Džeba, I.,Čelične konstrukcije 1, IA Projektiranje, Zagreb 2009., 2. Androić, B., Dujmović, D., Džeba, I.,Čelične konstrukcije 2, IA Projektiranje, Zagreb 2008., 3. Androić, B., Dujmović, D., Džeba, I.,Metalne konstrukcije 4, IA Projektiranje, Zagreb 2003., 4. Lecture notes. Optional literature: 1. Trahair, N.S., Bradford, M.A., Nethercot, D.A., Gardner, L.,The Behaviour and Design of Structures to EC 3, Taylor and Francis, London 2008 2. Beg, D., Kuhlmann, U., Davaine, L.; Braun, B.,Design of Plated Structures, Ernst und Sohn, Berlin 2011

Module name:	**Reliability of Structures**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	21786
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	I (Winter)
Person responsible for the module	Darko Dujmović
Lecturer	
Language	Croatian
Relation to curriculum	Master degree programme, Structural Engineering, Compulsory. Semester I.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30
Workload	(Estimated) workload divided into face-to-face teaching and independent study, in hours. (1ECTS is 30 hours) Lecture hours 30 Midterm written examination hours 3 Self study hours 55 Other contact hours 1 Final written and oral examination hours 1
Credit points	3 ECTS
Requirements according to the examination regulations	• Attendance in lectures, • 2 written pre-exams.
Recommended prerequisites	• Knowledge about probability theory and statistics.
Module objectives/intended learning outcomes	• Identifying a framework within which design standards are developed with special emphasis on the EN1990, • Describing quantitatively the loads using probabilistic method for different situations, • Assessing the probability of failure for structural elements using time independent reliability methods, • Applying the first-order reliability and second-order methods for the analysis of structural elements, • Applying the methods of simulation, including a “Crude Monte Carlo” method and "Importance sampling" method for the reliability assessment of structural elements, • Identifying the optimal values of partial factors of action and resistance in order to achieve a target reliability levels.
Content	• Lectures: 1. The meaning of reliability engineering [2] 2. Definitions and basic notions [2] 3. The analysis and assessment of structural damage [2] 4. Hazards in civil engineering and residual risks [2] 5. Identifying hazards and planning the countermeasures [2] 6. Collecting and processing of data on structures [2] 7. Stochastic modelling of structural responses, actions andresistances [2] 8. Basic variables and models [2] 9. The reliability of structural elements [2] 10. The fundamental problem of the limit state function [2] 11. The extensions of problem of the limit state function [4] 12. The reliability of structures in fire [4] 13. The basic principles of reliability in European standards [2]

Study and examination requirements and forms of examination	• Final written exam: theory (minimum 50% score), • Oral exam.
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. Androić, B., Dujmović, D., Džeba, I.,Inženjerstvo pouzdanosti, IA Projektiranje, Zagreb, 2003, 2. Androić, B., Dujmović, D., Džeba, I.,Metalne konstrukcije 4, IA Projektiranje, Zagreb, 2004, 3. Androić, B., Dujmović, D., Džeba, I.,Čelične konstrukcije , IA Projektiranje, Zagreb, 2009, 4. Lecture notes. Optional literature: 1. Ditlevsen, O., Madsen, H. O.,Structural Reliability Methods, Wiley, New York, 1996, 2. Miličić, V., Peroš, B.,Uvod u teoriju sigurnosti nosivih konstrukcija, GF Split, Split, 2003

II. SEMESTER

Module name:	**Concrete and Masonry Structures 2**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	21787
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	II (Summer)
Person responsible for the module	Tomislav Kišiček
Lecturer	Martina Carić, Nikola Perković, Tvrtko Renić
Language	Croatian, English,
Relation to curriculum	Master degree programme, Structural Engineering Programme. Compulsory. Semester II.
Type of teaching, contact hours	Number of hours (in semester): • Lectures:30 • Exercises: 30 (auditory – 18, design - 12)
Workload	Lecture hours 30 Hours of laboratories or skills Exercise 30 Other contact hours 40 Self study hours 80
Credit points	6 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, • Doing an independent exercise assignment, • Pass in both pre-exams (minimum 25% score).
Recommended prerequisites	• Theoretical and practical knowledge about the basics of reinforced concrete and masonry elements and structures design.
Module objectives/intended learning outcomes	• Acquiring knowledge and skills needed for designing reinforced concrete and masonry structural systems, • Knowledge about the basic principles of conceptual design, • Knowledge and skills needed to analyse behaviour of reinforced concrete and masonry structures according to ultimate and serviceability limit states, • Ability to use modern methods and European norms criteria.
Content	• Lectures: 1. Short revision of masonry structures knowledge in undergraduate course: "Concrete and masonry structures 1". Constructive details (beginning) [2] 2. Types of walls, thicknesses and connections. Details of reinforcement. Connections of walls. Thermal and long term movements. Masonry below ground. Calculation examples. Masonry executions. Materials and their storage. Preparation of mortar and infill concrete. Protection of newly constructed masonry. Permissible deviations of the design values. Category of masonry execution. Other measures of masonry construction. Fixing accessories on masonry walls [2] 3. Masonry structures in seismic areas. Materials and masonry bond arrangements. Rules of construction. Special rules for simple buildings [2] 4. Masonry structures in seismic areas (continued). Design models. Calculation examples. Special rules for simple buildings [2] 5. Rules for seismic areas. Stability and robustness. Loadings, strengths and limitation of dimensions. Wall thicknesses. Rules for stiffening walls, wall piers and chimneys. Walls subjected mainly to wind loading. Non load bearing intern walls. Wall chases and recesses. Outer walls of one-story houses. Simplified calculation methods and simple rules for masonry

	buildings. Calculation examples. Strengthening of walls. Buildings damaged by earthquake [2] 6. Building heritage. Connections of masonry building elements. Research. Strengthening masonry buildings. Calculation examples [2] 7. Introduction with the new European norms EN 1996 and EN 1998 (related to masonry structures). Masonry structures damaged in fire [2] 8. Pre-exam no. 1 – (Masonry walls capacity when subjected to seismic forces,. [2] 9. Short revision of the subject related to concrete structures in undergraduate course "Concrete and masonry structures 1". Shearbetween web andflangesof Tsections.Beamswithinclinedchords (edges). Serviceability limit states. Creepandshrinkageofconcrete [2] 10. Deflectionsofslabsandbeams. Calculationofdeflectionsaccording to EC2 [2] 11. Cracks. Minimum reinforcementarea for crackingcontrol. Calculationofcrackwidthaccording toEC2 [2] 12. Punchingshear. Torsionofreinforcedconcretesections. Deepbeams [2] 13. Pre-exam no. 2 – Deflectionofreinforcedconcrete slab or beam[2] 14. Slendercolumns. Foundations. Strengtheningandretrofitting ofreinforcedconcretestructures [2] 15. New Europeannorms EN 1992 and EN 1998 (for concretestructures) [2]. • Exercises (auditory, design): 1. Introduction, layout and dimensions of elements,structuralloadanalysis (auditory) [2] 2. Designofroofstructureand one reinforcedconcreteroofbeam (auditory) [2] 3. Designofstaircases (auditory) [2] 4. Design[2] 5. Design ofreinforcedconcretetwo-way slab. Modeling slab withdesignsoftware. Reinforcementdetails. (auditory) [2] 6. Design ofreinforcedconcretebeam (auditory) [2] 7. Design[2] 8. Calculation of wall capacity to vertical loading and to horizontal wind loading perpendicular to wall. (auditory) [2] 9. Seismicanalysisofmasonrystructureandcalculationofseismicforces on differenttypesofmasonrywalls (confined and reinforced) (auditory) [2] 10. Design[2] 11. Resistancecalculationofmasonrywallssubjected to in-plane horizontalseismicload(auditory) [2] 12. Design[2] 13. Design of reinforcedconcretebasementwalls subjected to verticaland horizontalload. Designoffoundations. (auditory) [2] 14. Design[4]
Study and examination requirements and forms of examination	• Written exam – minimum 55% score, • Oral exam.
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. Sorić, Z., Kišiček, T.,Betonske konstrukcije 2, Projektiranje betonskih konstrukcija prema europskim normama EN, mimeographed lecture notes, Faculty of civil engineering, Zagreb, 2012, 2. Sorić, Z., Kišiček, T., Galić, J., Betonske i zidane konstrukcije 2 - Betonske konstrukcije prema EC2 - 2 , mimeographed lecture notes, Faculty of civil engineering, Zagreb, 2009, 2010, 2011,

	3. Sorić, Z.: Betonske konstrukcije 1, betonske konstrukcije prema Europskoj prednormi (HRN ENV 1992-1-1), Zagreb, 2010, 4. Sorić, Z., Kišiček, T.,Betonske konstrukcije 1, projektiranje betonskih konstrukcija prema europskim normama EN, Zagreb, 2010, 2011, 5. Sorić, Z.,Zidane konstrukcije I, (second, revised ed.), Zagreb, 2004, 6. Sorić, Z.,Betonske i zidane konstrukcije 2 - Zidane konstrukcije, mimeographed lecture notes, Faculty of civil engineering, Zagreb, 2008, 2009, 2010 ori 2011, 7. Sorić, Z., Betonske i zidane konstrukcije 1 - Zidane konstrukcije, mimeographed lecture notes, Faculty of civil engineering, Zagreb, 2008, 2009, 2010 or 2011, 8. Sorić, Z.,Zidane konstrukcije, paragraph 11 - Projektiranje zidanih konstrukcija prema europskim normama EN, Zagreb 2009, 2010, 2011, 9. Lectures and exercises

Module name:	**Metal Structures 3**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	96456
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	II (Summer)
Person responsible for the module	Darko Dujmović
Lecturer	Ivan Lukačević, Davor Skejić
Language	Croatian
Relation to curriculum	Master degree programme, Structural Engineering, Compulsory. Semester II.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Construction exercises: 30
Workload	Lecture hours 30 Numerical exercises hours 30 Midterm written examination hours 2 Self study hours 112 Other contact hours 4 Final written and oral examination hours 2
Credit points	6 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, • Submitted program - design of single storey steel structure, • Written pre-exam.
Recommended prerequisites	• Knowledge about the basic procedures for plastic analyses in structural systems, • Dimensioning steel structural elements.
Module objectives/intended learning outcomes	• Learning the application of global elastic and plastic analyses and adequate dimensioning of structural steel elements, • Identifying instability modes of frame structures, • Explaining how to take into account instability effects for analysis and dimensioning of frame systems, • Applying the basic principles of design and construction tensile-integrity structures, multi-storey and domes.
Content	• Lectures: 1. Modeling steel frame structures [2] 2. Classification of frames, imperfections of frames and bracing systems [2] 3. The elastic critical load of frame for sway mode [2] 4. The methods of global elastic frame analysis [3] 5. The methods of global plastic frame analysis [1] 6. Plasticity theory in steel frame structures [3] 7. Analysing and dimensioning of frame systems [2] 8. Numerical examples [2] 9. The analysis and classification of joints [2] 10. Floor structures [2] 11. Special types of steel structures (tensegrity structures) [3] 12. Structural systems of steel structures (multi-storey buildings, domes) [3] 13. Seismic resistance of steel structures [4] • Design exercises: 1. Design of steel structure – structural concept and preliminary dimensioning [4] 2. Analysis of actions on structure [2]

	3. Determining the effects of actions (bending moments & internal forces) [4] 4. Dimensioning of structural elements[6] 5. Dimensioning of joints [4] 6. Preparation workshop drawings[6] 7. Quality assurance program[2] 8. Final submission of programs[2].
Study and examination requirements and forms of examination	• Final written exam – theory (minimum 50% score), • Oral exam.
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. Dujmović, D., Androić, B., Džeba, I.,Modeliranje konstrukcija prema EC3, IA Projektiranje, Zagreb, 2004, 2. Androić, B., Dujmović, D., Džeba, I., Čelične konstrukcije 1, IA Projektiranje, Zagreb 2008, 3. Androić, B., Dujmović, D., Džeba, I.,Metalne konstrukcije 4, IA Projektiranje, Zagreb, 2003, 4. Džeba, I., Androić, B., Dujmović, D.,Metalne konstrukcije 3, IA Projektiranje, Zagreb, 1998, 5. Lecture notes. Optional literature: 1. Trahair, N.S., Bradford, M.A., Nethercot, D.A., Gardner, L.,The Behaviour and Design of Structures to EC 3, Taylor and Francis, London, 2008, 2. Davies, J.M., Brown, B.A.,Plastic Design, Blackwell Science, 1996

Module name:	**Timber structures II**
Module level, if applicable	Master's Degree Programme
Code, if applicable	21789
Subtitle, if applicable	Structural engineering
Courses, if applicable	
Semester(s) in which the module is taught	II (Summer)
Person responsible for the module	Vlatka Rajčić
Lecturer	Jure Barbalić, Mislav Stepinac
Language	Croatian
Relation to curriculum	Master degree programme, Structural Engineering Programme. Compulsory. Semester II.
Type of teaching, contact hours	Number of hours: • Lectures: 30 • Exercises: 30 (auditory – 15, construction – 15) • E-learning: 15
Workload	Lecture hours 30 Hours of auditoria and constructive exercises (face-to-face) 30 Hours of only constructive exercises (face-to-face) 30 Independent study 90 hours
Credit points	6 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, • Preparation of a project, • Pre-exams - minimum 25% score.
Recommended prerequisites	• Theoretical knowledge about the behavior of structures under load and other actions on structures, understanding the concepts of stress and strain and internal forces, practical knowledge about the calculation methods for statically determinate and statically indeterminate structures, practical and theoretical knowledge about design of timber structures and joints in timber structures, basics of Eurocode 5.
Module objectives/intended learning outcomes	• Theoretical and practical knowledge about wood and wood products. Design of timber structures made of laminated and cross laminated timber. Details in timber structures. Limit state design of planar and spatial timber structures. Structural stabilization of timber structures with complicated geometry. Design of timber houses and timber roofs. Basic knowledge about the design of timber bridges. Basic knowledge about timber composite structures.
Content	• Lectures: 1. Introduction [2] 2. Industrial production of standard laminated elements [2] 3. Wood and wood products: quality control, laminated timber and wood based products, cross laminated timber, new materials and composites [3] 4. Glue laminated elements: the current design standards according to Eurocode 5. Basis of structural analysis (ultimate limit states and serviceability state) [3], 5. Stresses in curved laminated beams as the result of production. Practical measures for strengthening elements with dominant stress perpendicular to grain [3] 6. Planar systems made of glue laminated elements: frames and arches. Spatial systems. Details in planar and spatial structures [2] 7. Traditional and modern timber carpentry roofs. The protection, restoration and rehabilitation of timber structures [2] 8. Fundamentals of design and construction of timber multi-storey buildings[2]

	9. Fundamentals of design and construction of timber bridges: history and modern systems (types, details and design)[2] 10. Spatial concepts and spatial systems made of timber: arches, spheres and geodetic domes [2] 11. Structural modeling and design of details. Design models; plane and spatial [2] 12. Structural timber composites. Prestressing in wooden structures Howe and Cruciano lattice systems. Transversely prestressed systems [2] 13. Components and assemblies made of wood. Glued thin-webbed beams. Mechanically jointed and glued columns [3]. • Auditory exercises: 1. Problem description. Introduction to timber engineering[1] 2. Design plan (drawing) for timber truss system [2] 3. Actions on structures [2] 4. Design according to Eurocode 5 standards. Structural analysis and design of secondary timber structures [2] 5. Timber truss – structural analyses [1] 6. Design of main timber truss elements. Structural stabilization [2] 7. Details in timber structures [2] 8. Design of glass panes and columns [2] 9. Design of aluminium columns. Technical description of the project [1]. • Exercises (design): 1. Design plan (drawing) [3] 2. Structural analysis and design of secondary timber structures [3] 3. Timber truss – structural analyses [3] 4. Design of main timber truss elements. Structural stabilization[3] 5. Details in timber structures [3].
Study and examination requirements and forms of examination	• Practical and theoretical exam.
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. Rajčić, V., Bjelanović, A.,Drvene konstrukcije prema europskim normama, Zagreb, 2007, 2. Rajčić, V., Čizmar, D., Stepinac, M., Riješeni primjeri iz drvenih konstrukcija, Zagreb, 2014, Optional literature: 1. Žagar, Zvonimir,Drvenekonstrukcije I, Pretei, Zagreb, 2002, 2. Žagar, Zvonimir,Drvenekonstrukcije II, Pretei, Zagreb, 2002, 3. Žagar, Zvonimir,Drvenimostovi, Pretei,Zagreb, 2003, 4. Halas, R.; Scheer, C., Holzbau-Tachenbuch, IES Verlag, Berlin, 2000, 5. Natterer et all.,Holzbauatlas ,Birkhauser, München, 2003

Module name:	**Durability of Structures I**
Module level, if applicable	Master's Degree Programme
Code, if applicable	21790
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	II (Summer)
Person responsible for the module	Ana Mandić Ivanković
Lecturer	Marija Kušter Marić
Language	Croatian
Relation to curriculum	Master's degree programme, Structural Engineering Programme. Compulsory. Semestar II.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises: 30 (auditory - 15, design - 15)
Workload	Lecture hours 30 Exercise hours 30 Self study hours 85 Hours of skills 30 Other contact hours 5
Credit points	6 ECTS
Requirements according to the examination regulations	• Attendance inf lectures and exercises, • Project containing a visual inspection and assessment of an existing structure, • Two pre-exams (minimum 25 % score in each exam required for the signature)
Recommended prerequisites	• Knowledge on structures in terms of properties of materials and design methods
Module objectives/intended learning outcomes	• Knowledge on different effects on durability through the design, construction and maintenance of structures, • Knowledge on the maintenance of existing structures and structural management, • Skills in durability verification in designing new structures, • Knowledge and skills in collecting data on existing structures for their assessment.
Content	• Lectures: 1. Definitions, Basic concepts, Contemporary approach to the durability of construction, Design for durability [2] 2. Mechanisms of deterioration of concrete, masonry, steel and wooden structures, Examples of structural damages [2] 3. Impact of the design on durability, Impact of the construction on durability [2] 4. Impact of the maintenance on durability, Structural management, Other influences on the structural durability [2] 5. Diagnostics and monitoring of structures [2] 6. Durability design and limit states [2] 7. Achieving durability of concrete structures [3 8. Achieving durability of masonry structures [2] 9. Achieving durability of wooden structures [2] 10. Achieving durability of steel structures [2] 11. Failures, accidents and disasters, Risk Management [3] 12. Temporary and auxiliary buildings, renovation methodology [2] 13. Aesthetic, ecological and ethical aspects of durability [2] 14. Sustainable construction [2].

	• Auditory exercises: 1. Inspection and assessment of structures [2] 2. Making the basic documentation for the inspection of buildings [2] 3. Inspection of bridges [3] 4. Inspection of buildings [2] 5. Types of damages and their graphical representation [2] 6. Examples of durability verification, grades of exposure [2] 7. The categorisation of damages and the assessment of the structure [2]. • Design exercises: 1. Students make the project: Visual inspection and assessment of the structure according to the points explained in the auditory exercises for an assigned existing building or a bridge.
Study and examination requirements and forms of examination	• Written final exam - minimum 50% score, • Oral final exam - optional.
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. J. Radić,Durability of structures I (in Croatian), Hrvatska sveučilišna naklada, Jadring, Sveučilište u Zagrebu, Građevinski fakultet, Zagreb, 2010, 2. Exercise notes published on the web. Optional literature: 1. J. Radić et al.,Concrete structures – Handbook (in Croatian), Hrvatska sveučilišna naklada, Sveučilište u Zagrebu,Građevinski fakultet, Andris, Zagreb, 2006, 2. J. Radić et al.,Concrete structures – Practical examples (in Croatian), Hrvatska sveučilišna naklada, Sveučilište u Zagrebu ,Građevinski fakultet, SECON HDGK, Andris, Zagreb, 2006, 3. J. Radić et al.,Masonry structures – Handbook (in Croatian), Hrvatska sveučilišna naklada, Sveučilište u Zagrebu,Građevinski fakultet, Andris, Zagreb, 2007, 4. J. Radić et al.,Concrete structures – Construction (in Croatian), Hrvatska sveučilišna naklada, Sveučilište u Zagrebu, Građevinski fakultet, SECON HDGK, Andris, Zagreb, 2008, 5. J. Radić et al.,Concrete structures – Repairs (in Croatian), Hrvatska sveučilišna naklada, Sveučilište u Zagrebu,Građevinski fakultet, SECON HDGK, Andris, Zagreb, 2008, 6. Proceedings of the International Symposium: Durability and Maintenance of Concrete Structures, Ed.: J. Radić, 2004.

Module name:	**Precast Reinforced Concrete Structures**
Module level, if applicable	Master's Degree Programme
Code, if applicable	21791
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	II (Summer)
Person responsible for the module	Darko Meštrović
Lecturer	Jelena Bleiziffer, Tvrtko Renić
Language	Croatian
Relation to curriculum	Master degree programme, Structural Engineering Programme.Compulsory. Semestar II.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises: 30 (auditory - 12, design - 18)
Workload	Lecture hours 30 Exercise hours 30 Self study hours 85 Hours of skills 30 Other contact hours 5
Credit points	6 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises • Conceptual design of the assigned structure • Two pre-exams (minimum 25% score necessary for the signature).
Recommended prerequisites	Prior knowledge on structures from bachelor degree program.
Module objectives/intended learning outcomes	• Ability to make a conceptual design of various systems of precast concrete structures (frames and combined structures), • Ability to observe and analyse various actions on precast concrete structures by applying contemporary European standards, • Ability to analyse precast concrete structures, • Ability to analyse and dimension structural elements, precast concrete structures by using contemporary European methods and criteria.
Content	• Lectures: 1. What it precast concrete?[2] 2. Materials used in precast structures[2] 3. Precast frame analysis[2] 4. Precast concrete floors[2] 5. Precast concrete beams[2] 6. Columns and shear walls[2] 7. Horizontal floor diaphragms[2] 8. Beam and column connections[2] 9. Joints and connections[2] 10. Precast reinforced concrete with other structures [2] 11. Precast column foundation connections[2] 12. Earthquake analysis of precast concrete constructions[2] 13. Design of precast concrete structures [2] 14. Analysis of ductility of precast concrete structures [2] 15. Precast concrete elements in bridges[2] • Auditory exercises: 1. Layout of the structure[2] 2. Analysis of vertical loadings[2] 3. Analysis of horizontal loadings[1] 4. Actions on precast concrete construction[1]

	5. Modeling for structural analysis on computer[2] 6. Static analysis on computer[2] 7. Creating the plan for steal and prestressed reinforcement[2] • Design exercises : 1. Conceptual design of a precast structure according to the points explained inauditory exercises.
Study and examination requirements and forms of examination	• Written final exam - minimum 50% score, • Oral final exam - optional.
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. Twelmeier, H.,Betonfertigteilkonstruktionen, TU Hannover, 1973, 2. Mokk, L.,Montagebau in Strahlbeton, Akademiai Kiado, Budapest, 1968, 3. Elliott, K.S.,Precast concrete structures, Butternwoorth-Heineman, 2002, 4. Elliott, K.S.,Multi-storey precast concrete framed structures, Blackwell Science, 1996, 5. Seismic design of precast concrete building structures. State of art, FIB, October 2003 Optional literature: 1. Precast concrete in mixed construction. State of art, FIB, June 2002, 2. Floor Connections – Precast concrete Connection Details, Beton – Verlag, Düsseldorf, 1981, 3. Structural Design Manual – Precast Concrete Connection Details, Beton – Verlag, Düsseldorf, 1978

III. SEMESTER

Module name:	**Concrete Structures 3**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	21793
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	III (Winter)
Person responsible for the module	Tomislav Kišiček
Lecturer	Martina Carić, Tvrtko Renić
Language	Croatian, English.
Relation to curriculum	Master's degree programme, Structural Engineering Programme. Compulsory. Semestar III.
Type of teaching, contact hours	Number of hours (in semester): • Lectures:30 • Exercises: 30 (auditory – 12, design - 18)
Workload	Lecture hours 30 Hours of laboratories or skills Exercise 30 Other contact hours 20 Self study hours 100
Credit points	6 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, • Doing an independent exercise assignment, • Pre-exam – minimum 25 % score.
Recommended prerequisites	• Theoretical and practical knowledge about reinforced concrete elements and structures design.
Module objectives/intended learning outcomes	• Acquiring knowledge and skills needed to design reinforced concrete structural systems and to use conceptual designing principles, • Knowledge and skills needed to analyse behaviour of advanced reinforced concrete structures according to ultimate and serviceability limit states, • Ability to use modern methods and European norms criteria to analyse the behaviour of advanced reinforced concrete structures.
Content	• Lectures: 1. Short revision of concrete structures in undergraduate courses.(Concrete and masonry structures 1 and Concrete and masonry structures 2, Engineering structures [2] 2. Engineering structures. Brief introduction to codes EN 1990 and EN 1991 [2] 3. Confinement of concrete, ductility, determining of moment – curvature diagram of concrete section. Balanced failure, partially loaded areas of reinforced concrete elements, shear at the interface between concrete cast at different times, modification of partial factors for materials[2] 4. Strength of concrete at time t. Creep and shrinkage of concrete. Plasticity theory. [2] 5. Slender columns[2] 6. Biaxial bending and lateral instability of slender beams[2] 7. Concrete structures in seismic active areas - Concrete structures in seismic areas. Recent earthquakes and damages to reinforced concrete structures. Provisions for reinforced concrete beams, columns and walls according to EN 1998-1 [2]

	8. (continued) Concrete structures in seismic active areas - Response spectrum of structures on seismic excitation. Seismic forces. Ability of energy dissipation and ductility classes. Local ductility conditions. Preparation for midterm exam: Determination of (M-1/r) diagrams, confinement, ductility, balanced failure [2] 9. (continued) Concrete structures in seismic active areas - Calculation of Medium Ductility Class (MDC) and of High Ductility Class (HDC) for beams, columns and walls in seismic loaded reinforced concrete structures. Confining concrete core of columns. Pushover Analysis Method and seismic calculation. Preparation for pre-exam: Determination of (M-1/r) diagrams, confinement, ductility, balanced failure [2] 10. Reinforced concrete thin shell structures [2] 11. FRP reinforcement in new reinforced concrete structures, strengthening of reinforced concrete structures with FRP materials, fiber reinforced concrete, high strength concrete. [2] 12. Pre-exam. 1 [2] 13. Case studies [2] 14. Lightweight aggregate concrete structures, plain and lightly reinforced concrete structures[2] 15. Overview of nonstandard buildings: Sea and river piers, Ship channels, Ship slipways, Foundations of gas and steam turbines. High reinforced concrete buildings. Anti-vibration and anti-seismic isolations. Reinforcement of dynamic loaded foundations. Recapitulation of the course, guidelines for the exam and for the make up pre-exam. [2] • Exercises: 1. Introduction to assignments in exercises assignments. (auditory) [2], 2. Definingloadbearingstructure for each student assignment. (auditory) [2], 3. Definingloads on everytypeofstructure. (auditory) [2], 4. Some specificremarks on the calculationofeveryloadbearingstructure. (auditory) [2], 5. (design) [10], 6. Designofloadbearingstructuralelements. (auditory) [2], 7. (design) [2], 8. Reinforcementlayouts (auditory) [2], 9. (design) [6].
Study and examination requirements and forms of examination	• written exam – minimum 55 % score • Oral exam.
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. EN 1992, 2. EN 1990, 3. EN 1991, 4. EN 1998, 5. Technical regulations for concrete structures (2009), 6. Sorić, Z., Kišiček, T., Betonske konstrukcije 3, Projektiranje betonskih konstrukcija prema europskim normama EN, mimeographed lecture notes by the Faculty of Civil Engineering, Zagreb, 2013, 7. Sorić, Z., Kišiček, T.,Betonske konstrukcije 1, Projektiranje betonskih konstrukcija prema europskim normama EN, mimeographed lecure notes, Faculty of Civil Engineering , Zagreb, 2013, 8. Sorić, Z., Kišiček, T.,Betonske konstrukcije 2, Projektiranje betonskih konstrukcija prema europskim normama EN, mimeographed lecture notes, Faculty of Civil Engineering, Zagreb, 2013, 9. Scientificpapers,

	10. Tomičić, I.,Betonske konstrukcije - Odabrana poglavlja, Zagreb, 1996, 11. Lectures and exercises

Module name:	**Bridges III**
Module level, if applicable	Master's Degree Programme
Code, if applicable	21794
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	III (Winter)
Person responsible for the module	Jelena Bleiziffer
Lecturer	Marija Kušter Marić, Anđelko Vlašić
Language	Croatian
Relation to curriculum	Master’s degree programme, Structural Engineering Programme. Compulsory. Semester III.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises: 30 (auditory - 9, design - 21)
Workload	Lecture hours 30 Exercise hours 30 Self study hours 75 Hours of skills 40 Other contact hours 5
Credit points	6 ECTS
Requirements according to the examination regulations	• Presence in lectures and exercises, • Solving 2 tasks, presentation and submission of seminar papers during exercises, • Passing two pre-exams (minimum 25% score in each).
Recommended prerequisites	• Adopted knowledge about the analysis of bridge loads and dimensioning of structural elements of reinforced concrete, steel and composite bridges, • Adopted knowledge and skills of prestressed structural elements design, • Adopted a basic knowledge of degradation processes in structure, maintenance of existing and new buildings and calculation of structure durability according to modern codes.
Module objectives/intended learning outcomes	• Knowledge about different methods of bridge maintenance and elements of bridge management system, • Practical knowledge about various causes of bridge elements damages with elaborate methods of repair and rehabilitation, • Basic knowledge about the diagnosis, monitoring, evaluation and categorization of bridge condition and different methods of calculation of the remaining service life of structures, • Knowledge and skills necessary for the aesthetic design of bridges, depending on bearing system and bridge function, • Knowledge about and ability to select and design appropriate bearing system of bridge, depending on the geometry and boundary conditions in accordance with European codes and aesthetic criteria, • Additional knowledge about accidental loads on bridges as well as the application of advanced materials and structures to bridge engineering.
Content	• Lectures: 1. Introduction to the course: problems of bridge management, philosophy of durability and economic issues [2] 2. Development of bridge management system: examples of different management systems, data base: content, creation, updating data[2] 3. Damage of bridges: examples and causes of damages of structural elements. Diagnostics and monitoring: examinations, investigations, determining the condition [2]

	4. Assessment and classification of conditions; prediction of future condition- strategies for maintenance: maintenance plan, LCC and LCA analysis[2] 5. Calculation of remaining life, calculation of remaining capacity: assumptions, different methods and approaches[2] 6. Maintenance, repair, renovation, reconstruction, additional protection. Examples from practice[2] 7. Design of contemporary bridges: bridge aesthetics, harmony with the environment, aesthetic design of a whole bridge and bridge elements[2] 8. Aesthetic bridge design according tothe bearing systems: girders, arches, strut frame bridges, suspension bridges, cable-stayed bridges[2] 9. Aesthetic bridge design according to their function: pedestrian bridges, overpasses, large crossings [2] 10. Culture of bridge building: examples of modern bridge design[2] 11. Suspension bridges[2] 12. Cable-stayed bridges[2] 13. Polygonal arch bridges [2] 14. Timber bridges [2] 15. Integrated multidisciplinary approach to bridge design[2]. • Exercises (auditory, design,): 1. Introduction to exercises – auditory[2] 2. Task 1 - investment strategy for rehabilitation of deteriorated bridges - auditory [2] 3. Solving the task 1 – design[2] 4. Completion of task 1 – design[2] 5. Task 2 – predicting bridge condition (degradation) using Markov chain model – auditory[2] 6. Guidelines for the 1st pre-exam, solving the task 2 - auditory + design 7. 1st pre-exam; completion of task 2 - design [2] 8. Topics of written seminars: consideration and selection of topics; Completion of task 2 - auditory + design [2] 9. Seminar overview – design[4] 10. Seminar Presentations – design[4] 11. Seminar presentations; guidelines for the 2nd pre-exam - auditory + design [2] 12. Seminar Presentations - design [2] 13. 2nd pre-exam, submission of seminars – design[2].
Study and examination requirements and forms of examination	• Written exam – minimum 60% dvotr, • Oral exam.
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. Radić J. et al.,Concrete structures – Rehabilitation, Andris, Zagreb 2008 (in Croatian) 2. Radić J. et al.,Concrete structures – Handbook, Andris, Zagreb 2006 (in Croatian) 3. Radić J., Bleiziffer J., Kušter M., Puž G.,Bridges 3 – lectures published on the web, Zagreb, 2013/2014, 4. Mimeographed exercise notes. Optional literature: 1. Radić, J.: Introduction to bridge engineering (Uvod u mostarstvo), Hrvatska sveučilišna naklada, Jadring, Sveučilište u Zagrebu-Građevinski fakultet, Zagreb 2009, (in Croatian)

	2. Radić, J.: Masonry bridges (Masivni mostovi), Hrvatska sveučilišna naklada, Sveučilište u ZagrebuGrađevinski fakultet, Andris, Zagreb 2007, (in Croatian) 3. Radić, J, Mandić, A., Puž, G.: Design of bridges (Konstruiranje mostova), Jadring, Zagreb 2005, (in Croatian) 4. Horvatić D., Šavor Z.: Steel bridges (Metalni mostovi), HDGK, Zagreb, 1998 (in Croatian)

Module name:	**Dynamics of Structures**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	21880
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	III (Winter)
Person responsible for the module	Damir Lazarević, Marta Šavor Novak
Lecturer	Mario Uroš
Language	Croatian
Relation to curriculum	Master degree programme, Structural Engineering Programme. Compulsory. Semester III.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises (auditory, design, laboratory): 15
Workload	Lecture hours 30 Hours of computer research15 Other contact hours 15 Self study hours 75
Credit points	4,5 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, • Two written pre-exams: minimum 25% score, one make up exam.
Recommended prerequisites	• Knowledge about differential and integral calculus (including ordinary differential equations) and linear algebra, • Knowledge of linear static analysis procedures for frame structures, • Knowledge of kinematics fundamentals for simple structural systems, • Knowledge of dynamics of a material point.
Module objectives/intended learning outcomes	• Applying the principles of structural dynamics, • Carrying out the analyses of structures under dynamic excitations, • Analysing the results of dynamic structural analyses, • Following scientific and professional literature in the field of structural dynamics.
Content	• Lectures: 1. Introductory examples [2] 2. Single-degree-of-freedom systems without damping [2] 3. Single-degree-of-freedom systems with damping [2] 4. Single-degree-of-freedom systems: harmonic excitation [2] 5. Single-degree-of-freedom systems: Duhamel's integral [2] 6. Concept of response spectrum [2] 7. Response of linear systems to earthquake excitations [2] 8. Response of elastoplastic systems to earthquake excitations [2] 9. Generalised single-degree-of-freedom systems: Rayleigh quotient [2] 10. Multi-degree-of-freedom-systems: problem formulation [2] 11. Multi-degree-of-freedom-systems: static condensation [2] 12. Multi-degree-of-freedom-systems without damping and with damping [2] 13. Multi-degree-of-freedom-systems: harmonic excitation [2] 14. Damping in structures [2] 15. Response of linear multi-degree-of-freedom-systems to earthquake excitations and application of response spectrum to response of multi-degree-of-freedom-systems [2]. • Exercises (auditory):

	1. Single-degree-of-freedom systems without damping: formulation of the problem and evaluation of stiffness [3] 2. Single-degree-of-freedom systems without damping: static condensation [1] 3. Single-degree-of-freedom systems without damping: forced vibrations - analytical solution [1] 4. Single-degree-of-freedom systems without damping: forced vibrations - Duhamel's integral [1] 5. Single-degree-of-freedom systems without damping: concluding remarks [1] 6. Response of linear systems to earthquake excitations and application of response spectrum [1] 7. Multi-degree-of-freedom systems without damping: formulation of the problem [1] 8. Multi-degree-of-freedom systems: modal analysis [1] 9. Multi-degree-of-freedom systems: numerical examples [5].
Study and examination requirements and forms of examination	• Written part of the final exam - minimum 50% score, • Oral exam.
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. Lazarević, D., Dinamika konstrukcija s uvodom u potresno inženjerstvo , mimeographed lecture notes, GF, Zagreb, 2012 Optional literature: 1. Chopra, A.: Dynamics of Structures, Theory and Application to Earthquake Engineering, 3rd Edition, Prentice Hall, New Jersey, 2007, 2. Mihanović, A.: Dinamika konstrukcija, Građevinski fakultet Sveučilišta u Splitu, Split, 1995, 3. Čaušević, M.: Dinamika konstrukcija, diskretni sustavi, Školska knjiga, Zagreb, 2005

Module name:	**Stability of Structures**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	21795
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	III (Winter)
Person responsible for the module	Darko Dujmović
Lecturer	Ivan Lukačević, Davor Skejić
Language	Croatian
Relation to curriculum	Master degree programme, Structural Engineering, Elective. Semester III.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises (design): 15
Workload	Lecture hours 30 Numerical exercises hours 15 Midterm written examination hours 1 Self study hours 85 Other contact hours 2 Final written and oral examination hours 2
Credit points	4,5 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, • Preparing 3 program assignments, • 1 pre-exam, one make up exam.
Recommended prerequisites	• Knowledge about the methods for determination of action effects in structural systems (bending moments, internal forces).
Module objectives/intended learning outcomes	• Ability to calculate critical load of structural elements and simple framing systemsexactly or approximately by energy methods, • Ability to explain the effects of material plasticity and geometrical and structural imperfections on the bucklingresistance of structural elements, • Ability to analyze geometrically perfect and imperfect systems for structural stability, • Ability to identify the difference between linear and nonlinear buckling analysis, • Ability to explain the occurrence of post buckling behaviour, • Ability to applymethods in analysing the basic structural elements and systems which are susceptible to instability.
Content	• Lectures: 1. General criteria for elastic stability [2] 2. Methods of critical load assessment [2] 3. Global and local instability of structural elements [2] 4. Iterative methods for solving the stability problems [4] 5. The impact of imperfections on the stability of structural elements and systems [2] 6. Stability of real structural elements [2] 7. Stability of structural elements subjected to axial force and bending [2] 8. Stability of real framing systems [2] 9. Stability of real plates [2] 10. Analysis of shell stability [2] 11. The stabilityproblems of framed systems with plastic hinges [2] 12. Stability in the European standard [2] 13. Special problems of structural stability [2] 14. Practical examples [2].

	• Design exercises: 1. Numerical example: Computation of critical load and the adequate buckling mode [6] a) Exact b) The Raleigh method c) The Rayleigh-Ritz method d) The Galerkin method e) The Vianello-Newmark method 2. Numerical example: Computation of critical load of regular frames [7] a) Exact computation of critical load a1) Sway is prevented / a2) Sway is not prevented b) Approximate computation of critical load by finite el. b1) Sway is prevented/ b2 Sway is not prevented 3. Numerical example: Computation of critical stress of rectangular plate under compression by Rayleigh-Ritz method [2].
Study and examination requirements and forms of examination	• Final written exam - theory (minimum 50% score). • Oral examination.
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. Čaušević, M.,Statika i stabilnost konstrukcija, Građevinski fakultet Rijeka, Rijeka 2004, 2. Androić, B.; Dujmović, D.; Džeba, I.,Čelične konstrukcije 1, IA Projektiranje, Zagreb 2009, 3. Androić, B.; Dujmović, D.; Džeba, I.,Čelične konstrukcije 2, IA Projektiranje, Zagreb 2008, 4. Dujmović, D.; Androić, B.; Džeba, I,: Modeliranje konstrukcija prema EC3, IA Projektiranje, Zagreb 2003, 5. Lecture notes for the course in structure stability, Faculty of Civil Engineering, Zagreb Optional literature: 1. Galambos, T.V., Surovek, A.E. Structural Stability of Steel, John Wiley and Sons, 2008, 2. Galambos, T.V. (ed.) Guide to Stability Design Criteria for Metal Structures, John Wiley and Sons, 1998, 3. Beg, D., Kuhlmann, U., Davaine, L., Braun, B.,Design of Plated Structures, Ernst und Sohn, Berlin, 2011

Module name:	**Durability of structures II**
Module level, if applicable	Master's Degree Programme
Code, if applicable	21796
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	III (Winter)
Person responsible for the module	Ana Mandić Ivanković
Lecturer	Marija Kušter Marić
Language	Croatian
Relation to curriculum	Master's degree programme, Structural Engineering Programme. Elective. Semester III.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises: 15 (auditory - 5, design - 10)
Workload	Lecture hours 30 Exercise hours 15 Self study hours 55 Hours of skills 30 Other contact hours 5
Credit points	4,5 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, • Preparing a research paper on a given topic and presenting it in front of other students, • Taking two preliminary exams during semester (minimum 25 score in each exam required for the signature).
Recommended prerequisites	• Knowledge on the basic concepts and principles in achieving durable structures, • Knowledge on implicit durability design of structures for the life time of 50 years, • Knowledge on the design of reinforced and prestressed concrete structures.
Module objectives/intended learning outcomes	• Knowledge on maintenance of existing structures and structural management, • Knowledge on numerical modeling of corrosion effect on concrete structures, • Ability to verify the durability in designing a new structure using contemporary methods and the European standards, • Knowledge and skills in collecting the data on existing structures for their assessment, • Ability to assess the existing structures according to contemporary understanding of structural reliability, • Ability to verify ultimate and serviceability limit states for existing structures.
Content	• Lectures: 1. Contemporary approach to structural durability through design, construction and maintenance [2] 2. Implicit and explicit design for durability: theory and examples [2] 3. Robustness of structures [2] 4. Assessing existing structures – introduction, collection of data on structure, numerical modeling of the existing structures and procedures for reliability verification [2] 5. Assessment of existing structures – methods of assessing existing structures, classes and levels of assessment [2]

	6. Assessment of existing structures – Further knowledge on structural inspection [2] 7. Assessment of existing structures – Examples [4] 8. Numerical modeling of concrete structures – linear and nonlinear analysis, basics on fracture mechanics, Microplane model [2] 9. Numerical modeling of corrosion effect in concrete structures [2] 10. Earthquakes: general information, regulations and standards, seismic assessment of structures [2] 11. Protective barriers on roads and bridges, the impact of vehicle collision with overpass piers[2] 12. Fire: General knowledge, Design of the building for the fire situation [2] 13. Repairs and strengthening [2] 14. Strengthening of structures using fibre reinforced polymers and external pre-stressing[2]. • Auditory exercises: 1. Examples of durability verification in designing a new structure [2] 2. Design examples of assessing existing structure [3]. • Design exercises: Students present topics that are processed in seminars (research work) and other students ask questions and express their views and opinions, • Seminars: Students individually or in pair (sometimes in larger groups depending on the complexity of the issue) prepare a research paper on a given topic. Topics are mainly practical and are related to real existing structures.
Study and examination requirements and forms of examination	• Written final exam - minimum 50% score, • Oral final exam – optional.
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. J. Radić & A. Mandić,Durability of structures II, lecture notes published on the web, 2010/2011, 2. J. Radić,Durability of structures I (in Croatian), Hrvatska sveučilišna naklada, Jadring, Sveučilište u Zagrebu, Građevinski fakultet, Zagreb, 2010, 3. J. Radić et al.,Concrete structures – Repairs (in Croatian), Hrvatska sveučilišna naklada, Sveučilište u Zagrebu ,rađevinski fakultet, SECON HDGK, Andris, Zagreb, 2008 Optional literature: 1. Rombach, G.,Spannbetonbau, Ernst&Sohn, Berlin, 2010 2. J. Radić et al.,Concrete structures – Handbook (in Croatian), Hrvatska sveučilišna naklada, Sveučilište u Zagrebu – Građevinski fakultet, Andris, Zagreb, 2006, 3. J. Radić et al,: Concrete structures – Practical examples (in Croatian), Hrvatska sveučilišna naklada, Sveučilište u Zagrebu , Građevinski fakultet, SECON HDGK, Andris, Zagreb, 2006, 4. J. Radić et al.,Masonry structures – Handbook (in Croatian), Hrvatska sveučilišna naklada, Sveučilište u Zagrebu, Građevinski fakultet, Andris, Zagreb, 2007, 5. J. Radić et al.,Concrete structures – Construction (in Croatian), Hrvatska sveučilišna naklada, Sveučilište u Zagrebu, Građevinski fakultet, SECON HDGK, Andris, Zagreb, 2008,

	6. Vollrath, F., Tathoff, H.,Handbuch der Brücken – instandhaltung, Verlag Bau+Technick GmbH, Düsseldorf 2002, 7. Demetrios E. Tonias, Jim J. Zhao,Bridge Engineering: Design, Rehabilitation and Maintenance of Modern Highway Bridges, McGraw-Hill Companies, 2007, 8. Management of bridges/Gestion des ponts, Highway agency-Service d'Etudes Techniques des Routes et Autoroutes-Transport Research Laboratory-Laboratoire Central des Ponts et Chaussées, Thomas Telford, 2005, 9. Protection of structures against hazards, Proceedings of the 3rd International Conference organized by CI-Premier Conference Organisation, Venice, Italy, 28-29 September 2006, Ed.: C. Majorana, V. Salamoni, T.S. Lok 10. Rücker, W., Hille, F., Rohrmann, R. : F08a - Guideline for the Assessment of Existing Structures, SAMCO Final Report 2006, Federal Institute of Materials Research and Testing (BAM), Division VII.2 Buildings and Structures, Berlin, Germany 11. Durability and Maintenance of Concrete Structures, Proceedings of the International Symposium organized by CSSE and ASCCT, Dubrovnik, Croatia, Oct 21-23, 2004, Ed.: J. Radić, SECON HDGK, 2004

Module name:	**Tall Buildings**
Module level, if applicable	Master's Degree Programme
Code, if applicable	112460
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	III (Winter)
Person responsible for the module	Anđelko Vlašić, Goran Puž
Lecturer	Dominik Skokandić
Language	Croatian
Relation to curriculum	Master degree programme, Structural Engineering Programme. Elective. Semester III.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises: 15 (auditory)
Workload	Lecture hours 30 Exercise hours 30 Self study hours 55 Hours of skills 15 Other contact hours 5
Credit points	4,5 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, • Completion of an individual bridge design task, • 2 pre-exams (minimum 25% score in each).
Recommended prerequisites	• Knowledge about engineering mechanics, statics and dynamics of structures, knowledge about the base design of concrete and steel structures and Eurocode norms EN1990 and EN1991.
Module objectives/intended learning outcomes	• Identifying structural systems of tall buildings and the performance of concrete and/or steel parts, identifying the requirements of the space, purpose, location, safety, special architectural features and other conditions that affect the structural design of tall buildings, comprehension of the flow of horizontal and vertical loads in the main load bearing structural parts of tall buildings (with the focus on the effects of the horizontal actions), • Applying acquired knowledge about concrete and steel structures to practical examples of complex structures of tall buildings, • Ability to draw and make an approximate calculation of a tall building according to architectural demands.
Content	• Lectures: 1. Historical overview of tall residential or commercial buildings, examples of important tall buildings and their structural systems [2] 2. Special demands in the design of tall buildings[2] 3. Use of structural systems in tall buildings[2] 4. Vertical loads[2] 5. Fire loads[2] 6. Wind loads[2] 7. Earthquake loads[2] 8. Frame structures[2] 9. Braced structures [2] 10. Tube structures[2], 11. Shear wall structures[2] 12. Outrigger structures[2] 13. Hybrid structures[2] 14. Floor constructions[2] 15. Numerical modeling of tall buildings, equipment of tall buildings [2].

	• Auditory exercises: 1. Tall building design concept[2] 2. Program design task explanation[2] 3. Load analysis[2] 4. Calculus for the stability and horizontal loads distribution[2] 5. Strain control [2] 6. Ultimate limit state design[2] 7. Serviceability limit state design[2].
Study and examination requirements and forms of examination	• Grading the finished design assignment, • Grading the oral exam.
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. Lecture notes: http://www.grad.unizg.hr/predmet/visgra_a 2. Puž, G., Perić, K., Brozović, T., Čačić, B.,Tall buildings, mimeographed lecture notes, 3. Stafford Smith, B., Coull, A.,Tall Building Structures, Analysis and Design, John Wiley & Sons, 1991 Optional literature: 1. Dupré, J.,Skyscrapers, Revised Edition, Black Dog & Leventhal Publishers, Inc., 2008, 2. Chew Yit Lin, M.,Construction Technology for Tall Buildings, (2nd Edition), Singapore University Press & World Scientific Publishing Co., 2007, 3. Wells, M.: Skyscrapers Structure and Design, Yale University Press, 2005, 4. Terranova, A. (Ed.),New Urban Giants - the Ultimate Skyscrapers, Edizioni White Star, 2008

Module name:	**Structural Testings**
Module level, if applicable	Master's Degree Programme
Code, if applicable	21870
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	III (Winter)
Person responsible for the module	Domagoj Damjanović, Marko Bartolac
Lecturer	Janko Košćak
Language	Croatian
Relation to curriculum	Master's degree programme, Structural Engineering Programme. Compulsory. Semestar III.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises (laboratory): 15
Workload	Lecture hours 30 Exercise 15 Other contact hours 20 Self study hours 70
Credit points	4,5 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, • Doing seminar work.
Recommended prerequisites	• Knowledge about the procedures for determining forces in structures, • Knowledge about the calculus of stress and deformations caused by axial and shear forces, torque moment (moment of force) and banding moment, • Knowledge about the basic procedures in analysing and dimensioning structures (concrete, metal and timber).
Module objectives/intended learning outcomes	• Analysing the behaviour of structure elements and bearing systems based on investigations, • Understanding the behaviour of structures at static and dynamic loads action, impact of the surroundings and rheological changes in the material, • Selection and application of equipment, procedures and methods in structural testing, • Planning the procedures to verify the structural safety, • Assessment of the state of structures and structural elements based on investigations, • Proving the structure's and its elements' ability to withstand the anticipated loads.
Content	• Lectures: 1. Introduction: the object of structural testing, classification of testings (research , control, laboratory, static and dynamic, short-term and long-term [3] 2. Mechanical and geometrical measures which are measured in structural testing. Absolute displacement of structural point. Changing the spacing of structural points (deformation). Angle of twist. Curvature. Relative deformations [3] 3. Measuring mechanical and geometric measures: equipment elements, hysteresis, measuring area etc. [2] 4. Measuring mechanical and geometric measures. Measuring equipment for: displacement, change of length, angle changes etc. Calibrating the equipment [2] 5. Tensometer, types of tensometers: mechanical, optical-mechanical, optical, acoustic, electric [2]

	6. Electro-resistant tensometers (ERT). Types. Installation, making an additional device for measuring displacement, acceleration, pressure force etc. [2] 7. Analysis of plane state of stress by deformation measurements. Types of states of stress. [2] 8. Methods of analysing the state of deformation and strain of structures and their elements. Moire method. Procedure with brittle materials [2] 9. Methods of analysing the state of deformation and strain of structures and their elements. Holographic methods, surveying, modelling [2] 10. Procedures for material testing and characteristics of tested structure. Extracting cores, ultra sound, sclerometer, radiography [2] 11. Static structural testing, project, implementation of the project [2] 12. Static structural testing. Loading mode. Result evaluation. Standards and conditions for the validity of a structure [2] 13. Dynamic testing. Project, implementation of the project. Loading mode and measurements taken [2] 14. Dynamic testing. Dynamic parameters of structures. Measurement result evaluation [2]. • Laboratory exercises: 1. Demonstration and description of the instruments for static and dynamic measuring [2] 2. Measuring the same measure by a portable comparator (determining the accuracy of the instrument). Calibrating the dose for measuring force (determining the constant of the instrument). Calibrating the inductive sensor (LVDT) for measuring displacement [3] 3. Measuring the deformations and deflection on the model of grids and walls with openings (models of plexiglass) [2] 4. Photoelastic method [2] 5. Measuring vibrations on the models [2] 6. Presentation of some examples of model testing and structure elements in laboratory [4].
Study and examination requirements and forms of examination	• Written exam – minimum 50% score, • Oral exam.
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. Lj. Herceg: Ispitivanje konstrukcija – skripta, http://www.grad.unizg.hr/predmet/ispkon 2. D. Damjanović: Ispitivanje konstrukcija – Bilješke preda anja, http://www.grad.unizg.hr/predmet/ispkon 3. A. Kiričenko i sur.: Mjerenje deformacija i analiza naprezanja konstrukcija, DIT-Zagreb, Zagreb, 1982, 4. D. Aničić: Ispitivanje konstrukcija, Osijek, 2002 Optional literature: 1. J. Krolo, D. Šimić, Mehanika materijala, Sveučilište u Zagrebu, Građevinski fakultet, Zagreb, 2011, 2. I. Alfirević, S. Jecić, Fotoelasticimetrija, Liber, Zagreb, 1983, 3. V. Brčić, R. Čukić, Eksperimentalne metode u projektiranju konstrukcija, Građ. knjiga, Beograd, 1988, 4. Thomas G. Beckwith, Roy D. Marangoni, John H. Lienhard, Mechanical measurements, AddisonWesley Publishing company, New York, 1995

Module name:	**English Language in Civil Engineering 2**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	93234
Subtitle, if applicable	
Courses, if applicable	Master's's programme 7 classes
Semester(s) in which the module is taught	III (Winter)
Person responsible for the module	Alemka Kralj Štih
Lecturer	
Language	English
Relation to curriculum	Master's Degree Programmes. Elective. Semester III.
Type of teaching, contact hours	Number of hours (in semester): • Exercises: 45
Workload	Lecture hours 45 Other contact hours 10 Self study hours 80
Credit points	4,5 ECTS
Requirements according to the examination regulations	• 75% attendance in lectures, • Making a presentation, • 3 pre-exams.
Recommended prerequisites	• Intermediate level, B 1.
Module objectives/intended learning outcomes	• Developing language competences which include professional terminology in the field of transport facilities and geotechnical engineering, • Independent user – ability to read technical literature independently, • Revision of basic grammar categories in professional language – passive, past tenses, modal verbs, • Confident use of sentences in professional language, developing presentation skills and skills in writing professional papers.
Content	• Exercises: 1. A Career in Structural Engineering – Varieties in the field of structural engineering [3] 2. Bridge Building – Damages in Arch Building [3] 3. Europe's Longest Viaduct[3] 4. Wembley Stadium[3] 5. Weak Points of the House[3] 6. At the Heart of Dome's Design Process [3] 7. Joint students' presentations [3] 8. Single students' presentations [3] 9. The Story of the Dome[3] 10. Hyatt Hotel Collapse[3] 11. Terminology practice in TIMBER STRUCTURES I [3] 12. Career Job Hunting – avoiding potential job (interview) disasters – Tips and Advice [3] 13. Creating a CV - How to write a CV? How to write a letter of application / Job Interview Questions [3] 14. Professional Development. Preparing for the Interview Skills – Techniques, Tips and Advice. Recruitment of graduates [3] 15. Preliminary exam [3]
Study and examination requirements and forms of examination	• The credits earned through all the testing and pre-exams make up the final grade. The grades are based as follows: pre-exam results, points earned during semester - active participation in class, grammar checks, translations into a foreign language, translations from a foreign language, professional vocabulary checks. Maximum number of points that can be

	earned in the pre-exam is 20 – the grade is multiplied by four. Students who have not earned enough points are required to take the final exam. • Grading is as follows - 50-62% score = sufficient (2), - 63-75% score = good (3), - 76-88% score = very good (4), - 89-100% score = excellent (5).
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. A. Kralj Štih: English in Structural Engineering, course materials. Optional literature: 5. D. Bonamy: Technical English 4, Pearson Longman, 2011 6. The Internet pages, program Building Big, Brantacan, ASCE. 7. Z. Vulelija: Ilustrirani rječnik arhitekture i građe inar t a – hrvatsko engleski i englesko hrvatski, Masmedia, Zagreb, 2010 8. A. Prager: Trojezični građevinski rječnik, Masmedia, Zagreb, 2002

Module name:	**German Language in Civil Engineering 2**
Module level, if applicable	Master's Degree Programm
Code, if applicable	93235
Subtitle, if applicable	
Courses, if applicable	Master's Programmes 1 class
Semester(s) in which the module is taught	III (Winter)
Person responsible for the module	Alemka Kralj Štih
Lecturer	
Language	German
Relation to curriculum	Master's Degree Programmes. Elective. Semester III.
Type of teaching, contact hours	Number of hours (in semester): 45 • Exercises (auditory):45
Workload	Lecture hours 45 Other contact hours 10 Self study hours 80
Credit points	4,5 ECTS
Requirements according to the examination regulations	• 75% attendance in exercised, • Preparing one presentation, • 3 pre-exams.
Recommended prerequisites	• German language competence at B1, B2 level.
Module objectives/intended learning outcomes	• Understanding and interpreting technical texts, • Independent oral skills in technical field, ability to explain professional terms, • Writing a CV and job applications.
Content	• Auditory exercises: 1. Die Geschichte des Kuppelbaus [3] 2. Wie schreibt man einen Lebenslauf? [3] 3. Bewerbungsschreiben [3] 4. Wie man sich auf ein Interview vorbereitet [3] 5. Die größte Drehbrücke der Welt [3] 6. Bewerbungsschreiben [3] 7. Die Geschichte der Tunnelkonstruktion [3] 8. Kräfte und Gegenkräfte [3] 9. Einige Festigkeitsarten [3] 10. Elastizität und Verformung [3] 11. Der Straßenbau [3] 12. Gebäude im Erdbeben [3] 13. Der Flughafen [3]
Study and examination requirements and forms of examination	• The credits earned through all the testing and pre-exams make up the final grade. The grades are based as follows: pre-exam results, points earned during semester - active participation in class, grammar checks, translations into a foreign language, translations from a foreign language, professional vocabulary checks. Maximum number of points that can be earned in the pre-exam is 20 – the grade is multiplied by four. Students who have not earned enough points are required to take the final exam. • Grading is as follows - 50-62% score = sufficient (2), - 63-75% score = good (3), - 76-88% score = very good (4), - 89-100% score = excellent (5).
Media employed	Whiteboard, projector.
Reading list	Required literature:

	1. A. Kralj Štih: Deutsch für Konstruktionen, Geotechnik, Verkehr un Theorie un M ellierung der Konstruktionen, Kursunterlagen, 2011 Optional literature: 1. A. Prager: Trojezični građevinski rječnik, Masmedia, Zagreb, 2002

IV. SEMESTER

Module name:	**Special Engineering Structures**
Module level, if applicable	Master's Degree Programme
Code, if applicable	21798
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	IV (Summer)
Person responsible for the module	Ana Mandić Ivanković
Lecturer	Dominik Skokandić
Language	Croatian
Relation to curriculum	Master degree programme, Structural Engineering Programme. Compulsory. Semester IV.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises: 15 (auditory - 6, design - 9)
Workload	Lecture hours 30 Exercise hours 15 Self study hours 55 Hours of skills 30 Other contact hours 5
Credit points	4,5 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, • Conceptual design of a special engineering structure, • Taking two pre-exams during semester (25 % score in each exam necessary for the signature).
Recommended prerequisites	• Knowledge on structures in terms of properties of materials and design of basic elements, • Knowledge on action effects on structures.
Module objectives/intended learning outcomes	• Theoretical knowledge about the specifics of engineering structures such as shells, tensile structures, high buildings, towers, chimneys, masts, wind and water towers, telecommunication structures, movable and floating bridges and submerged tunnels, • Ability to design a special engineering structure, • Knowledge and skills required to analyse the effects of wind and earthquakes on special engineering structures, • Knowledge and ability to design a special engineering structure in accordance with contemporary methods and criteria of European standards.
Content	• Lectures: 1. Shells – theory, types, design, examples [3] 2. Tensile structures – form finding, materials [2] 3. Tensile structures – actions, examples of real structures [2] 4. Tall buildings – structural systems, horizontal actions, rigid systems [3] 5. Towers, chimneys, masts, wind towers – general, types, function, examples [2] 6. Concrete towers – foundation, design [4] 7. Water towers – function, shapes, construction, seismic design of liquid containers [2] 8. Steel towers, masts, chimneys – design [2] 9. Telecommunication structures – design of masts with stay cables, demolition of masts and towers, foundations [4]

	10. Movable bridges – types, examples of design, construction and maintenance [2] 11. Floating bridges – types, examples of design, construction and maintenance [2] 12. Submerged tunnels [2]. • Auditory exercises: 1. Layout of the structure [1] 2. Definition of actions [1] 3. Structural analysis [1] 4. Designing for ultimate limit state [1] 5. Verification of serviceability limit states [1] 6. Detailing structure, creating the plan for a reinforcement or workshop drawing [1]. • Design exercises: 1. Conceptual design of a special engineering structure according to the points explained in the auditory exercises.
Study and examination requirements and forms of examination	• Written final exam - minimum 50% score, • Oral final exam – optional.
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. Z. Šavor, A.Mandić: Special Engineering Structures – lectures published on the web (in Croatian), Zagreb, 2011/2012, 2. Exercise notes published on the web. Optional literature: 1. Smith, B.V., Communication Structures,Thomas Telford, 2007, 2. Turmbauwerke, BetonKalender 2006 Teil 1, Ernst & Sohn, 3-517, 3. Lewis, W.J., Tension Structures Form and Behaviour, Thomas Telford, 2003, 4. Huntigton, C.G., TheTensioned Fabric Roof, ASCE Press, 2004, 5. Schlaich, J., Bergermann, R., leicht weit Light Structures, Prestel, 6. Widespan Roof Structures, compiled by M. Barnes & M. Dickson, Thomas Telford, 2000, 7. Petersen, Ch., Abgespannte Maste und Schornsteine Statik und Dynamik, Bauingenieur-Praxis, Heft 76, W. Ernst & Sohn 1970, 8. Irvine, M., Cable Structures, MIT Press, Cambridge, Mass., 1981, 9. Frei Otto Complete Works, Lightweight Construction Natural Design, Birkhäuser. Architekturmuseum TU München, 2005. 10. Koglin, T.L., Movable Bridge Engineering, John Wiley & Sons, 2003. 11. Analysis of the submerged floating tunnel concept, Forum of European National Highway Research Laboratories (FEHRL), Report No. 1996/2a. 12. Watanabe, E., Floating Bridges: Past and Present, Structural Engineering International (SEI), 2/2003.

Module name:	**Composite Structures**
Module level, if applicable	Master's Degree Programme
Code, if applicable	115165
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	IV (Summer)
Person responsible for the module	Ivica Džeba
Lecturer	Ivan Čurković
Language	Croatian
Relation to curriculum	Master degree programme, Structural Engineering Programme. Compulsory. Semester IV.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Design exercises: 15
Workload	Lecture hours 30 Excersizes hours 26 Consultations hours 4 Mid-term exams hours 4 Exam hours 3 Self study hours 68
Credit points	4,5 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, • 2 pre-exams - minimum 25%score in each, • Makeup pre-exam for students who did not achieve minimum 25% score in pre-exams, or for students who want to improve their score in regular pre-exam.
Recommended prerequisites	• Knowledge about statics of rigid body and connected systems, • Knowledge about the behavior of steel and reinforced concrete structures, • Knowledge about theoretical and practical procedures related to the design of steel and concrete structural elements and connections.
Module objectives/intended learning outcomes	• Ability to apply knowledge about the behaviour of steel and concrete as materials and the impact of that behavior on the resistance of composite structural elements, • Identifying key factors for determination of basic actions on composite structures, • Ability to determine the action effects at structural elements level for statically determined and statically undetermined systems, • Ability to determine design resistances of composite structural elements of beams, slabs and columns relating to ultimate limit state and serviceability limit state.
Content	• Lectures: 1. Introduction[2] 2. Terminology and defining the contents of the course[4] 3. General information on composite action, materials, types of connectors[4] 4. Structural analysis of composite structures [4] 5. Composite beams [2] 6. Composite slabs [2] 7. Composite columns and composite compression members [2] 8. Serviceability limit state[2] 9. Composite joints[2] 10. Resistance of cross-sections and member[2] 11. Shear connection[2]

	12. Constructional details [2]. • Design exercises: 1. Composite and non-composite state of steel elements[1] 2. Determination of creep of concrete[1] 3. Resistance of shear connectors[2] 4. Plastic bending resistance of composite beams[2] 5. Elastic bending resistance of composite beams[2] 6. Bending resistance of beams with partial shear connection[1] 7. Resistance of composite slabs[1] 8. Resistance of composite slabs – without end anchorage[1] 9. Resistance of composite slabs – with end anchorage[1] 10. Resistance of composite columns in compression[1] 11. Resistance of composite columns in combined compression and uniaxial bending[1] 12. Resistance of composite columns in combined compression and biaxial bending[1].
Study and examination requirements and forms of examination	• A two-part written exam and oral exam. The written part of the exam contains a practical part – design (students may be exempt from taking this part of the exam) and a theoretical part (mandatory for all students), • Minimum 60% score in each part of the exam.
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. Androić, Dujmović, Džeba: Steel Structures , IA Projektiranje, Zagreb, 2009, 2. Džeba: Composite Structures - Lectures, www.grad.hr/metali 3. Horvatić: Composite Strucures Steel - Concrete, Masmedia, Zagreb, 2003 Optional literature: 1. HRN EN 1994-1-1:2012 – Design of composite steel and concrete structures, Part 1-1: General rules and rules for buildings, 2. Johnson: Composite Structures of Steel and Concrete, Blackwell Publishing, Oxford, 3rd Edition, 2004

Module name:	**Earthquake Engineering**
Module level, if applicable	Master's Degree Programme
Code, if applicable	21800
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	IV (Summer)
Person responsible for the module	Darko Meštrović
Lecturer	
Language	Croatian
Relation to curriculum	Master degree programme. Structural Engineering Programme. Elective. Semester IV.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30
Workload	Lecture hours 30 Self study hours 40 Seminar preparation hours 15 Other contact hours 5
Credit points	3 ECTS
Requirements according to the examination regulations	• Attendance in lectures, • Two pre- exams.
Recommended prerequisites	• Prior knowledge on structures from Bachelor degree program, • Understanding and ability to apply calculus for concrete and steel structures, • Understanding basic structure systems, • Understanding and knowledge about static calculus for various static systems.
Module objectives/intended learning outcomes	• Ability to do conceptual design of various structure systems (concrete, steel, masonry and composite structures), • Ability to identify and analyse earthquake action on buildings and bridges by the use of modern European standards, • Ability to do conceptual design of structures with passive energy dissipation systems, • Ability to analyse and design seismically isolated structures.
Content	• Lectures: 1. Introduction to earthquakes [2] 2. Characteristics of the movement of the earth's surface [2] 3. Structural dynamic analysis [2] 4. Introduction to the range of responses [2] 5. The energy concept of earthquake engineering [2] 6. Earthquake design by Eurocode8 [2] 7. Fundamentals of seismic design of buildings and bridges [2] 8. Earthquake design of concrete structures [2] 9. Earthquake design of steel structures [2] 10. Earthquake design of masonry structures [2] 11. Earthquake design of composite structures [2] 12. Basic concept and design of structures with passive energy dissipation systems [2] 13. Dampers [2] 14. Basic analysis and design of structures for earthquake isolated structures [2] 15. Seismically isolated systems [2].

Study and examination requirements and forms of examination	• Written final exam - minimum 50% score,
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. Čaušević, M.,Potresno inženjerstvo, Sveučilišni udžbenik, Školska knjiga, Zagreb, 2001, 2. Čaušević, M.,Dinamika konstrukcija, Sveučilišni udžbenik, Školska knjiga, Zagreb, 2005 Optional literature: 1. Chopra, A.K,Dynamics Of Structures – Theory and Applications to Earthquake Engineering, Second edition, Prentice Hall, New Jersey, 2001, 2. Clough, R.; Penzien, J.,Dynamics Of Structures, McGraw-Hill, New York, 1975, 3. Eurocode 8 – Design of structures for earthquake resistance – Part 1: General rules, seismic actions and rules for buildings, EN 1998-1, Doc CEN/TC250/SC8/N335, Brussels, January 2003

Module name:	**Numerical Mathematics**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	21805
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	IV (Summer)
Person responsible for the module	Tomislav Došlić, Alan Filipin
Lecturer	
Language	Croatian
Relation to curriculum	Master's degree programme.Elective.Semestar IV.
Type of teaching, contact hours	Number of hours (in semester): 60 • Lectures: 30 • Exercises (auditory): 30
Workload	Lecture hours 28 Exercises hours 30 Other contact hours 2 Self study hours 60
Credit points	6 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises.
Recommended prerequisites	• Familiarity with the calculus, including ordinary differential equations, and basic linear algebra.
Module objectives/intended learning outcomes	• Understanding the conditions and limits of applicability of particular numerical methods, • Ability to choose and successfully apply correct methods.
Content	• Lectures: 1. Sources and types of errors (5) 2. Methods for solving non-linear equations (5) 3. Interpolation and approximation (5) 4. Numerical integration (5) 5. Numerical methods for solutions of ordinary differential equations (5) 6. Numerical linear algebra (5) • Exercises (auditory): follow the lectures.
Study and examination requirements and forms of examination	• Correct solution of a pre-assigned problem, • Oral exam.
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. T. Došlić, Numerička matematika, available at the course web-page. Optional literature: 1. E. Kreyszig: Advanced Engineering Mathematics, John Wiley and Sons Ltd., 1999,. 2. F. Scheid: Numerical Analysis, Schaum's Outline Series in Mathematics, McGraw-Hill

Module name:	**Perspective**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	21806
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	IV (Summer)
Person responsible for the module	Sonja Gorjanc
Lecturer	Iva Kodrnja, Helena Koncul, Dora Pokaz
Language	Croatian
Relation to curriculum	Master's Degree Programmes. Elective. Semester IV.
Type of teaching, contact hours	Number of hours (in semester): 60 • Lectures:30 • Exercises (auditory, design, laboratory): 30
Workload	Lecture hours 30 Hours of laboratories or skills 30 Other contact hours 30 Self study hours 90
Credit points	6 ECTS
Requirements according to the examination regulations	• 100% attendance in lectures and exercises, • 4 projects, • 1 seminar paper, • 1 pre-exam.
Recommended prerequisites	• Familiarity with the methods of parallel projection.
Module objectives/intended learning outcomes	• Mastering basic constructive procedures in perspective, • Acquiring knowledge on methods of construction of perspective image of an object, • Acquiring knowledge on geometric properties of algebraic surfaces of higher order, • Ability to construct perspective image of objects from civil engineering.
Content	• Lectures: 1. Central projection [8] 2. Quadric surfaces [4] 3. Ruled surfaces [6] 4. Computer modeling of surfaces [8] 5. Terrains in perspective [4] • Exercises (constructive, in computer classroom): 1. Central projection [8] 2. Quadric surfaces [4] 3. Ruled surfaces [6] 4. Computer modeling of surfaces [8] 5. Terrains in perspective [4]
Study and examination requirements and forms of examination	• Written exam - minimum 60% score, • Oral exam, • Students who have achieved a positive grade in projects, seminar paper and pre-exam are exempt from the written and oral exam.
Media employed	Whiteboard, projector.

Reading list	Required literature: 1. P. Kurilj, N. Sudeta, M. Šimić, Perspektiva (Perspective), Arhitektonski fakultet, Zagreb, 2005 Optional literature: 1. V. Niče, Perspektiva (Perspective), Školska knjiga, Zagreb, 1978, 2. B. Kučinić et al., Oble forme u graditeljstvu, Građevinar, Zagreb, 1992, 3. H. Brauner, W. Kickinger, Geometrija u graditeljstvu, Školska knjiga, Zagreb,1980

Module name:	**Basics of Differential Geometry**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	21804
Subtitle, if applicable	
Courses, if applicable	1 class for lectures 1 class for exercises
Semester(s) in which the module is taught	IV (Summer)
Person responsible for the module	
Lecturer	Iva Kodrnja, Sonja Gorjanc
Language	Croatian
Relation to curriculum	Master's degree programme.Elective.Semester IV.
Type of teaching, contact hours	Number of hours (in semester): 60 • Lectures:30 • Exercises (auditory, design, laboratory): 30
Workload	Lecture hours 30 Hours of exercise 30 Other contact hours 30 Self study hours 90
Credit points	6 ECTS
Requirements according to the examination regulations	• 100% attendance in lectures and exercises, • 2 projects, • 1 seminar paper, • 2 pre-exams.
Recommended prerequisites	• Familiarity with the basics of differential calculus and linear algebra.
Module objectives/intended learning outcomes	• Acquiring basic knowledge about differential geometry of curves and surfaces in Euclidean space, • Ability to solve tasks in differential geometry by using program Mathematica, • Knowledge about the properties of minimal surfaces, • The ability to apply the methods and content of differential geometry in civil engineering.
Content	• Lectures: 1. Curves in Euclidean space [8] 2. Surfaces in Euclidean space [10] 3. Curvatures of surfaces [6] 4. Mapping of surfaces [4] 5. Minimal surfaces [4]. • Exercises (constructive, in computer classroom): 1. Curves in Euclidean space [8] 2. Surfaces in Euclidean space [10] 3. Curvatures of surfaces [6] 4. Mapping of surfaces [4] 5. Minimal surfaces [4].
Study and examination requirements and forms of examination	• Written exam - minimum 60% score, • Oral exam, • Students who have achieved a positive grade in projects, seminar paper and pre-exam are exempt from written and oral exam.
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. I. Kamenarović, Diferencijalna geometrija, Sveučilište u Rijeci, Pedagoški fakultet, Rijeka, 1990,

	2. J. Beban-Brkić: web-scrip:http://www.grad.hr/itproject_math/Links/jelena/index.html Optional literature: 1. Gray, A.: Modern Differential Geometry of Curves and Surfaces With Mathematica, CRS Press, Boston, London, 1998, 2. On-line Encyclopedia of mathematical concepts: MathWorldWolfram

Module name:	**Waves and Oscillations**
Module level, if applicable	Master's Degree Programme
Code, if applicable	21807
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	IV (Summer)
Person responsible for the module	Dario Jukić
Lecturer	
Language	Croatian and/or English
Relation to curriculum	Master degree programme, Physics. Elective. IV Semester.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises: 30 (auditory - 15, laboratory - 15)
Workload	Lecture hours 30 Hours of laboratories 15 Hours of practical exercies 15
Credit points	6 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, • Three pre-exams – minimum 35% score in each, • One make up exam.
Recommended prerequisites	• Undergraduate course mathematics, including differential equations, • Basics of programming and use of Mathematics software.
Module objectives/intended learning outcomes	• Mastering equations on given problems: free vibrations of simple systems – wires, slabs; waves and wire extension in one, two or three dimensions, deformations, • Understanding the physical background of the equations taught in professional and mathematical courses, • Ability to find equations through physical properties of a problem – coupled oscillations and vibrations, acoustic wave spreading, acoustic insulation, • Modeling by applying a harmonic oscillator, • Computer modelling of individual physical models of the problems dealt with in professional and mathematical courses, • Understanding physical properties of forced oscillation and interference, • Understanding the physical basis for measurements in civil engineering.
Content	• Lectures: 1. Basics of deriving equations from given problems (4) 2. Waves and wave propagation in one, two or three dimensions, deformations (5) 3. Physical background for the equations mastered in professional and mathematical courses (5) 4. Finding solutions for the equations through physical properties of problems (5) 5. Modeling by harmonic oscillator (2) 6. Computer modeling of physical models for problems dealt with in professional and mathematical courses (3) 7. Physical properties of forced oscillations, interferences (5) 8. Physical basis of measurements in civil engineering (2). • Exercises (auditory, laboratory): 1. Free vibrations of simple systems – wires, slabs (4) 2. Coupled oscillations and vibrations, acoustic wave spreading, acoustic insulation (9)

	3. Coupled oscillations and vibrations, acoustic wave spreading, acoustic insulation (7) 4. Modeling: physical models (3) 5. Forced oscillations, interferences (5) 6. Physical measurements (2). • Seminars: included in exercises.
Study and examination requirements and forms of examination	• Pre-exam – students with a minimum 60% score are exempt from a part of the final exam (only final test is mandatory) End of semester grading: • The final test is the requirement for the final exam.
Media employed	Whiteboard, projector, experiments integrated with the lecture presentation.
Reading list	Required literature: 1. F. S. Crawford, Waves: Berkeley physics course v.3, McGraw-Hill college, 1968 Optional literature: 1. A. P. French, Vibrations and Waves, W.W. Norton & Company, New York, 1971

CONSTRUCTION MATERIALS PROGRAMME

I. SEMESTER

Module name:	**Mathematics 3**
Module level, if applicable	Master’s Degree Programmes
Code, if applicable	21802
Subtitle, if applicable	
Courses, if applicable	I class (84 students) 1 lecture, 2 auditory groups
Semester(s) in which the module is taught	I (Winter)
Person responsible for the module	Tomislav Došlić, Alan Filipin
Lecturer	Nikola Adžaga, Rafael Mrđen
Language	Croatian
Relation to curriculum	Master’s degree programme for all engineering programmes. Compulsory elective. Semester I.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 45 • Exercises (auditory): 30
Workload	Lecture hours 45 Hours of exercise 15 Other contact hours 30 Self study hours 135
Credit points	7,5 ECTS
Requirements according to the examination regulations	• Regular attendance in lectures and exercises, • Minimum 25 % score in the pre-exam.
Recommended prerequisites	• Understanding the calculus of one and several variables, including ordinary differential equations, and basic linear algebra.
Module objectives/intended learning outcomes	• Understanding the conditions and limits of applicability of linear models, • Ability to recognize and choose a correct model, • Ability to solve (analytically and/or numerically) simple linear models.
Content	• Lectures: 1. Ordinary differential equations [3] 2. Fourier series [3] 3. Partial differential equations, linear models of mathematical physics [20] 4. Numerical methods for solutions of ordinary and partial differential equations [16] • Exercises (auditory) follow the lectures.
Study and examination requirements and forms of examination	• Minimum 50% score in the written exam, • Students passing the pre-exam take only the second part, • Oral exam.
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. T. Došlić, D. Pokaz: Matematika 3, available on the course web-page. 2. T. Slijepčević-Manger: Zbirka zadataka iz Matematike 3, available on the course web-page. Optional literature: 1. E. Kreyszig: Advanced Engineering Mathematics, John Wiley and Sons Ltd., 1999, 2. F. Scheid: Numerical Analysis, Schaum's Outline Series in Mathematics, McGraw-Hill

Module name:	**Stochastic Processes**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	I (Winter)
Person responsible for the module	Tomislav Došlić, Alan Filipin
Lecturer	Rafael Mrđen, Kristina Ana Škreb
Language	Croatian
Relation to curriculum	Master degree programme for all engineering programmes. Compulsore elective. Semester I.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 45 • Exercises (auditory): 30
Workload	Lecture hours 45, hours of exercise 30, other contact hours 30, self study hours 120.
Credit points	7.5 ECTS
Requirements according to the examination regulations	• Regular attendance • Minimum 25 % score in the pre-exam.
Recommended prerequisites	
Module objectives/intended learning outcomes	• Understanding conditions and limits of applicability of stochastic models, • Ability to recognize and choose correct model. • Ability to formulate and solve simple problems in terms of Markov chains and processes.
Content	• Lectures: 1. Basic characteristics and examples of stochastic processes [3], 2. Markov chains with discrete time and finite and countable set of states [27], 3. Markov processes [6], 4. Poisson processes and the theory of queues [6], • Exercises (auditory: follow the lectures.
Study and examination requirements and forms of examination	• Eliminatory written exam - minimum 50 % score, • Students who pass the pre-exam take only the second part, • Oral exam.
Media employed	Blackboar, whiteboard, projector.
Reading list	Required literature: 1. N. Berglund, Processus aleatoires et applications, available as Croatian translation on the course web-page and originally at ArXiv.org. Optional literature: 1. R. Durrett: Essentials of Stochastic Processes, Springer Texts in Statistics, Springer, New York, 1999, 2. D. P. Bertsekas, J. N. Tsitsiklis: Introduction to Probability, On line lecture notes, M.I.T., 2000.

Module name:	**Research methods**
Module level, if applicable	Master's Degree Programme
Code, if applicable	21822
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	I (Winter)
Person responsible for the module	Anita Cerić
Lecturer	
Language	Croatian
Relation to curriculum	Master's degree programme. Compulsory for all subject areas at Graduation studies. Semestar I.
Type of teaching, contact hours	• Lectures: 15 • Seminars: Students are obliged to write a seminar paper on an assigned topic.
Workload	Lecture hours 15 Other contact hours 10 Self study hours 20
Credit points	1.5 ECTS
Requirements according to the examination regulations	Writing a seminar paper or a positively graded test.
Recommended prerequisites	
Module objectives/intended learning outcomes	• Collecting literature from different sources, • Defining the hypothesis, • Choosing an appropriate research method and methodology, • Using different techniques in data collection, • Writing essays, papers and reviews, • Presenting and discussing research findings.
Content	• Lectures: 1. Collecting literature and information 1 (2) 2. Role of hypothesis and general structure of the thesis 1 (1) 3. Writing papers, critiques and essays 2 (2) 4. Data collection 1 (1) 5. Research methodology 2 (1) 6. Research methods 3 (2) 7. Reporting the results 1 (2) 8. Citing references 2 (3) 9. Bibliography 1 (2) 10. Presentation skills 1 (1)
Study and examination requirements and forms of examination	• Written paper, • Written exam
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. Zelenika, R. Metodologija i tehnologija izrade znanstvenog i stručnog djela, Rijeka: Ekonomski fakultet Sveučilišta u Rijeci, 1999 (in Croatian) 2. Cerić, A., Textbook for Civil Engineering Students, 2012, (in Croatian) Optional literature: 1. Fellows, R. And Liu, A., Research Methods for Construction, Oxford: The Blackwell Science, 1997 2. 2.Naoum, S.G., Dissertation Research and Writing for Construction Students, Oxford: ButterworthHeinemann, 2007

Module name:	**Theory and Technology of Concrete**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	21808
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	I (Winter)
Person responsible for the module	Nina Štirmer
Lecturer	Ana Baričević, Marija Jelčić Rukavina
Language	Croatian
Relation to curriculum	Master's degree programme. Construction Materials Programme. Compulsory. Semester I.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises: 14 (auditory -8, laboratory – 6) • Seminars: 16
Workload	Lecture hours 30 Hours of exercises 30 Preparation of independent project 30 Other contact hours 20 Self study hours 70
Credit points	6 ECTS
Requirements according to the examination regulations	• Attendance in lectures – minimum 75 %, • Attendance in all exercises, • Seminar paper, • pre-exams – minimum 25% score in each.
Recommended prerequisites	• Basic knowledge on components for concrete production, • Knowledge about concrete mix design.
Module objectives/intended learning outcomes	• Making concrete mix design for required properties in use (validated by testing on the structure), • Making designed concrete in concrete plant, • Creating quality assurance plan for execution of concrete structures, • Testing concrete properties in fresh state and certain properties in hardened state, • Estimating influence of components and technology of production on the properties of concrete in fresh and hardened state, • Evaluating the results of testing concrete properties, • Ability to differentiate special concrete types and their basic properties, • Knowledge about future trends in the field of concrete technology.
Content	• Lectures: 1. Introduction [2] 2. Components of concrete composition – Cement – classification according to types and production technology, production, hydration, setting, hardening, quality assurance [2] 3. Components of concrete composition – Aggregate – significance, classification, types, mineralogy, texture, grain size distribution; Water [2] 4. Components of concrete composition – Additives, classification, significance, types, influence on concrete properties [2] 5. Fresh concrete – properties and its significance; concrete mix design [2] 6. Structure of hardened concrete [2] 7. Strength and conditions of stress in concrete [2] 8. Dimensional stability [4] 9. Durability / Influences – special durability loads, causes of concrete degradation and consequences of durability loads [2]

	10. Concrete production; Transport, placing, compaction and curing [2] 11. Modeling concrete properties, the most significant software programs, explanation, application [2] 12. Special concretes – new types and technologies [4] 13. The future of concrete – scope and perspectives in properties and application [2]. • Exercises (auditory, design, laboratory): Auditory exercises: 1. Quality assurance of materials for concrete structures – selection of constituents for concrete, production, quality control, conformity assessment [2] 2. Quality assurance of materials for concrete structures – requirements for execution of concrete works, maintenance plan for concrete structure [2] 3. Concrete mix design by using software programs [2] 4. Control of concrete production and placement [2]. Laboratory exercises: 1. Testing concrete properties in fresh state [3] 2. Testing concrete properties in hardened state [3]. • Seminar: 1. Selection of concrete constituents for specific concrete structure, concrete mix design, quality control of execution of concrete structure including transport, placement, compaction, curing and sampling of concrete.
Study and examination requirements and forms of examination	• Written exam - minimum 60 % score, • Oral exam.
Media employed	Whiteboard, projector, laboratory equipment
Reading list	Required literature: 1. D. Bjegović, N.Štirmer,Theory and technology of concrete, course repository http://www.grad.unizg.hr/predmet/titb, 2. Ukrainczyk, V.,Concrete – structure, properties and technology, Alcor, Zagreb, 1994, 3. P. Krstulović, Properties and technology of concrete, Faculty of civil engineering, University of Split, ISBN 953-6116-20-0 4. P. K. Mehta, P. J. M.Monteiro,Concrete – microstructure, Properties and Materials, McGraw-Hill, 2006, 5. A. M. Neville, Properties of Concrete, Prentice Hall, 1995, 6. D. Bjegović, G.Balabanić, D. Mikulić,Construction materials - collection of solved problems, Faculty of civil engineering, University of Zagreb, 2007, 7. A. Đureković, Cement, cement composite and additives for concrete, Školska knjiga, Zagreb, 1996 Optional literature: 1. M. F. Ashby, D. R. Jones, Engineering materials 1, Butterworth Heinemann, 1996, 2. J. M. Illston, P. L. J. Domone, (ed.), Construction materials – their nature and behaviour, E & FN SPON Chapman & Hall, 1994, 3. K. Maekawa, Chaube, R. P., Kishi, T.,Modelling of Concrete Performance, Hydration, Microstructure and Mass Transport, Spon Press, 2000, 4. Dewar, J.,Computer modeling of Concrete Mixtures, Spon Press, 2000, 5. Muravljov, M.,Basics of theory and technology of concrete, 3rd edition, Građevinska knjiga, Beograd, 2005, 6. Grdić, Z.,Technology of concrete, GAF, Niš, 2011

Module name:	**Building physics**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	21809
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	I (Winter)
Person responsible for the module	Ivana Banjad Pečur, Bojan Milovanović
Lecturer	Marina Bagarić
Language	Croatian
Relation to curriculum	Master degree programme. Construction Materials Programme. Compulsory. Semester I.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises: 30 (auditory - 16, design - 8, laboratory - 6)
Workload	Lecture hours 30 Hours of exercises 30 Project 15 Seminar 15 Other contact hours 15 Self study hours 75
Credit points	6 ECTS
Requirements according to the examination regulations	• Attendance in lectures – minimum 75%, • Attendance in exercises 100%, • Program execution, • Seminar paper, • Two pre-exams – minimum 50% score in each, • One make up exam.
Recommended prerequisites	• Knowledge about physical, mechanical and thermal properties of materials, • Knowledge about the basics of statistics.
Module objectives/intended learning outcomes	• Describing the production technology of various construction materials, • Ability to explain testing manners of thermal-hygrometric and acoustic properties of insulation building materials, • Ability to define the mechanisms of action of the environment on insulating materials, • Designing thermal-hygrometric and acoustic protection of buildings, • Ability to compare the properties of different insulation materials, • Ability to apply the testing results of insulating building materials.
Content	• Lectures: 1. Introduction to Building physics. Definition, importance, history [2] 2. Heat: basic scientific terms on heat. Heat transfer – conduction, convection, radiation, solar radiation [2] 3. Thermal properties of building materials [2] 4. Thermal insulation of construction elements. Temperature curve. Heat accumulation [2] 5. Moisture transport. Moisture, humid air. Condensation on the inner surface of the outer building elements [2] 6. Diffusion of water vapour through construction elements [2] 7. Combined transport – heat, air, moisture [2] 8. Thermal bridges [2] 9. Thermal stability of outer construction elements [2] 10. Acoustics: physical properties of sound. Sound waves in enclosed space [2]

	11. Building materials for noise protection. Contemporary materials [2] 12. Transmission of airborne sound from room to room [2] 13. Transmission of impact sound from room to room [2] 14. Noise. Sound insulation and calculation methods of sound insulation [2] 15. Noise protection [2]. • Exercises (auditory): 1. Thermal problems – tasks [2] 2. Mass transport problems [2] 3. Mass transport problems – tasks [2] 4. Introduction to the calculation standards [2] 5. Design project phases [2] 6. Moisture [2] 7. Noise [2] 8. Noise protection – details of construction [2]. • Exercises (design): 1. Computer software for building physics – program task solutions [8] • Exercises (laboratory): 1. Thermal conductivity: task perfosmance, interpretation of results [2] 2. Thermography [2] 3. A visit to the Laboratory for building physics at the Croatian Civil Engineering Institute [2].
Study and examination requirements and forms of examination	• Oral exam.
Media employed	Whiteboard, projector, laboratory testing equipment.
Reading list	Required literature: 1. Šimetin, Vladimir, Građevinska fizika, GI, Fakultet građevinskih znanosti Sveučilišta u Zagrebu, Zagreb, 1983, 2. Hens, Hugo, Building Physics - Heat, Air and Moisture: Fundamentals and Engineering Methods with Examples and Exercises, Wiley-VCH, 2008, 3. Hagentoft, Carl-Eric, Introduction to Building Physics, Studentlitteratur AB, 2001, 4. Galović, Antun, Termodinamika I, Fakultet strojarstva i brodogradnje, Zagreb, 2004, 5. Galović, Antun, Termodinamika II, Fakultet strojarstva i brodogradnje, Zagreb, 2003, 6. Kulišić, Petar, Mehanika i toplina, Školska knjiga, Zagreb, 2005 Optional literature: 1. Staufenbiel, Georg, Wessig, Josef, Bauphysik und Baustofflehre – eine Einfuhrung in Experimenten, Bauverlag BV GmbH, 1989, 2. Porges, George, Applied Acoustics, Peninsula Publishing, 1987, 3. Burns, William, Noise and Man, John Murray Publishers Ltd, 1973, 5. Brandt, Jörg, Moritz, Helmut, Bauphsysik nach Maß, Vbt Verlag Bau U. Technik, 2003, 6. Cammerer, Walter F.,Wärme- un Kälteschutz im Bauwesen un in der Industrie, Springer, Berlin, 2002, 7. Monograph,Građevinska fizika i materijali – Jugoslovensko društvo za ispitivanje i istraživanje materijala i konstrukcija, Beograd, 2003. 8. Gaskell, David,Introduction to the Thermodynamics of Materials, Taylor & Francis, London, 1995, 9. Isachenko, V.,Osipova, Sukomel, Alexander,Heat Transfer, University Press of the Pacific, 2000

Module name:	**Polymers**
Module level, if applicable	Master's Degree Programme
Code, if applicable	21875
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	I (Winter)
Person responsible for the module	Ana Skender
Lecturer	
Language	Croatian
Relation to curriculum	Master degree programme. Construction Materials Programme. Compulsory. Semester I.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises: 9 • Midterm exams: 3 • Field trip: 3
Workload	Lecture hours: 30 Hours of laboratories or skills: 15 Face-to-face teaching: 10 Independent study: 80
Credit points	4,5 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, • Pre-exam.
Recommended prerequisites	• Familiarity with specific literature, prior knowledge of Strength of materials, skills or participation in preparatory modules.
Module objectives/intended learning outcomes	• Knowledge about basic types of polymeric materials and their properties as well as appropriate production processes, • Understanding the advantages of using polymeric materials and composites in civil engineering over conventional materials; • Learning about different application areas of polymeric materials and composites in civil engineering with the emphasis on bridge construction; • Learning about the principles of quality control and certification of structural elements based on examples like structural bearings and expansion joints.
Content	• Lectures: 1. General information on polymers: history; polymeric materials in civil engineering; composition; procedures of polymers: polymerisation, polycondensation, polyaddition, combined procedures; classification of polymeric materials on the basis of physical properties, conditions of processing, application [3] 2. Major types of polymeric materials in construction of buildings[3] 3. Processing: vulcanisation; extrusion; calendaring; pouring; pressing; sintering; blowing; laminating; rolling; injection [3] 4. Properties. Mechanical properties: static and dynamic load; long-term and short-term load; fatigue; temperature depended properties; residual stresses and brittle fracture; permanent deformations; boundary states at unidirectional and multidirectional stresses; time depended properties; theory of linear and non-linear viscoelasticity; rheological models; testing procedures. Non-mechanical properties: density, thermal properties, diffusion, electrical properties, chemical resistance, toxicity, optical

	properties, resistance to biological influences. Testing procedures. Ageing. Characteristics under fire. Bonding [3] 5. Reinforced polymeric materials: types; properties; production [3] 6. Foam polymeric materials: types; properties; production [3] 7. Application of polymeric materials in civil engineering: wall and roof elements; pipes and fitting elements; domes, shells and membranes; geosynthetic materials; sandwich elements; polymeric mortars and concretes; surface protection; waterproofing; environmental protection; supports; sealings; vibration and earthquake resistant isolation; design, production and installation. Polymeric materials in structure repair and maintenance [9] 8. Quality control of polymeric products in civil engineering [3]. • Exercises (auditory, design, laboratory): 1. Experimental testing of polymeric materials and structural elements. • Field trip: 1. Visiting companies that produce polymeric materials and composites used in civil engineering.
Study and examination requirements and forms of examination	written and/or oral final exam
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. Ž. Šimunić, Polymers in Civil Engineering, University of Zagreb, Faculty of Civil Engineering, Zagreb, 2006 2. Ž. Šimunić, A. Dolanjski, Elastomeric bearings, University of Zagreb, Faculty of Civil Engineering, Zagreb, 2007 Optional literature: 1. N.G. McCrum, C. P. Buckley, B. Bucknall, Principles of Polymer Engineering, 2nd ed., Oxford University Press, New York, 1997, 2. F. Naeim, F.,J. Kelly, Design of Seismic Isolated Structures, Wiley & Sons, Inc., New York, 1999

Module name:	**Mechanics of Materials**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	21862
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	I (Winter)
Person responsible for the module	Joško Krolo, Diana Šimić Penava
Lecturer	Janko Košćak, Ivan Duvnjak
Language	Croatian
Relation to curriculum	Master's Degree Programme. Construction Materials Programme. Compulsory. Semestar I.
Type of teaching, contact hours	Number of hours (in semester): • Lectures:30 • Exercises: 15 (auditory - 4, design - 11)
Workload	Lecture hours 30 Exercise hours 6 Experimental practice in laboratory hours 9 Other contact hours 10 Self study hours 80
Credit points	4,5 ECTS
Requirements according to the examination regulations	• Attending lectures and exercises, • One Colloquium: student should solve at least 25%, • Writing a seminar paper.
Recommended prerequisites	• Knowledge about differential and integral calculus. Knowledge about mechanics (statics and kinematics). Understanding the concepts of stress and strain. Knowledge about calculation stresses and strains in the elements loaded internal forces (longitudinal and transverse, to torque and bending moment).
Module objectives/intended learning outcomes	• Knowledge about strength, stiffness and stability of engineering structures. Dimensioning engineering structural members, • Ability to solve different engineering problems in the field of mechanics of body deformability, • Understanding the types of testing mechanical properties of materials, methods and standards for testing. • Understanding the structure of matter, structurally sensitive and insensitive properties, selective and additive theory, • Understanding and interpreting the method of determining the mechanical properties of materials, • Understanding the strength of materials under cyclic loading, • Identifying the meaning of rheology and fracture mechanics, • Understanding the concept of hardness of materials and test methods. • Understanding the manners of non-destructive testing of materials and applying them, • Applying the experimental stress and strain analysis in determining the physical and mechanical properties of materials.
Content	• Lectures: 1. The impact of a construction material structure on mechanical properties of a material, probabilistic character of mechanical properties and sensitivity structure, the theory of selectivity and the theory of addition. 2. Modeling and measurement effect. Load, time temperature. Testing methodology, testing devices. Devices for strain measuring. Interpretation of testing results. Mechanical properties of material in static loads. Conventional work chart of a material in stretching and pressure.

	Characteristics of a material deformability. Ductility material. Brittle materials. 3. Real material chart. Anisotropy of mechanical properties. Idealization of work material chart. Elastoplastic material with strengthening ideally elastoplatic material, solid plastic material, solid and plastic material with reinforcement. 4. Impact of external factor on mechanical properties of material in static load. Backward stresses. Basic forms of material destruction in stretching and pressure. Long-term static loading. Statically durable strength of material. Creeping of material. Relaxation of stress. 5. Strength of material in dynamic loading. Types of dynamic loading. Impact strength of material ductility. External factors affecting the impact strenth of material. Testing procedures. Strength of material in cyclically changeable loading. 6. Fatigue in material. Determination of dynamic strength of material. The impact of factors on durable dynamic strength of material. Coefficient of safety and allowed stress. 7. Fracture mechanics and strength of material. Basic shapes of crack development. Stress intensity factor. Criteria of fracture. Ductility of fracture. Material sensitivity on cuts and cracks. 8. Rheological properties of material. Rheological condition equation of material. The principle of superposition of time and temperature. Rheological models. Hardness of material. Procedures of hardness testing: ripping, indenting and rebound. Hardness correlation of material and strength of material. • Exercises (auditory, design, laboratory): 1. Auditory– Strength of material in cyclically variable load. Fatigue of materials. Determination of the dynamic strength of materials. Fracture mechanics. The hardness of the material. Nondestructive testing. 2. Laboratory–σ-εdiagram under static and dynamic loading. Bauschingerov effect. Elastic hysteresis. Determination of the tensile strength of brittle materials. Testing of pressure. Effect of sample size on the strength of the material. Testing of shear. Bending test. Testing of alternate folding. Testing of twisting. Charpy impact strength and Föpplu. Fatigue of materials. Hardness: Martens, Brinell, Poldi, Schmidt hammer. Fracture mechanics. Acoustic procedures. Determination of stress in the wire.
Study and examination requirements and forms of examination	• The written part of the exam: at least 50%, • Oral exam.
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. J. Krolo, D. Šimić: Mehanika materijala, Sveučilište u Zagrebu, Građevinski fakultet, Zagreb, 2011. 2. Šimić, V.: Otpornost materijala II, Školska knjiga, Zagreb, 2002. Optional literature: 1. Bazjanac, D., Nauka o čvsrstoći, Tehnička knjiga, Zagreb, 1973. 2. Timošenko, S., Otpornost materijala II, Građevinska knjiga, Beograd, 1965. 3. Timošenko, S., Mechanics of Materials, Van Hostrand Reinhold Company, New York, 1972.

II. SEMESTER

Module name:	**Applied Geology**
Module level, if applicable	Master’s Degree Programmes
Code, if applicable	21717
Subtitle, if applicable	
Courses, if applicable	1. Applied Geology, 2. Hydrogeology and Engineering Geology
Semester(s) in which the module is taught	II (Summer)
Person responsible for the module	Meho-Saša Kovačević
Lecturer	
Language	Croatian, English
Relation to curriculum	Master’s degree programme. Compulsory elective. Semestar II.
Type of teaching, contact hours	Number of hours (in semester): • Lectures:30
Workload	Lecture hours 30 Other contact hours 10 Self study hours 50
Credit points	3 ECTS
Requirements according to the examination regulations	• Attendance in 75% lectures, • Minimum 25% score in the pre-exam.
Recommended prerequisites	• Kowledge of basic chemical elements and compounds.
Module objectives/intended learning outcomes	• Ability to distinguish between igneous, metamorphic and sedimentary rocks, • Ability to identify layers, faults and overthrust, • Knowledge about the process of the formation of karst and various karst formations and learning about the problems which constructors encounter during construction of tunnels in karst, • The ability to use geological maps – recognition of geological symbols, determination of the geological age of rocks, their composition and other important geological phenomena of a terrain, • Knowledge of basic engineering-geological rock mass classification.
Content	• Lectures: 1. Introduction [2] 2. General information about the geosciences, Geology general, stratigraphic; Constitution of Earth; Geoid; Mineralogy; Mineral; Crystal [2] 3. Isotropic and anisotropic minerals; pyrogenic, pneumatogenic, hydrothermal, hydatogenic; Axis, center plane of symmetry; crystal systems; properties of crystals, crystal connection; tetrahedral coordination, coordination number; Polymorphism; Isomorphism [2] 4. The properties of minerals, Mineral groups; oxides and hydroxides, carbonates, sulfates, silicates [2] 5. Introduction to Petrology; Rock phenocrysts, Monomineral; igneous rocks; types of igneous rocks, structure and texture of igneous rocks; Acidity of magma; Bowen series of crystallization; Table of igneous rocks [2] 6. Sedimentary rocks, sediment transport, mineral composition of sedimentary rocks , structures and textures of sedimentary rocks; General overview of sedimentary rocks, metamorphic rocks, metamorphic zones; types of metamorphic rocks [2] 7. Tectonics, rock exposures, outcrops, thickness of layers, anticlines and synclines, faults, over thrust, types of cracks [2]

	8. Pre-exam [2] 9. Egzodynamic processes; insolation, hydrogeology, water, the hydrologic cycle, porosity, permeability, laminar and turbulent flow; types of aquifers; Ghyben Herzberg law; Ice and Snow, Wind, organisms [2] 10. Pre-exam [2] 11. Karst; external karst formations; interior karst formations [2] 12. Types of caves, speleothems, groundwater [2] 13. Landslides; Endodynamics; orogeny, epirogensis [2] 14. Volcanoes, Earthquakes; Earthquake scales, seismicity [2] 15. Geological maps, RMR and Q classification of rocks in the construction domain; determining the age of rocks [2]
Study and examination requirements and forms of examination	Written and oral exam.
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. Herak, M., Geology, 1990 2. Šestanović, S., Basics of Geology and Petrology, 2001 Optional literature: 1. West, T.,Geology Applied to Engineering, 1994 2. Monroe, J. & Wicander, R., Physical geology, 2006 3. Plummer,C., McGeary,D. & Carlson, C., Physical Geology, 2010

Module name:	**Environmental Protection**
Module level, if applicable	Master's Degree Programme
Code, if applicable	
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	II (Summer)
Person responsible for the module	Živko Vuković
Lecturer	
Language	Croatian
Relation to curriculum	Master's degree programme. Compulsory elective. Semester II..
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30
Workload	Lecture hours 30 Consultation hours 30 Self study hours 30
Credit points	3 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, • Two pre-exams.
Recommended prerequisites	• Basic knowledge in physics, biology, chemistry and civil engineering.
Module objectives/intended learning outcomes	• Understanding basic ecological processes, • Recognising and explaining basic ecological principles, • Explaining basic technological procedures of wastewater treatment, • Understanding waste management, • Understanding the concept of "sustainable development".
Content	• Lectures: 1. Introduction [2] 2. Basic ecological concepts (ecology, biotop, biocenose, ecosystem, biodiversity) [3] 3. Global changes in biosphere –changes in atmosphere [2] 4. Pedosphere pollution [2] 5. Hydrosphere pollution [3] 6. The impact of cities [3] 7. The impact of landfills [3] 8. Impact of hydraulic structures [3] 9. Transportation facilities impact [3] 10. Environmental sustainability and sustainable development [3] 11. Measures and environmental protection procedure (political and sociological approach, legal measures, environment planning, economic and financial measures, scientific approach and technological measures, institutional measures [3]
Study and examination requirements and forms of examination	Students with minimum 60 % score in each pre-exam are exempt from the final oral exam.
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. Vuković, Ž.: Environment Protection, Manuscript, 2014, Zagreb (in Croatian). Optional literature: 1. Raven, P. H., Berg, L. R., Hassenzahl, D. M.: Environment, 7th Edition, Wiley, 2010. 2. Miller, G. T.: Living in the Environment: Principles, Connections, and Solutions, 15th Edition, Thomson Books, 2007.

Module name:	**Quality Management**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	93220
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	II (Summer)
Person responsible for the module	Nina Štirmer, Ivan Gabrijel
Lecturer	
Language	Croatian
Relation to curriculum	Master's degree programme. Construction Materials Programme. Elective. Semester II.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 45 • Exercises: 30 (auditory – 10, design – 20)
Workload	Lecture hours 30 Hours of exercise 30 Seminar 10 Other contact hours 20 Self study hours 90
Credit points	7,5 ECTS
Requirements according to the examination regulations	• Attendance lectures minimum 75 %, • Attendance in exercises 100%, • programs, • pre-exams - minimum 25 % score in each.
Recommended prerequisites	• Knowledge on basic probability distributions, • Kknowledge on conformity assessment of construction materials.
Module objectives/intended learning outcomes	• Preparation of quality manual, • Organizing interlaboratory comparison testing, • Ability to apply statistical methods for construction materials quality assessment, • Creating a sampling plan, • Making a control chart and operative curve, • Describing management systems.
Content	• Lectures: 1. Introduction to quality and quality management [3] 2. Laboratory accreditation and certification of construction products [3] 3. Basic principles of quality control, quality assurance and total quality management [3] 4. Statistical tools for analysing data [3] 5. Quality information systems [3] 6. Quality management methods and techniques [3] 7. Factory production control [3] 8. Quality management in concrete production [3] 9. Harmonisation of Croatian legislation with EU legislation [3] 10. European and international quality standards [3] 11. Quality in construction projects [3] 12. Environmental management – life cycle assessment (LCA) [3] 13. Uncertainty measurement [3] 14. Quality assurance of testing results [3] 15. Trends in quality management [3]. • Auditory exercises: 1. Creation of laboratory quality manual [2] 2. Materials sampling plans for testing quality control [2]

	3. Preparation of quality control plan for construction materials [2] 4. Application of statistical methods for assessment of materials quality [2] 5. Conformity assessment of construction materials [2]. • Design exercises: 1. Preparing procedures for laboratory quality manual, sampling plans, operative curves, assessment of measurement uncertainty [20].
Study and examination requirements and forms of examination	• Written exam– minimum 60 % score, • Oral examination
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. Štirmer, N., Gabrijel, I.,Quality management, course repository, http://www.grad.unizg.hr/predmet/uprkva 2. Juran, J. M., Gryna, F. M., Quality Planning and Analysis, 3rd edition, Mate d.o.o., Zagreb, 1999 3. Skoko, H.,Quality management, Sinergija, Zagreb, 2000 Optional literature: 1. De Feo, J.,Barnard, W., Juran Institute's Six Sigma Breakthrough and Beyond, Juran Institute, 2003 2. Feigenbaum, A. V., Total quality control, McGraw-Hill, 1991 3. Juran, J. M., De Feo, J.,Juran's Quality Handbook: The Complete Guide to Performance Excellence, 6th Edition, McGraw Hill, 2010 4. Deming, W. E.,Some Theory of Sampling, Dover Publications, 2010 5. Kelly, J. M.,Total Quality Management, Protecon, Zagreb, 1997 6. Shewhart, W. A.,Statistical Method from the Viewpoint of Quality Control, Dover Publications, 2011

Module name:	**Theory of Elasticity and Plasticity**
Module level, if applicable	Master's Degree Programme
Code, if applicable	21864
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	II (Summer)
Person responsible for the module	Ivan Duvnjak, Domagoj Damjanović
Lecturer	Marina Frančić Smrkić
Language	Croatian
Relation to curriculum	Master's degree programme, Construction Materials Programme, Compulsory, Semestar II.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 45 • Exercises (auditory): 30
Workload	Lecture hours 45 Exercise 30 Other contact hours 10 Self study hours 140
Credit points	7,5 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, • Writing a seminar paper.
Recommended prerequisites	• Knowledge about differential and integral mathematics, partial differential equations, vectors and tensors analysis, • Good knowledge on general theoretical mechanics and numerical mathematics, • Knowledge about static, dynamic and strength of materials theory.
Module objectives/intended learning outcomes	• Recognizing appropriate boundary value problems of the theory of elasticity and plasticity, • Explaining differential equations of equilibrium and compatibility in stress and strain analysis, • Adequate formulation of boundary value problem. Solving problems using displacements or stress components, • Choosing the optimal method for solving appropriate boundary value problems, • Understanding the methods for solving boundary value problems in 2D and 3D region. • Understanding the behavior law of materials in elastic and plastic region.
Content	• Lectures: 1. Vector and tensor analysis[6] 2. Deforming models of material continuum [3] 3. Finite deformation tensors and infinitesimal deformation tensors [6] 4. External and internal forces on solids, stress tensor and its properties [6] 5. Thermodynamics of real solids, constitutive equations – general Hooke's low [3] 6. Definition, formulation and solution of boundary value problems using displacement or stress components[3] 7. Virtual work equations and energy principles[3] 8. Analitical and numerical methods for solving problem in theory of elasticity [3] 9. Plane problems, Airy's function, harmonic and biharmonic functions [3] 10. 3D problems of the theory of elasticity (torsion, thin plates, infinite solid and semi-infinite solid) [3] 11. Introduction to plasticity, yield criteria, plasticity parameters [3]

	12. Viscoelastic and viscoplastic models of materials, creep and relaxation [3]. Exercises (auditory): 1. Transformations of vectors and tensors, principal stress and principal strains [4] 2. Analitical and numerical methods for solving boundary value problems (Ritz method, Galerkin's, finite elements, finite differences, Fourier's series and complex-variable methods [12] 3. Solving plane problems, Airy's function, polynoms and infinite series [4] 4. Solving 3D problems (torsion of beams, thin plates and semi-infinite solid) [4] 5. Solving plastic problems, creep and relaxations [4].
Study and examination requirements and forms of examination	• Seminar paper, written and oral exam.
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. M. Rak,Teorija elastičnosti i plastičnosti (http://www.grad.unizg.hr) Optional literature: 2. T. Herman,Teorija elastičnosti iplastičnosti, Element, Zagreb, 2008 3. Z Kostrenčić,Teorija elastičnosti, Školska knjiga, Zagreb, 1982 4. S Timošenko, J.Gudier,Teorija elastičnosti, Građevinska knjiga, Beograd, 1962 5. I. Alfirević,Uvod u tenzore i mehaniku kontinuuma, Golden marketing, Zagreb, 2006 6. J. Brnić,Elastomehanika i plastomehanika, Školska knjiga, Zagreb, 1996 7. G.E. Mase,Theory and Problems of Continuum Mechanics, McGrow-Hill Company, 1970 8. Y.A. Amanzade,Theory of Elasticity, MIR, Publishers Moscow, 1979

Module name:	**Durability of Structural Materials**
Module level, if applicable	Master's Degree Programs
Code, if applicable	21810
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	II (Summer)
Person responsible for the module	Marijana Serdar, Ana Baričević
Lecturer	
Language	Croatian
Relation to curriculum	Master's degree programme. Construction Materials Programme. Compulsory. Semester II.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises: 20 (auditory - 12, design - 8) • Seminars: 10
Workload	Lecture hours 30 Hours of exercises 30 (experimental, construction, auditory, seminars, case studies) Preparation of seminars and projects 30 Other contact hours 10 Self study hours 80
Credit points	6 ECTS
Requirements according to the examination regulations	• 75% attendance in lectures, • 100% attendance in exercises, • 60% score in each of 2 pre-exams, • Independent preparation and presentation of homework assignment, • Team preparation and presentation of student project.
Recommended prerequisites	• Knowledge about the main properties and composition of structural materials, • Understanding the main transport mechanisms and exchange of mass inside materials, • Knowledge about the basic chemical reactions between materials and the environment.
Module objectives/intended learning outcomes	• Extensive knowledge on degradation processes (chemical, physical, mechanical and biological) of structural materials and special environmental loading, • Independent preparation of structural assessment and plan of maintenance depending on the type of structural material and service life, • Consulting targeted groups on new methods of prevention of structural material degradation depending on the environment and material type, • Ability for interdisciplinary research (civil engineering, electrochemistry, timber industry, mechanical engineering etc.).
Content	• Lectures: 1. Introduction: general facts on durability; corrosion; destructions; special durability loads [2] 2. Mechanisms of metal corrosion; types of metal corrosion; methods and measuring instruments applied in determining the condition of metals [2] 3. Methods of metal protection [2] 4. Mechanisms of concrete destruction; types of concrete destruction; methods and measuring instruments applied in determining the condition of concrete [2] 5. Methods of concrete protection [2] 6. Pre-exam [2]

	7. Mechanisms of wood destruction; types of wood destruction; methods and measuring instruments applied in determining the condition of wood, methods of wood protection [2] 8. Destruction mechanisms of stone, glass, types of stone, glass destruction; methods and measuring instruments applied in determining the condition of stone, glass; methods of protecting stone, glass [2] 9. Destruction mechanisms of masonry and polymer destruction; types of destruction; methods and measuring instruments applied in determining the condition of masonry and polymers; protection methods of masonry and polymers [2] 10. Degradation of materials in soil [2] 11. Sustainable structural materials [2] 12. Durability design strategy of concrete structures: design with set service life; various models of designing durability; probabilistic method of service life design; the expense of total service life [2] 13. Durability design strategy of metal structures: design with set service life; various models of designing durability; probabilistic method of service life design; the expense of total service life [2] 14. Pre-exam [2] 15. Presentation of student projects [2]. • Auditory exercises: 1. Fundamentals of electrochemical corrosion of metals, methods for detecting corrosion [2] 2. Corrosion of steel in concrete – calculation of material loss and crack formation [2] 3. Examples of protection of metals and reinforced concrete (inhibitors, cathodic and anodic protection, stainless steel) [2], 4. Application of software for calculation of service life of structures in different environments[2] 5. Methods for investigating corrosion of steel in concrete (electrochemical methods, corrosion monitoring)[2] 6. Methods and instruments for assessing the degradation of concrete in structures [2]. • Design exercises: 1. Specific types of corrosion in civil engineering and other engineering fields [2] 2. Protection of metals – example of galvanising [2] 3. Examples of degradation of timber in civil engineering and other engineering fields [2] 4. Examples of methods for detecting corrosion in soil [2]. • Seminars: 1. Application of Faraday's law, determining corrosion behaviour of different materials[1] 2. Recognition of different degradation mechanisms based on the chemical and microscopic analysis [1] 3. Critical overview of state of the art in the field of durability of structural materials [1] 4. Calculation of expected service life using software [1], 5. Student project on assessment of structure (choice of structure, categorisation of degradation, analysis of causes and consequences of environmental loading depending on the structural material) [1].
Study and examination requirements and forms of examination	• Two pre-exams 60% , • Homework assignment 20% • Project work 20%.

Media employed	Whiteboard, projector, laboratory testing equipment.
Reading list	Required literature: 1. Bjegović, D., Serdar, M., Baričević. A., Mimeographed lecture notes, http://www.grad.unizg.hr/predmet/tkm 2. Bijen, J.,DurabilityofEngineeringStructures, CRC Press, WoodheadPublishingLimited, Cambridge, England, 2003 Optional literature: 1. Mays, G. DurabilityofConcreteStructures, E & FN Soon, London, 1992, 2. Bentur, A., Diamond, S., Berke, N. S.,Steel CorrosioninConcrete, E & FN Soon, London, 1997, 3. Maekawa, K., Rajesh, P., ChaubeandKishi, T.,CoupledMass Transport, HydrationandStructureFormationTheory for DurabilityDesignofConcreteStructures, http://concrete.t.utokyo.ac.jp/en/demos /ducom/brieftheory/consec1.html. 4. E. Gjorv, Koji Sakai,ConcreteTechnology for a SustainableDevelopment in the 21st Century, E&FN SPON, London, 2000, 5. Ch. F. Hendriks, H.S. Pieterson,SustainableRawmaterials, ConstructionandDemolitionwaste, RILEM, Report 22, 2000, 6. Jamal M. Khatib,Sustainabilityofconstructionmaterials, WoodheadPublishingLimited, 2009

Module name:	**Special Concretes and Technologies**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	21811
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	II (Summer)
Person responsible for the module	Ivana Banjad Pečur, Marijan Skazlić
Lecturer	
Language	Croatian
Relation to curriculum	Master's degree programme. Construction Materials Programme. Compulsory subject. Semester II.
Type of teaching, contact hours	Number of hours (in semester): 75 • Lectures: 45 • Exercises: 30 (auditory - 16, laboratory - 14) • E-learning: optional
Workload	Lecture hours 45 Exercise 18 Hours of exercises 12 Project 3 Other contact hours 12 Self study hours 135
Credit points	7,5 ECTS
Requirements according to the examination regulations	• Attendance in lectures - minimum 75 %, • Attendance in auditoryexercises - 100 %, • Attendance in laboratory exercises - 100 %, • Self compacting concrete seminar, • Fibre reinforced concrete seminar, • Two pre-exams.
Recommended prerequisites	• Basic knowledge on concrete components, composition, properties and technologies.
Module objectives/intended learning outcomes	• Basic knowledge of the propertiesin fresh and hardened state for different special concretes and technologies, • Practical skills in mix design for various special concretes, • Practical knowledge about different requirements for special concrete types and technologies depending on structural and environmental issues, • Theoretical knowledge about advantages and disadvantages of particular concrete type for a given practical application, • Understanding the process of quality control for different special concrete types, • Integration of knowledge in future study and work.
Content	• Lectures: 1. Development of concrete technology [3] 2. Self compacting concrete [3] 3. Architectural concrete types [3] 4. Fibre reinforced concrete [3] 5. Lightweight and heavyweight concrete [3] 6. Sprayed concrete [3] 7. High performance/high strength concrete [3] 8. Mass concrete, roller compacted concrete [3] 9. Concrete in roads, concrete in tunnels [3] 10. Polymer modified concrete and mortar, repair concrete and mortar [3] 11. Concrete with recycled aggregate [3] 12. Mortars, injection grouts [3]

	13. Concrete technology for extreme clime conditions [3] 14. Special technology of concrete production [3] 15. Advanced processes and concrete technologies [3]. • Exercises (auditory): 1. Special concretes achievement [2] 2. Self compacting concrete [2] 3. Fibre reinforced concrete [2] 4. Thermal analysis of mass concrete [2] 5. High performance concrete [2] 6. High performance fibre reinforced concrete [2] 7. Quality control of concrete and components [2] 8. Case studies [2]. • Exercise (laboratory): 1. Self compacting concrete [2] 2. Fibre reinforced concrete [2] 3. Properties of concrete components [2] 4. Testing methods for fresh concrete [2] 5. Durability testing of high performance concrete [2] 6. Mechanical properties tests for high performance concrete [2] 7. Analysis and interpretation of experimental results [2]. • Student projects: 1. Self compacting concrete seminar, 2. Fibre reinforced concrete seminar.
Study and examination requirements and forms of examination	Oral exam.
Media employed	Whiteboard, projector, laboratory testing equipment
Reading list	Required literature: 1. Beslać. J., Skazlić, M.,Special concrete types, in Concrete structures 3, Andris, Zagreb, 2007, (in Croatian) 2. Ukrainczyk, V.,Concrete: structure, properties and technology, Alcor, Zagreb, 2001, (in Croatian) 3. Newman J., Seng Choo B.,Advanced Concrete Technology-Process, Elsevier Ltd., 2003 4. Kosmatka S.H., Kerkhoff B., Panarese W.C., MacLeod N.F., McGrath R.J.,Design and Control of Concrete Mixtures, Cement Association of Canada, Seventh Edition, 2002 Optional literature: 1. Mehta P.K.,Concrete, Structure, Properties and Materials, New Yersey, Prentice Hall, Inc., Englewood Cliffs,1986 2. Neville, A.M.,Properties of concrete, Essex, Longman Group Limited,1995 3. Nawy, E.,Fundamentals of high-performance concrete, Second edition, John Wiley&Sons, Inc., New York, 2001 4. Aitcin, P. C.,High-Performance Concrete, E&FN SPON, London, 1998

Module name:	**Concrete and Masonry Structures 2**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	21787
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	II (Summer)
Person responsible for the module	Tomislav Kišiček
Lecturer	Martina Carić, Nikola Perković, Tvrtko Renić
Language	Croatian, English
Relation to curriculum	Master's degree programme. Construction Materials Programme. Compulsory subject. Semester II.
Type of teaching, contact hours	Number of hours (in semester): • Lectures:30 • Exercises: 30 (auditory – 18, design - 12)
Workload	Lecture hours 30 Hours of laboratories or skills Exercise 30 Other contact hours 20 Self study hours 100
Credit points	6 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, • Doing an independent exercise assignment, • Pass in both pre-exams (minimum 25% score).
Recommended prerequisites	Theoretical and practical knowledge about the basics of reinforced concrete and masonry elements and structures design.
Module objectives/intended learning outcomes	• Acquiring knowledge and skills needed for designing reinforced concrete and masonry structural systems, • Knowledge about the basic principles of conceptual design, • Knowledge and skills needed to analyse behaviour of reinforced concrete and masonry structures according to ultimate and serviceability limit states, • Ability to use modern methods and European norms criteria.
Content	• Lectures: 1. Short revision of masonry structures knowledge in undergraduate course: "Concrete and masonry structures 1". Constructive details (beginning) [2] 2. Types of walls, thicknesses and connections. Details of reinforcement. Connections of walls. Thermal and long term movements. Masonry below ground. Calculation examples. Masonry executions. Materials and their storage. Preparation of mortar and infill concrete. Protection of newly constructed masonry. Permissible deviations of the design values. Category of masonry execution. Other measures of masonry construction. Fixing accessories on masonry walls [2] 3. Masonry structures in seismic areas. Materials and masonry bond arrangements. Rules of construction. Special rules for simple buildings [2] 4. Masonry structures in seismic areas (continued). Design models. Calculation examples. Special rules for simple buildings [2] 5. Rules for seismic areas. Stability and robustness. Loadings, strengths and limitation of dimensions. Wall thicknesses. Rules for stiffening walls, wall piers and chimneys. Walls subjected mainly to wind loading. Non load bearing intern walls. Wall chases and recesses. Outer walls of one-story houses. Simplified calculation methods and simple rules for masonry buildings. Calculation examples. Strengthening of walls. Buildings damaged by earthquake [2]

	6. Building heritage. Connections of masonry building elements. Research. Strengthening masonry buildings. Calculation examples [2] 7. Introduction with the new European norms EN 1996 and EN 1998 (related to masonry structures). Masonry structures damaged in fire [2] 8. Pre-exam no. 1 – (Masonry walls capacity when subjected to seismic forces,. [2] 9. Short revision of the subject related to concrete structures in undergraduate course "Concrete and masonry structures 1". Shearbetween web andflangesof Tsections.Beamswithinclinedchords (edges). Serviceability limit states. Creepandshrinkageofconcrete [2] 10. Deflectionsofslabsandbeams. Calculationofdeflectionsaccording to EC2 [2] 11. Cracks. Minimum reinforcementarea for crackingcontrol. Calculationofcrackwidthaccording toEC2 [2] 12. Punchingshear. Torsionofreinforcedconcretesections. Deepbeams [2] 13. Pre-exam no. 2 – Deflectionofreinforcedconcrete slab or beam[2] 14. Slendercolumns. Foundations. Strengtheningandretrofitting ofreinforcedconcretestructures [2] 15. New Europeannorms EN 1992 and EN 1998 (for concretestructures) [2]. • Exercises (auditory, design): 1. Introduction, layout and dimensions of elements,structuralloadanalysis (auditory) [2] 2. Designofroofstructureand one reinforcedconcreteroofbeam (auditory) [2] 3. Designofstaircases (auditory) [2] 4. Design[2] 5. Design ofreinforcedconcretetwo-way slab. Modeling slab withdesignsoftware. Reinforcementdetails. (auditory) [2] 6. Design ofreinforcedconcretebeam (auditory) [2] 7. Design[2] 8. Calculation of wall capacity to vertical loading and to horizontal wind loading perpendicular to wall. (auditory) [2] 9. Seismicanalysisofmasonrystructureandcalculationofseismicforces on differenttypesofmasonrywalls (confined and reinforced) (auditory) [2] 10. Design[2] 11. Resistancecalculationofmasonrywallssubjected to in-plane horizontalseismicload(auditory) [2] 12. Design[2] 13. Design of reinforcedconcretebasementwalls subjected to verticaland horizontalload. Designoffoundations. (auditory) [2] 14. Design[4]
Study and examination requirements and forms of examination	Written exam – minimum 55% score, • Oral exam.
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. Sorić, Z., Kišiček, T.,Betonske konstrukcije 2, Projektiranje betonskih konstrukcija prema europskim normama EN, mimeographed lecture notes, Faculty of civil engineering, Zagreb, 2012, 2. Sorić, Z., Kišiček, T., Galić, J., Betonske i zidane konstrukcije 2 - Betonske konstrukcije prema EC2 - 2 , mimeographed lecture notes, Faculty of civil engineering, Zagreb, 2009, 2010, 2011, 3. Sorić, Z.: Betonske konstrukcije 1, betonske konstrukcije prema Europskoj prednormi (HRN ENV 1992-1-1), Zagreb, 2010,

	4. Sorić, Z., Kišiček, T.,Betonske konstrukcije 1, projektiranje betonskih konstrukcija prema europskim normama EN, Zagreb, 2010, 2011, 5. Sorić, Z.,Zidane konstrukcije I, (second, revised ed.), Zagreb, 2004, 6. Sorić, Z.,Betonske i zidane konstrukcije 2 - Zidane konstrukcije, mimeographed lecture notes, Faculty of civil engineering, Zagreb, 2008, 2009, 2010 ori 2011, 7. Sorić, Z., Betonske i zidane konstrukcije 1 - Zidane konstrukcije, mimeographed lecture notes, Faculty of civil engineering, Zagreb, 2008, 2009, 2010 or 2011, 8. Sorić, Z.,Zidane konstrukcije, paragraph 11 - Projektiranje zidanih konstrukcija prema europskim normama EN, Zagreb 2009, 2010, 2011, 9. Lectures and exercises

III. SEMESTER

Module name:	**Precast Systems**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	115170
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	III (Winter)
Person responsible for the module	Marijan Skazlić
Lecturer	
Language	Croatian
Relation to curriculum	Master's degree programme. Construction Materials Programme. Compulsory. Semester III.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises: 30 (auditory – 24, design – 6)
Workload	Lecture hours 30 Exercises 15 Project and conrete plant tour 15 Self study hours 120
Credit points	6 ECTS
Requirements according to the examination regulations	• Attendance in lectures – minimum 75%, • Attendance in auditory exercises – 100%, • Attendance in design exercises – 100%, • Two pre-exams – minimum 25% score in each,one make up exam, • Seminar on application of precast concrete elements.
Recommended prerequisites	• Basic knowledge about the concrete structures: material, properties, design and detailing.
Module objectives/intended learning outcomes	• Basicknowledge of precast elements properties for application in different areas of civil and environmental engineering, • Practical skill on designing and detailing connections between precast concrete systems and elements, • Practical knowledge of requirements for production, storage, transport, erection and quality control of different precast concrete elements, • Theoretical knowledge of advantages and disadvantages of particular precast concrete type for a given practical application, • Understanding process of interaction between precast element design, material properties, technology of production and construction and type of concrete structure, • Integration of knowledge in future study and work.
Content	• Lectures: 1. Basic principles of production and building with precastelements [2] 2. Materials for precast systems [2] 3. Structuralsystems [2] 4. Properties of precast elements [2] 5. Precast elements in building construction [2] 6. Non-reinforced precast elements [2] 7. Precast clay elements [2] 8. Application of precast elements in road construction [2] 9. Precast systems in other fields of civil engineering [2] 10. Composite structures with precast elements [2] 11. Precast concrete plants[2]

	12. Storage, transport and erection of precast elements [2] 13. Special technologies and materials in precastelements [2] 14. Robotics, economics and coordination between designers and manufacturers [2] 15. Ecological aspects of precast construction [2]. • Auditory exercises: 1. Design procedures and connections between precast concrete elements [2] 2. Types of joints and connections in precast concrete systems[2] 3. Precast concrete skeletal elements connections[2] 4. Connections in precast panel systems[2] 5. Precast floor structures joints[2] 6. Connections of composite structures [2] 7. Special connections between precast concrete [2] 8. Case study on precast element design[2] 9. Case study on precast element production[2] 10. Case study on transport and erection of precast concrete elements [2]. • Design exercises: 1. Precast concrete elements production plants[2] 2. Precast systems in bridge construction[2] 3. Advanced concrete types in precast concrete systems[2]. • Student projects: Seminar on practical application of certain precast concrete elements
Study and examination requirements and forms of examination	• Written exam – minimum 60% score, • Oral exam.
Media employed	Projector, whiteboard, laboratory instrumentation for materials testing
Reading list	Required literature: 1. FIB Commission 6, Planning and Design Handbook on Precast Building Structures, 2004 2. Kim S. Elliot, Precast Concrete Structures, Butterworth Heinmann, 2002 3. Kim S. Elliot, Multi-storey precast concrete framed structures, Blackwell Science, 1996 4. National Precast Concrete Association Australia, Concrete Institute of Australia: Precast Concrete Handbook, 2002 5. FIB Task Group 6.4: Precast concrete bridges, 2004. 6. FIB Task Group 3.1: Environmental issues in prefabrication, 2003. 7. FIB Task Group 6.3: Precast concrete in mixed construction, 2002. Optional literature: 1. Precast Concrete Institute: Design Handbook Precast and Prestressed Concrete, Fifth Edition,1999

Module name:	**Non-destructive Testings**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	115171
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	III (Winter)
Person responsible for the module	Ivana Banjad Pečur, Marijan Skazlić
Lecturer	Ivan Gabrijel, Bojan Milovanović
Language	Croatian
Relation to curriculum	Master's degree programme. Construction Materials Programme. Compulsory. Semester III.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises: 30 (auditory - 10, laboratory - 20)
Workload	Lecture hours 30 Hours of exercises 30 Project 15 Other contact hours 20 Self study hours 85
Credit points	6 ECTS
Requirements according to the examination regulations	• Attendance in lectures – minimum 75%, • Attendance in auditory exercises – 100%, • Attendance in laboratory exercises – 100%, • Two pre-exams – minimum 25% score in each, one make up exam.
Recommended prerequisites	• Basic knowledge on material properties, quality control, structural elements used in civil engineering, durability of structures
Module objectives/intended learning outcomes	• Basicknowledge of the non-destructive testing methods used in civil engineering, • Practical skill on application ofcertain testing method, analysis and interpretation of getting results for testing material property or structural integrity, • Theoretical and factual knowledge of advantages and disadvantages of non-destructive testing methods for a practical application, • Understanding process of quality control of new and existing structural elements and materials used in civil engineering, • Understanding correlation between results of non-destructive testing and material or structural state and property, • Integration of knowledge in future study and work.
Content	• Lectures: 1. Definitionsand classificationof non-destructivetesting [2] 2. Planning and selection of non-destructive testing, equipment fornon-destructive testing, reliability of test results, penetrantmethods [2] 3. Basicprinciplesof visual inspection, tools and methodologyof implementation [2] 4. Non-destructivedetermination ofmaterial strength in construction, correlation with the resultsof destructivetesting [2] 5. Early age concrete strength and properties [2] 6. Concrete durability tests, electromagnetic testing methods [2] 7. Ultrasonictesting method [2] 8. Impact echo, dynamic response testing methods [2] 9. Acoustic emission [2] 10. Thermography: development, theoretical basis, the application [2] 11. Radar [2]

	12. Radiography and radiometry [2] 13. Standards and regulations and standardsfor the implementation ofnon-destructive testing, statistical analysisand interpretationof test results [2] 14. Application ofnon-destructivetesting methodsduring construction [2] 15. Applicationof non-destructivetesting methodsfor evaluationof existing structures properties [2] • Auditory exercises: 1. Planning and interpretation of in-situ testing [2] 2. Non-destructive testing of concrete strength [2] 3. Testsof concrete propertiesrelevantfordurability [2] 4. Non-destructive methods based on wave propagation through material [2] 5. Case study and examplesof non-destructivetesting on existingbuildings, bridges, tunnelsandother facilities [2] • Laboratory exercises: 1. Schmidt hammer, pull-out and pull-off tests [2] 2. Maturity testing methods [2] 3. Eletromagnetic concrete cover measurement, corrosion rate tests, concrete absorption and permeability tests [2] 4. Non-destructive testingof durability properties [2] 5. Ultrasound pulse velocity method for fresh concrete [2] 6. Applicationof ultrasound tests inhardenedconcrete [2] 7. Impact echo and impulse response [2] 8. Acoustic emission [2] 9. Thermography [2] 10. Analysis and interpretation of thenon-destructive testingresults [2]
Study and examination requirements and forms of examination	Oral exam.
Media employed	Projector, whiteboard, laboratory instrumentation for materials testing
Reading list	Required literature: 1. Malhotra, V. M., Carino, N. J., Handbook on Nondestructive Testing of Concrete, Second Edition, CRC Press, 2004 2. Proceedings from International Symposium Non-Destructive Testing in Civil Engineering, Berlin, 2003. 3. Bungey, J. H.; Millard, S. G.: Testing of concrete in structures, Blackie Academy & Professional, 1996. Optional literature: 1. Innovations in Non-Destructive Testing of Concrete, ACI International SP-168, ed. Pessiki S. And Olson L., 1997. 2. FIB bulletin no. 22, Monitoring and Safety Evaluation of Existing Concrete Structures, State-of-art report, 2003

Module name:	**Fire Protection**
Module level, if applicable	Masters' Degree Programmes
Code, if applicable	115172
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	III (Winter)
Person responsible for the module	Marija Jelčić Rukavina
Lecturer	Ivana Carević
Language	Croatian
Relation to curriculum	Master's degree programme. Construction Materials Programme. Compulsory. Semester III.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises: 30 (auditory - 10, design - 16, laboratory - 4)
Workload	Lecture hours 30 Hours of exercises 30 (experimental, auditory, case studies) Preparation of seminars and projects 30 Other contact hours 10 Self study hours 80
Credit points	6 ECTS
Requirements according to the examination regulations	• Attendance in lectures – 75% , • Attendance in exercises–100%, • Two pre-exams – minimum 60% score in each, • Independent preparation and presentation of projects (Study of fire protection measures in buildings).
Recommended prerequisites	• Elementary knowledge aboutf materials science, mathematics, thermodynamics and chemistry.
Module objectives/intended learning outcomes	• Quantitative assessment of various parameters offires in enclosed spaces (fire load, heat release rate, the maximum temperature achieved in enclosed space, maximum temperature thatstructural element is exposed to, etc.), • Evaluating and classifyingmaterialsandbuilding productsaccording tothe results ofreaction to fire testing, • Analysing the main effects of fire temperatures on the properties (thermal and mechanical) of the construction materials (concrete, steel, wood, etc.), • Analysing the structural elements in case of fire, using the prescriptive and the performance-based design, • Developing the Study of fire protection according to the current regulations in the Republic of Croatia, • Assessing the structures after fire considering the material of structure (concrete, steel, wood, brick, etc.).
Content	• Lectures: 1. Introduction into course[2] 2. Basics of occurrence and spread of fires in buildings [2] 3. Modeling the occurrence and spread of fire[2] 4. Effects of fires on materials and structures – generally[2] 5. Architectural and urban measures of fire protection – part 1 [2] 6. Architectural and urban measures of fire protection – part 2 [2] 7. Architectural and urban measures of fire protection – part 3 [2] 8. Architectural and urban measures of fire protection – part 4 [2] 9. Fire fightening systems and active fire measures –part 1 [2] 10. Active fire measures– part 2 [2]

	11. The effect offireon the reinforced concretestructural elementsandtheir protection [2] 12. The effect offireon steel structural elementsandtheir protection [2], 13. The effect offireon the wood structural elementsandtheir protection [2] 14. Assessment of fire damaged structuresandstrengthening of structures [2] 15. Legislationin the fieldof fire protection [2]. • Exercises 1. Pre-exams [2]. • Auditory exercises: 1. The basics of occurrence and spread of fire in the enclosed spaces [4] 2. Effect offireonstructural elements, depending on materials they are made of (concrete,steel, wood, brick)[2] 3. The realfires andanalysis of fire consequences [2] 4. Examples of assessment of fire damaged structures [2]. • Laboratory exercises: 1. Reaction to fire testsof building materialsandproducts[2] 2. Fire resistance testsof structural elements [2]. • Design exercises: 1. Development and presentation of student projects: Study of fire protection measures inbuildings [14].
Study and examination requirements and forms of examination	• Grade formed according to the performance during semester.
Media employed	Whiteboard, projector, laboratory equipment
Reading list	Required literature: 1. Bjegović, D. et al. Subject repository,http://www.grad.unizg.hr/predmet/zop (inCroatian) 2. BuchananA.H., StructuralDesign for FireSafety, JohnWiley&SonsLtd, England, 2002 3. Purkiss, J.A.,Firesafetyengineering – Designofstructures, Secondedition. Oxford: Elsevier Ltd., 2007 4. Designofbuildings for thefiresituation, Leonardo da Vinci pilot project CZ/02/B/F/PP-134007 (http://eurocodes.jrc.ec.europa.eu/showpublication.php?id=66) 5. Vidaković M.,Fireandarchitecturaldesign, Fahrenheit, Beograd, 1995 (inSerbian). Optional literature: 1. D. Drysdale, AnIntroduction to Fire Dynamics, Wiley&Sons, 2003. (selected paragraphs) 2. Dougal Drysdale, AnIntroduction to Fire Dynamics, 2nd Ed., Wiley 1998, http://www.civ.ed.ac.uk/research/fire/technicalreports.html http://www.civ.ed.ac.uk/research/fire/thesis.html 3. B. Karlssonand, J.G. Quintiere, EnclosureFire Dynamics, CRC Press, 2000 (selected paragraphs) 4. HRNEN 1991-1-2:2008,Eurocode 1: Actions on structures -- Part 1-2: General actions -- Actions on structuresexposed to fire (EN 1991-1-2:2002) 5. HRNEN 1992-1-2:2008,Eurocode 2: Designof concrete structures -- Part 1-2: General rules – Structuralfiredesign (EN 1992-1-2:2004+AC:2008) 6. HRNEN 1993-1-2:2008,Eurocode 3: Designofsteelstructures -- Part 1-2: General rules – Structuralfiredesign (EN 1993-1-2:2005+AC:2005)

	7. HRNEN 1994-1-2:2008, Eurocode 4: Designofcompositesteeland concrete structures -- Part 1-2: General rules – Structuralfiredesign (EN 1994-1-2:2005+AC:2008) 8. HRNEN 1995-1-2:2008, Eurocode 5: Designoftimberstructures -- Part 1-2: General – Structuralfiredesign (EN 1995-1-2:2004+AC:2006)

Module name:	**Technology of Repair and Strengthening**
Module level, if applicable	Master's Degree Programm
Code, if applicable	115174
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	III (Winter)
Person responsible for the module	Ana Baričević, Marijan Skazlić
Lecturer	
Language	Croatian
Relation to curriculum	Master's degree programme. Construction Materials Programme. Elective. Semester III.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises: 22 (auditory - 14, design - 8) • Seminars: 8
Workload	Lecture hours 30 Hours of exercises 30 Preparation of group projects 30 Other contact hours 10 Self study hours 80
Credit points	6 ECTS
Requirements according to the examination regulations	• 75% attendance in lectures, • 100% attendance in exercises, • Two pre-exams, minimum 60% score in each, • Independent preparation and presentation of homework assignment, • Team preparation and presentation of student projects.
Recommended prerequisites	• Understanding specific properties of different structural materials and their corresponding degradation mechanisms, • Theoretic and practical knowledge about the behaviour of structures under loading, • Differentiating degradation mechanisms of materials based on the assessed damage.
Module objectives/intended learning outcomes	• Correlating specific degradation mechanism of concrete to principles and methods of repair of reinforced concrete structure, • Differentiating and comparing different materials and systems for repair and strengthening of reinforced concrete structures, • Defining required properties of materials and systems for repair and strengthening reinforced concrete structures, • Analysing and comparing different methods for repair of structures based on their functional, durability, ecological and economic benefits through the entire service life, • Recommending and prescribing optimal principle and method of repair depending on the mechanism of degradation and based on the multi-criteria analysis of alternatives, • Independent preparation of repair project, which includes: assessment of structure, recommended principle and method of repair, required properties of materials and systems, quality control plan during and after repair works.
Content	• Lectures: 1. Processes of material destruction: causes of damage; essential properties of material durability[2] 2. Assessment of structures[2] 3. Principles and methods of repair of reinforced concrete structures[2] 4. Materials and systems for repair of reinforced concrete structures[2]

	5. Methods of strengthening structures[2] 6. Pre-exam [2] 7. Repair of historic structures[2] 8. Special repair technologies[2] 9. Methodology for multi-criteria analysis of alternative repair solutions[2] 10. Control and assurance of repair work quality[2] 11. Main principles of monitoring repaired structures[2] 12. Standards and recommendations in the field of repair[2] 13. Pre-exam [2], 14. Final presentation of student projects with discussion[4]. • Auditory exercises: 1. Typical damage of structures and corresponding principles and methods of repair[2] 2. Examples of repair materials[2] 3. Examples of structure strengthening[2] 4. Examples of repair of historic structures[2] 5. Examples of special repair technologies[2] 6. Methods of comparing different repair options[2] 7. Examplesof comprehensive repair projects[2]. • Design exercises: 1. Choice and assessment of real structure[2] 2. Choice of principle and method of repair[2] 3. Specifying required material and system properties, defining quality control and assurance plan during and after repair works[2] 4. Plan of activities and approximate budget for repair of the structuren[2]. • Seminars: 1. Analysis of example from the literature of repair project (anamnesis - assessment of structure, diagnosis - causes of degradation and therapy - chosen repair solution), 2. Prescribing requirements for materials and systems, 3. Analysis and critical overview of state of the art in the field of repair of structures, 4. Multi-criteria analysis of different repair strategies.
Study and examination requirements and forms of examination	• Two pre-exams, • Seminar – four homework assignments, one student project.
Media employed	Whiteboard, projector, laboratory equipment
Reading list	Required literature: 1. Bjegović, D.; Serdar, M.,Mimeographed lecture notes, subject repository, http://www.grad.unizg.hr/predmet/tsio 2. HRN EN 1504 Proizvodiisustavizazaštituipopravakbetonskihkonstrukcija 3. StipanovićOslaković, I., ŠkarićPalić, S., Mavar, K., Općeplaniranjepopravka // Betonskekonstrukcije - Sanacije / Zagreb :Hrvatskasveučilišnanaklada, Sveučilište u Zagrebu – GrađevinskiFakultet, Secon HDGK, Andris, 2008 4. Barišić, E.,Materijalizazaštituipopravak, Betonskekonstrukcije – Sanacij, Zagreb,:Hrvatskasveučilišnanaklada, Sveučilište u Zagrebu – GrađevinskiFakultet, Secon HDGK, Andris, 2008 5. Mavar, K., Balagija, A.,Metodepopravkabetona, Betonskekonstrukcije – Sanacije, Zagreb :Hrvatskasveučilišnanaklada, Sveučilište u Zagrebu – GrađevinskiFakultet, Secon HDGK, Andris, 2008 6. Bjegović, D., Hranilović, M., Serdar, M.,Elektrokemijskemetodezaštite armature// Betonskekonstrukcije - Sanacije / Zagreb

	:Hrvatskasveučilišnanaklada, Sveučilište u Zagrebu – GrađevinskiFakultet, Secon HDGK, Andris, 2008 Optional literature: 1. Allen, R. T. L., Edwards, S. C.,Repair of Concrete Structures, Blackie & Son Limited, 1987 2. Emmons, P. H.,Concrete Repair and Maintenance Illustrated, Construction Publishers & Consultants, 1993 3. Concrete Repair Manual, ICRI & ACI International, 1999 4. Perkins, P.H.,Repair, Protection and Waterproofing of Concrete Structures, E&FN Spon, London, 1997 5. Repair of Concrete Structures to EN 1504, Danish Standards Association, 2004 6. fib Report: Management, maintenance and strengthening o concrete structures, Lausanne, 2002 7. fib Report: Monitoring and safety evaluation of existing concrete structures, Lausanne, 2003 8. BRITE-EURAM project BE4062 The service life of reinforced concrete structures, 9. CONTECVET IN30902I. 2001, A validated users manual for assessing the residual life of concrete structures, DG Enterprise, CEC, 10. DuraCrete (2000) DuraCrete Final Technical Report, Document no. BE95-1347/R17, Gouda, CUR. 11. REHABCON IPS-2000-00063, Strategy for Maintenance and Rehabilitation in Concrete Structures, DG Enterprise of the European Commission, 2000-2004

Module name:	**Concretes for Roads**
Module level, if applicable	Masters' Degree Programmes
Code, if applicable	114597
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	III (Winter)
Person responsible for the module	Ivana Banjad Pečur
Lecturer	Bojan Milovanović, Miro Matuzić, Zvjezdana Matuzić
Language	Croatian
Relation to curriculum	Master's degree programme. Construction Materials Programme. Elective. Semester III.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises: 30 (auditory – 14,design - 6, laboratory - 10)
Workload	Lecture hours 30 Hours of exercises 30 Preparation of independent project 30 Other contact hours 10 Self study hours 80
Credit points	6 ECTS
Requirements according to the examination regulations	• Attendance in lectures – 75%, • Attendance in auditory and laboratory exercises – 100%, • Development of one program, • Pre-exam – minimum 50% score, one make up exam.
Recommended prerequisites	• Knowledge on physical, mechanical and thermal properties of materials, • Basic statistics.
Module objectives/intended learning outcomes	• Ability to describe the technology of materials for particular concrete elements on roads, • Ability to explain relevant properties of concrete for elements, • Ability to design concrete composition, • Compare the properties of different concretes for roads, • Ability to apply the concrete testing results on individual elements.
Content	• Lectures: 1. Concrete elements on roads and aeroports [2] 2. Calculation of temperature flow in concrete and assessing the risk of cracks [2] 3. Pavements: concrete pavements, asphalt pavements [2] 4. Pavement joints [2] 5. Surface treatment – roughness [2] 6. Fiber reinforced concretes [2] 7. Porous concrete [2] 8. Polymer modified concretes [2] 9. Jet concretes [2] 10. Concrete in tunnels [2] 11. Injection [2] 12. Repair concretes and mortars [2] 13. Production technology of concretes for roads [2] 14. Vacuum concrete [2] 15. Quality control of concrete [2]. • Auditory exercises: 1. Technical requirement for concrete used for road elements [4] 2. Outline of regulations for concrete pavements [2] 3. Durability of concrete properties with examples [2]

	4. Testing of concrete pavements [2] 5. Quality control of concrete pavements [2] 6. Program of quality and control of concrete works on roads [2]. • Design exercises: 1. Defining the elements for quality program – program [2] 2. Description of relevant materials – program solving [2] 3. Description of relevant properties with control – program solving [2]. • Laboratory exercises: 1. The effect of chemical additives on the properties of fresh concrete [2] 2. The effect of chemical additives on the properties of hardened concrete [2] 3. Porous concrete [2] 4. Polymer modified and fibre reinforced concrete [2] 5. Durability properties of concretes for roads [2].
Study and examination requirements and forms of examination	• Written exam – minimum 50% score, • Oral exam.
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. Ukrainczyk, V., Beton: struktura, svojstva, tehnologija, Građevinski fakultet Sveučilišta u Zagrebu, 1994 2. Ukrainczyk, V., Poznavanje gradiva, Alcor, Zagreb, 2001 3. Beslać, J., Materijali u arhitekturi i građevinarstvu, Školska knjiga, Zagreb, 1989 4. Korlaet, Ž., Uvod u projektiranje i građenje cesta, udžbenik, Sveučilište u Zagrebu, 1995 Optional literature: 1. ACI Manual of Concrete Practice, ACI Publication, USA 2. Derucher, K. N., Korfiatis, G. P., Materials for Civil & Highway Engineers, second edition, Prentice Hall, 1988

Module name:	**Hydraulic Concrete**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	104068
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	III (Winter)
Person responsible for the module	Nina Štirmer
Lecturer	Ivan Gabrijel
Language	Croatian
Relation to curriculum	Master's degree programme. Hydraulic Engineering Programme. Electivet. Semester III.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises: 30 (auditory - 18, design - 12)
Workload	Lecture hours 30 Hours of exercises 30 Preparation of independent project 30 Other contact hours 10 Self study hours 80
Credit points	6 ECTS
Requirements according to the examination regulations	• Participation in lectures min. 75 %, • Participation in all exercises, • One program, • Two preliminary exams (min. 25 % on each).
Recommended prerequisites	• Knowledge on concrete composition and properties.
Module objectives/intended learning outcomes	• Ability to estimatethe risk of thermal cracks in mass concrete, • Ability to select appropriate components for mass concrete composition, • Ability to analyse influence of components and environment on the temperature changes in concrete, • Ability to recommend technology of execution for concrete in hydrotechnical structures, • Ability to evaluate results of testing concrete in hydrotechnical structures, • Ability to analyze and evaluate materials for repair of hydrotechnical structures.
Content	• Lectures: 1. Introduction: characteristics and application of concrete for hydrotechnical structures [2] 2. Mass concrete. Heat of hydration: thermal stresses and cracking; volume changes [2] 3. Selection of components for mass concrete and concrete mix design [2] 4. Control of cracks in mass concrete [2] 5. Transport, placement and curing of concrete: dynamics of concreting [2] 6. Concreting at extreme weather conditions [2] 7. Strength and deformations: risk of cracking [2] 8. Cooling systems for mass concrete [2] 9. Special concrete types and technologies for execution of hydrotechnical structures: rollercompacted concrete, preplaced -aggregate concrete, underwater concreting [2] 10. Concrete with improved water impermeability [2] 11. Erosion of concrete in hydraulic structures. Examples of repair [2] 12. Materials for repair of hydrotechnical structures [2] 13. Repair of concrete structures under water [2]

	14. Assessment of concrete condition in existing hydrotechnical structures [2] 15. Regulations and standards for application of concrete in hydrotechnical structures [2] • Auditory exercises: 1. Thermal stress and cracking: cracking risk calculations [2] 2. Control of concrete temperature and temperature gradient [2] 3. Recommendations for selection of aggregate type, cement and concrete additives: influence of components on concrete temperature development [2] 4. Concrete placement and curing methods [2] 5. Calculation of temperature changes in concrete - Schmidt's numerical method [2] 6. Modelling of temperature development in concrete [2] 7. Calculation of temperature flow in mass concrete and cracking risk estimation - examples [2] 8. Protection of concrete elements in hydrotechnical structures [2] 9. Testing methods for relevant concrete properties for hydrotechnical structures [2] • Design exercises: 1. Schmidt's numerical method, risk of thermal cracks in mass concrete [12]
Study and examination requirements and forms of examination	• written examination (min. 60 %), • Oral examination.
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. Štirmer, N.; Gabrijel, I.: Concrete for hydrotechnical structures, course repository, http://www.grad.unizg.hr/predmet/hidbet 2. Advanced Concrete Technology, Processes, ed. Newman, J.; Seng Choo, B., Elsevier, 2003 3. ACI 207.1R-05 Guide to Mass Concrete 4. ACI 207.2R-07 Report on Thermal and Volume Change Effects on Cracking of Mass Concrete 5. ACI 207.3R-94 Practises for Evaluation of Concrete in Existing Massive Structures for Service Conditions 6. ACI 207.4R-05 Cooling and Insulating Systems for Mass Concrete (Reapproved 2012) 7. ACI 207.5R-11 Report on Roller-Compacted Mass Concrete 8. ACI 210R-93 Erosion of Concrete in Hydraulic Structures Optional literature: 1. Prevention of Thermal Cracking in Concrete in Early Ages, RILEM Report, Ed. R. Springenschmid, E & FN Spon, 1998. 2. Monteiro, P. J. M.: Concrete – microstructure, Properties and Materials, McGraw-Hill, 2006

Module name:	**Metal Structures 2**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	21785
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	III (Winter)
Person responsible for the module	Darko Dujmović
Lecturer	Ivan Lukačević, Davor Skejić
Language	Croatian
Relation to curriculum	Master degree programme, Construction Materials, Elective. Semester III.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises (design): 30
Workload	Lecture hours 30 Numerical exercises hours 30 Midterm written examination hours 2 Self study hours 112 Other contact hours 4 Final written and oral examination hours 2
Credit points	6 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, • Preparation of 9 program assignments, • Written pre-exam.
Recommended prerequisites	• Basics of metal structures (undergraduate study).
Module objectives/intended learning outcomes	• Practical knowledge and skills required for the design of structural elements of steel structures and for the application of basic principles of conceptual design, • Analysing the action effects and combination of action for steel structures, • Identifying the advantages of steel in construction and stressing its potentials in thefuture, • Analysing and dimensioning structural elements of steel structures by using modern methods and the European standards criteria (EN).
Content	• Lectures: 1. Introduction [2] 2. Characteristics of steel structures [2] 3. Architecture and steel [2] 4. Economic parameters of steel constructions [2] 5. Basics of design procedure [2] 6. Actions on structures [2] 7. Beams subjected to bending and axial force [2] 8. Uniform built-up compression members [2] 9. Fatigue – dimensioning [2] 10. Basic approaches of plasticity theory [2] 11. Cold-formed thin-walled structures [2] 12. Design of plate elements and welded plate girders [2] 13. Spatial structural systems [2] 14. Structural systems of multi-storey buildings [2] 15. Details in steel structures [2] • Design exercises: 1. Revision of the examples in design of tension members within the course Metal structures [2]

	2. Revision of the examples in design of compression members within the course Metal structures [2] 3. Design examples of beams subjected to axial force and bending [4] 4. Design examples with uniform built-up compression members [4] 5. Fatigue design of steel members[4] 6. Examples of application of plastic theory [2] 7. Design examples with thin-walled structures [4] 8. Design examples with plate elements and girders [4] 9. Preliminary design of spatial structures[4].
Study and examination requirements and forms of examination	• Final written exam: numerical and theoretical tasks (minimum 50% score), • Oral exam.
Media employed	Whiteboard, projector.s
Reading list	Required literature: 1. Androić, B., Dujmović, D., Džeba, I.,Čelične konstrukcije 1, IA Projektiranje, Zagreb 2009., 2. Androić, B., Dujmović, D., Džeba, I.,Čelične konstrukcije 2, IA Projektiranje, Zagreb 2008., 3. Androić, B., Dujmović, D., Džeba, I.,Metalne konstrukcije 4, IA Projektiranje, Zagreb 2003., 4. Lecture notes. Optional literature: 1. Trahair, N.S., Bradford, M.A., Nethercot, D.A., Gardner, L.,The Behaviour and Design of Structures to EC 3, Taylor and Francis, London 2008 2. Beg, D., Kuhlmann, U., Davaine, L.; Braun, B.,Design of Plated Structures, Ernst und Sohn, Berlin 2011

IV. SEMESTER

Module name:	**Numerical Modeling in Engineering Materials**
Module level, if applicable	Master's Degree Program
Code, if applicable	114653
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	IV (Summer)
Person responsible for the module	Ivan Gabrijel
Lecturer	
Language	Croatian
Relation to curriculum	Master's degree program. Construction Materials Program. Compulsory. Semester IV.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises: 16 • Seminars: 14
Workload	Lecture hours 30 Hours of exercises 30 Project 30 Other contact hours 15 Self study hours 75
Credit points	6 ECTS
Requirements according to the examination regulations	• Attendance in lectures – 75 %, • Attendindance in exercises – 100 %.
Recommended prerequisites	• Understanding physical properties of construction materials, • Understanding the basic principles of mass and energy transport, • Basic calculus knowledge.
Module objectives/intended learning outcomes	• Ability to identify heat and mass transport mechanism required for numerical analysis of transport through concrete, • Ability to simulate temperature distribution in early age concrete, • Ability to analyze rate of chloride ingress into concrete exposed to maritime environment, • Ability to perform numerical investigation of thermal bridging in building physics, • Ability to simulate hydration process in Portland cement.
Content	• Lectures: 1. Introduction into transport processes [2] 2. Molecular transport mechanisms [2] 3. Principle of equilibrium [2] 4. Initial and boundary conditions [2] 5. Finite difference method (truncation error and Taylor series, elliptical equation, parabolic equation) [6] 6. Finite element method [4] 7. Application of FEA on 1-dimensional time dependent problems [2] 8. Invers methods [2] 9. Stohastic methods [2] 10. Artificial intelligence and expert systems [2] 11. Neural networks and fuzzy logic [2]. • Exercises (auditory, design): 1. Solving heat and mass transfer problems using FDM [4]

	2. Modeling temperature distribution in early age concrete [4] 3. Application of FEA on heat transfer problems [4] 4. Simulation of stresses caused by temperature distribution [1] 5. Simulation of cement hydration [3]. • Seminars: 1. Solving assignments [14].
Study and examination requirements and forms of examination	• Assignment grade, • Exam.
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. Balabanić, G., Numeričkomodeliranje u inženjerstvumaterijala, (selected chapters), mimeographed lecture notes, 2010 Optional literature: 1. Chapra S.C. ,Canale. R.P.,Numerical Methods for Engineers, McGraw-Hill, Sixth Edition, 2009 2. Brodkey R.S., Hershey H.C.,Transport Phenomena – A Unified Approach, McGraw-Hill, 1988 3. Rappaz, M.; Bellet, M.; Deville, M.,Numerical modeling in materials science and engineering, Springer, 2002 4. Raabe, D.,Computational materials: The simulation of materials Microstructure and properties, John Wiley & Sons Inc, 1998 5. DalbeloBašić, B.,Umjetneneuronskemreže–mimeographed lecture notes for the course Artificial Intelligence, Faculty of electrical engineering and Computing, Zagreb, May, 2008

Module name:	**High Performance Concrete**
Module level, if applicable	Master’s Degree Programmes
Code, if applicable	114663
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	IV (Summer)
Person responsible for the module	Ivana Banjad Pečur, Marijan Skazlić
Lecturer	
Language	Croatian
Relation to curriculum	Master’s degree programme. Construction Materials Programme. Elective. Semester IV.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises: 30 (auditory - 20, laboratory - 10) • E-learning: optional
Workload	Lecture hours 30 Hours of laboratories or skills 30 Other contact hours 30 Self study hours 90
Credit points	6 ECTS
Requirements according to the examination regulations	• Attendance in lectures – minimum 75 %, • Attendance in auditoryexercises– 100 %, • Attendance in laboratory exercises–100 %, • High performance concrete mix design seminar, • Two pre-exams.
Recommended prerequisites	• Basic knowledge on concrete components, concrete mix design and propertiesin fresh and hardened state.
Module objectives/intended learning outcomes	• Basicknowledge about high performance concrete propertiesin freshandhardenedstate and high performance concrete mix design, • Practical skill in applying certainhigh performance concrete technologydependingon the type ofstructure, • Theoretical and practical knowledge about advantages and disadvantages of high performance concrete in practice, • Understanding the process of high performance concrete quality control in concrete production plant and on-siteby usinglaboratory and fieldtest methods, • Knowledge about specialtypesof high performance concrete, • Integration of knowledge in future study and work.
Content	• Lectures: 1. Historical development, definitions and classification [2] 2. High performance concrete principles [2] 3. Materials selection [2] 4. Compatibility of components [2] 5. Mix design methods [2] 6. Technology of concrete production, transport and construction [2] 7. Optimization of curing process [2] 8. Correlation between concrete structure and properties [2] 9. Properties in fresh state [2] 10. Testing methods [2] 11. Mechanical properties [2] 12. Durability properties [2] 13. Technology selection based on the structure type [2] 14. Special types of high performance concretes [2]

	15. Potential for structural application [2]. • Auditory exercises: 1. Introductiontoselecting concrete componentsandmix design [2] 2. Selection ofconcrete components based onthe requiredproperties [2] 3. Mix design methods for different concrete types [2] 4. Specific problemsof concrete technology ina variety of applications [2] 5. Quality control [2] 6. High performance fiber reinforced concrete [2] 7. High performance concrete in aggressiveenvironment [2] 8. High performance concrete laboratory and on-sitepropertytests [2] 9. Case studies in building construction [2] 10. Case studies in infrastructure objects [2]. • Laboratory exercise: 1. Determining the properties of high performance concrete components [2] 2. Mix design[2] 3. Testing fresh concrete properties[2] 4. Testingdurability properties[2] 5. Testing mechanical properties in hardened state[2]. • Student project: 1. Seminar paper on high performance concrete mix design.
Study and examination requirements and forms of examination	• Oral exam.
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. Nawy, E.,Fundamentals of high-performance concrete, Second edition, John Wiley&Sons, Inc., New York, 2001 2. Aitcin, P. C.,High-Performance Concrete, E&FN SPON, London, 1998 3. Caldarone, M.,High-strength concrete, Taylor and Francis, 2009 4. ACI SP-189,High Performance Concrete: Research to Practice, 1989 5. Proceedings from the International Symposium on Ultra High Performance Concrete Optional literature: 1. Mehta P.K.,Concrete, Structure, Properties and Materials, New Yersey: Prentice Hall, Inc., Englewood Cliffs,1986 2. Neville, A.M.,Properties of concrete, fourth edition. Essex: Longman Group Limited,1995 3. Ukrainczyk, V.,Concrete: structure, properties and technology, Alcor, Zagreb, 2001, (in Croatian) 4. Proccedings from the International Symposiums on Utilization of High Strengtth/High Performance Concretes 5. Proceedings from the International Symposium on High Performance Fiber Reinforced Cement Composites (HPFRCC)

Module name:	**Design of Experiment**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	114669
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	IV (Summer)
Person responsible for the module	Ivana Banjad Pečur
Lecturer	
Language	Croatian
Relation to curriculum	Master's degree programme. Construction Materials Programme. Elective. Semester IV.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises: 30 (auditory - 12, design - 14, laboratory - 4)
Workload	Lecture hours 30 Hours of exercise 30 Project 20 Other contact hours 20 Self study hours 80
Credit points	6 ECTS
Requirements according to the examination regulations	• Attendance in lectures – minimum 75%, • Attendance in auditory, design and laboratory exercises – 100%, • Program development, • Pre-exam – minimum 50% score, • One make up exam.
Recommended prerequisites	• Knowledge about physical, chemical, mechanical and thermal properties of materials, • Basic statistics.
Module objectives/intended learning outcomes	• Ability to describe the effects (of loading) on materials and buildings, • Ability to describe the mechanisms of environmental effects on materials, • Ability to describe the testing methods for the properties of building materials with regard to various effects, • Ability to design testing methods for assigned effects, • Ability to compare the results of materials measurements, • Ability to apply the testing results on builging materials.
Content	• Lectures: 1. Introducton, goals, types and importance of testing [2] 2. Modeling physical phenomena [4] 3. Numerical solution and programming of physical models [2] 4. Planning and developing experiments [4] 5. Selection of experiment instruments [2] 6. Statistical design of experiments [2] 7. Design of measuring instruments [2] 8. Electrical measuring of non-electrical measures [2] 9. Computer aided automation of measuring [2] 10. Virtual laboratory [2] 11. An experiment example for professionaldly oriented investigations [2] 12. An experiment example for scientifically oriented investigation [2] 13. Research literature [2]. • Auditory exercises: 1. Defining experiments [2] 2. Selection of instruments [2]

	3. Instrument design for non-standardized testing [2] 4. Examples for non-standardized measurements [2] 5. Virtual laboratory [2], • Design exercises: 1. Task assignment – defining the problem (program) [2] 2. Modeling physical-chemical processes [4] 3. Selection of instruments [2] 4. Computer aided automation of measuring [2] 5. Data processing [2] 6. Result analysis [2] • Laboratory exercises: 1. Laboratory standardized testings [2] 2. Laboratory non-standardized testings [2].
Study and examination requirements and forms of examination	• Oral exam.
Media employed	Projector, whiteboard.
Reading list	Required literature: 1. Montgomery, D. C., Design and Analysis of Experiments, International Student Version, 7th Edition, Wiley, 2009 Optional literature: 1. Hicks, C. R., Fundamental Concepts in the Design of Experiments, Holt, Reinhart and Winston, Inc., 1973, 2. Ashby, M. F., Joneas, D. R. H., Engineering Materials 1, Butterworth-Heinemann, Oxford - Boston - Johannesburg - Melbourne - NewDelhi - Singapore, 1996

Module name:	**Applied Metallurgy**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	21792
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	IV (Summer)
Person responsible for the module	Davor Skejić
Lecturer	Ivan Čurković, Ivan Lukačević
Language	Croatian
Relation to curriculum	Master degree programme, Construction materials, Elective. Semester IV.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises: 30 (auditory - 10, design - 20)
Workload	Lecture hours 30 Numerical exercises hours 30 Midterm written examination hours 2 Self study hours 112 Other contact hours 4 Final written and oral examination hours 2
Credit points	6 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, • Development of four programs, • Pre-exam – minimum 25% score, • One make up exam.
Recommended prerequisites	• Knowledge about basic manufacture methods and properties of steels, • Basic knowledge about dimensioning of steel structures.
Module objectives/intended learning outcomes	• Ability to explain contemporary production methods and design of alloyed carbon seel products, • Ability to explain advanced engineering properties of steel with the emphasis on toughess and material fatigue properties, • Ability to apply knowledge and skills required for the selection of steel quality when designing structural elements of steel structures in various conditions of use according to contemporary methods and European norm criteria, • Ability to explain and apply knowledge about the weldability of structural steels, • Ability to apply specific skills and knowledge in steel structure design to avoid brittle fracture, • Ability to explain the basics of advance fracture mechanics and asses the durability of structures.
Content	• Lectures: 1. Indroduction [2] 2. Properties of carbon steel alloys [2] 3. Design and production methods [2] 4. Introduction to engineering properties of steel [2] 5. Advanced engineering properties of steel – toughness [2] 6. Advanced engineering properties of steel – material fatigue properties [2] 7. General information on types and qualities of steel [2] 8. Selection of high-quality groups of steel [2] 9. Selection of high-quality groups of steel to avoid brittle fracture – toughness requirements [2] 10. High-quality groups of steel according to Eurocode 3 [3] 11. Weldability of structural steels [3]

	12. Additional regulations on design with regard to avoiding brittle fracture [2] 13. Assessment of fatigue (durability of structures) based on fracture mechanics [4]. • Auditory exercises: 1. Determining engineering properties of steel [2] 2. Determining mechanical properties of welds by testing hardness [2] 3. Toughness at fracture [2] 4. Selection of high-quality subgroup of steel with regard to maximum permitted thickness[1] 5. Selection of high-quality subgroup of steel with regard to maximum permitted thickness based on the examples of structural elements on bridges [1] 6. Additional design regulations with the purpose of avoiding brittle fracture [1] 7. Selection of high-quality subgroup of steel with regard to the properties related to element thickness based on the examples of structural connections (joints) on bridges [1]. • Design exercises: 1. Selection of high-quality subgroup of steel with regard to the maximum allowed thickness [1] 2. Selection of high-quality subgroup of steel with regard to maximum permitted thickness based on the examples of structural elements on bridges [3] 3. Additional design regulations with the purpose of avoiding brittle fracture based on the examples of structural connections [3] 4. Selection of high-quality subgroup of steel with regard to element thickness based on the examples of structural connections (joints) on bridges [7] 5. Assessment of fatigue (remaining service life) in existing steel structures based on the example of Ličanka bridge [4].
Study and examination requirements and forms of examination	• Written exam – task - minimum 50% score, • Written exam – theory – minimum 50% score.
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. G. Sedlacek et al., Commentary and worked examples to EN 1993-1-Material toughness and through thickness properties and other toughness oriented rules in EN 993, First Edition, September 2008, 2. Androić, B. (a group of authors), Assessment of Existing Steel Structures: Recommendations for Estimation of Remaining Fatigue Life, JRC Scientific and Technical Reports, Joint Report, JRC European Commission, February 2008, 3. Skejić, D., Androić, B., Dujmović, D., Izvor čelika s obzirom na žilavost, Građevinar 64 (2012) 10, pp. 805-815, 4. mimeographed lecture and exercise notes. Optional literature: 1. McGannon, H. E., The Making, Shaping and Treating of Steel, 1985, 2. Brockenbrough, R. L., Metallurgy Chapter 1.1, Constructional Steel Design, an International Guide, 1992, 3. Leslie, W. L., The Physical Metallurgy of Steels, Washington, New York, London : Hemisphere Publishing Corporation, 1981, 4. Dahl, W., Steel-Handbook of Materials Research and Engineering Vol. 1, Duesseldorf : Springer-Verlag, 1990

Module name:	**Numerical Mathematics**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	21805
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	IV (Summer)
Person responsible for the module	Tomislav Došlić, Alan Filipin
Lecturer	
Language	Croatian
Relation to curriculum	Master's degree programme.Elective.Semestar IV.
Type of teaching, contact hours	Number of hours (in semester): 60 • Lectures: 30 • Exercises (auditory): 30
Workload	Lecture hours 28 Exercises hours 30 Other contact hours 2 Self study hours 60
Credit points	6 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises.
Recommended prerequisites	• Familiarity with the calculus, including ordinary differential equations, and basic linear algebra.
Module objectives/intended learning outcomes	• Understanding the conditions and limits of applicability of particular numerical methods, • Ability to choose and successfully apply correct methods.
Content	• Lectures: 1. Sources and types of errors (5) 2. Methods for solving non-linear equations (5) 3. Interpolation and approximation (5) 4. Numerical integration (5) 5. Numerical methods for solutions of ordinary differential equations (5) 6. Numerical linear algebra (5) • Exercises (auditory): follow the lectures.
Study and examination requirements and forms of examination	• Correct solution of a pre-assigned problem, • Oral exam.
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. T. Došlić, Numerička matematika, available at the course web-page. Optional literature: 1. E. Kreyszig: Advanced Engineering Mathematics, John Wiley and Sons Ltd., 1999,. 2. F. Scheid: Numerical Analysis, Schaum's Outline Series in Mathematics, McGraw-Hill

Module name:	**Perspective**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	21806
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	IV (Summer)
Person responsible for the module	Sonja Gorjanc
Lecturer	Iva Kodrnja, Helena Koncul, Dora Pokaz
Language	Croatian
Relation to curriculum	Master's Degree Programmes. Elective. Semester IV.
Type of teaching, contact hours	Number of hours (in semester): 60 • Lectures:30 • Exercises (auditory, design, laboratory): 30
Workload	Lecture hours 30 Hours of laboratories or skills 30 Other contact hours 30 Self study hours 90
Credit points	6 ECTS
Requirements according to the examination regulations	• 100% attendance in lectures and exercises, • 4 projects, • 1 seminar paper, • 1 pre-exam.
Recommended prerequisites	• Familiarity with the methods of parallel projection.
Module objectives/intended learning outcomes	• Mastering basic constructive procedures in perspective, • Acquiring knowledge on methods of construction of perspective image of an object, • Acquiring knowledge on geometric properties of algebraic surfaces of higher order, • Ability to construct perspective image of objects from civil engineering.
Content	• Lectures: 1. Central projection [8] 2. Quadric surfaces [4] 3. Ruled surfaces [6] 4. Computer modeling of surfaces [8] 5. Terrains in perspective [4] • Exercises (constructive, in computer classroom): 1. Central projection [8] 2. Quadric surfaces [4] 3. Ruled surfaces [6] 4. Computer modeling of surfaces [8] 5. Terrains in perspective [4]
Study and examination requirements and forms of examination	• Written exam - minimum 60% score, • Oral exam, • Students who have achieved a positive grade in projects, seminar paper and pre-exam are exempt from the written and oral exam.
Media employed	Projector, whiteboard.
Reading list	Required literature: 1. P. Kurilj, N. Sudeta, M. Šimić, Perspektiva (Perspective), Arhitektonski fakultet, Zagreb, 2005 Optional literature: 1. V. Niče, Perspektiva (Perspective), Školska knjiga, Zagreb, 1978,

	2. B. Kučinić et al., Oble forme u graditeljstvu, Građevinar, Zagreb, 1992, 3. H. Brauner, W. Kickinger, Geometrija u graditeljstvu, Školska knjiga, Zagreb,1980

Module name:	**Basics of Differential Geometry**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	21804
Subtitle, if applicable	
Courses, if applicable	1 class for lectures 1 class for exercises
Semester(s) in which the module is taught	IV (Summer)
Person responsible for the module	
Lecturer	Iva Kodrnja, Sonja Gorjanc
Language	Croatian
Relation to curriculum	Master's degree programme.Elective.Semester IV.
Type of teaching, contact hours	Number of hours (in semester): 60 • Lectures:30 • Exercises (auditory, design, laboratory): 30
Workload	Lecture hours 30 Hours of exercise 30 Other contact hours 30 Self study hours 90
Credit points	6 ECTS
Requirements according to the examination regulations	• 100% attendance in lectures and exercises, • 2 projects, • 1 seminar paper, • 2 pre-exams.
Recommended prerequisites	• Familiarity with the basics of differential calculus and linear algebra.
Module objectives/intended learning outcomes	• Acquiring basic knowledge about differential geometry of curves and surfaces in Euclidean space, • Ability to solve tasks in differential geometry by using program Mathematica, • Knowledge about the properties of minimal surfaces, • The ability to apply the methods and content of differential geometry in civil engineering.
Content	• Lectures: 1. Curves in Euclidean space [8] 2. Surfaces in Euclidean space [10] 3. Curvatures of surfaces [6] 4. Mapping of surfaces [4] 5. Minimal surfaces [4]. • Exercises (constructive, in computer classroom): 1. Curves in Euclidean space [8] 2. Surfaces in Euclidean space [10] 3. Curvatures of surfaces [6] 4. Mapping of surfaces [4] 5. Minimal surfaces [4].
Study and examination requirements and forms of examination	• Written exam - minimum 60% score, • Oral exam, • Students who have achieved a positive grade in projects, seminar paper and pre-exam are exempt from written and oral exam.
Media employed	overhead projector, Mathematica presentation notebooks, software Mathematica
Reading list	Required literature: 1. I. Kamenarović, Diferencijalna geometrija, Sveučilište u Rijeci, Pedagoški fakultet, Rijeka, 1990,

	2. J. Beban-Brkić: web-scrip:http://www.grad.hr/itproject_math/Links/jelena/index.html Optional literature: 1. Gray, A.: Modern Differential Geometry of Curves and Surfaces With Mathematica, CRS Press, Boston, London, 1998, 2. On-line Encyclopedia of mathematical concepts: MathWorldWolfram

Module name:	**Waves and Oscillations**
Module level, if applicable	Master's Degree Programme
Code, if applicable	21807
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	IV (Summer)
Person responsible for the module	Dario Jukić
Lecturer	
Language	Croatian and/or English
Relation to curriculum	Master degree programme, Physics. Elective. Semester IV.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises: 30 (auditory - 15, laboratory - 15)
Workload	Lecture hours 30 Hours of laboratories 15 Hours of practical exercies 15
Credit points	6 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, • Three pre-exams – minimum 35% score in each, • One make up exam.
Recommended prerequisites	• Undergraduate course mathematics, including differential equations, • Basics of programming and use of Mathematics software.
Module objectives/intended learning outcomes	• Mastering equations on given problems: free vibrations of simple systems – wires, slabs; waves and wire extension in one, two or three dimensions, deformations, • Understanding the physical background of the equations taught in professional and mathematical courses, • Ability to find equations through physical properties of a problem – coupled oscillations and vibrations, acoustic wave spreading, acoustic insulation, • Modeling by applying a harmonic oscillator, • Computer modelling of individual physical models of the problems dealt with in professional and mathematical courses, • Understanding physical properties of forced oscillation and interference, • Understanding the physical basis for measurements in civil engineering.
Content	• Lectures: 1. Basics of deriving equations from given problems (4) 2. Waves and wave propagation in one, two or three dimensions, deformations (5) 3. Physical background for the equations mastered in professional and mathematical courses (5) 4. Finding solutions for the equations through physical properties of problems (5) 5. Modeling by harmonic oscillator (2) 6. Computer modeling of physical models for problems dealt with in professional and mathematical courses (3) 7. Physical properties of forced oscillations, interferences (5) 8. Physical basis of measurements in civil engineering (2). • Exercises (auditory, laboratory): 1. Free vibrations of simple systems – wires, slabs (4) 2. Coupled oscillations and vibrations, acoustic wave spreading, acoustic insulation (9)

	3. Coupled oscillations and vibrations, acoustic wave spreading, acoustic insulation (7) 4. Modeling: physical models (3) 5. Forced oscillations, interferences (5) 6. Physical measurements (2). • Seminars: included in exercises.
Study and examination requirements and forms of examination	• Pre-exam – students with a minimum 60% score are exempt from a part of the final exam (only final test is mandatory) End of semester grading: • The final test is the requirement for the final exam.
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. F. S. Crawford, Waves: Berkeley physics course v.3, McGraw-Hill college, 1968 Optional literature: 1. A. P. French, Vibrations and Waves, W.W. Norton & Company, New York, 1971

Module name:	**English Language in Civil Engineering 2**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	93234
Subtitle, if applicable	
Courses, if applicable	Master's's programme 7 classes
Semester(s) in which the module is taught	IV (Winter)
Person responsible for the module	Alemka Kralj Štih
Lecturer	
Language	English
Relation to curriculum	Master's Degree Programmes. Elective. Semester IV.
Type of teaching, contact hours	Number of hours (in semester): • Exercises: 45
Workload	Lecture hours 45 Other contact hours 10 Self study hours 80
Credit points	4,5 ECTS
Requirements according to the examination regulations	• 75% attendance in lectures, • Making a presentation, • 3 pre-exams.
Recommended prerequisites	• Intermediate level, B 1.
Module objectives/intended learning outcomes	• Understanding technical texts, • Independent report writing on technical procedures and heir performance, • Coherent and structured speking competence and clear presentation of ideas with accurate pronunciation, • Using technical terms in efficient communication.
Content	• Auditory exercises: 1. Environmental Engineering – Development & Scope [3] 2. Wellspring of the High Plains – Ogallala Aquifer [3] 3. Writing a Letter of Application / Job [5] 4. Interview Questions and How to Master Them [5] 5. The Secrets of Roman Concrete [3] 6. Who Builds Big? – Interviews [5] 7. Irrigation & Drainage Systems [3] 8. Environmental Matters [3] 9. Canals – Factfile about canal [3] 10. Engineering – Falkirk Lock [3] 11. Dams – Aswan High Dam – a Success or a Failure? [3] 12. Principal Construction Materials [3] 13. Stormwater and Floods [3].
Study and examination requirements and forms of examination	• The credits earned through all the testing and pre-exams make up the final grade. The grades are based as follows: pre-exam results, points earned during semester - active participation in class, grammar checks, translations into a foreign language, translations from a foreign language, professional vocabulary checks. Maximum number of points that can be earned in the pre-exam is 20 – the grade is multiplied by four. Students who have not earned enough points are required to take the final exam. • Grading is as follows - 50-62% score = sufficient (2), - 63-75% score = good (3), - 76-88% score = very good (4), - 89-100% score = excellent (5).
Media employed	Whiteboard, projector.
Reading list	Required literature:

	1. A. Kralj Štih, English in Hydro Engineering and Construction Materials, course materials, Zagreb, 2010 Optional literature: 1. M. Ibbotson, Professional English in Use, Cambridge University Press, 2011, 2. I. Williams, English for Science and Engineering, Thomson ELT, USA, 2007

Module name:	**German Language in Civil Engineering 2**
Module level, if applicable	Master's Degree Programm
Code, if applicable	93235
Subtitle, if applicable	
Courses, if applicable	Master's Programmes 1 class
Semester(s) in which the module is taught	IV (Winter)
Person responsible for the module	Alemka Kralj Štih
Lecturer	
Language	German
Relation to curriculum	Master's Degree Programmes. Elective. Semester IV.
Type of teaching, contact hours	Number of hours (in semester): 45 • Exercises (auditory):45
Workload	Lecture hours 45 Other contact hours 10 Self study hours 80
Credit points	4,5 ECTS
Requirements according to the examination regulations	• 75% attendance in exercised, • Preparing one presentation, • 3 pre-exams.
Recommended prerequisites	• German language competence at B1, B2 level.
Module objectives/intended learning outcomes	• Understanding and interpretation of technical texts, • Independent oral communication in technical areas, • Ability to define expert terms, • Writing CV and job application.
Content	• Auditory exercises: 1. Bauplanung und Bauablauf 1.1. Projektmanagement im Ingenieurbau [2] 1.2. Bauhandwerk und Bauindustrie [2] 1.3. Die Geschichte einer Renovierung [2] 2. Beton – Stahlbeton – Spannbeton 2.1. Holz [3] 3. Eine Brücke wandert 3.1. Konstruktion nach einem Modell [2] 3.2. Bauen und Heben im Takt [2] 4. Das Beispiel eines Damms [3] 5. Jobsuche und Berufswelt 5.1. Wie schreibt man korrekt eine E-Mail [1] 5.2. Bewerbungsschreiben- ein Musterbrief [2] 5.3. Ein Lebenslauf [2] 5.4. Intervju – Training [2] 6. Porträts der Bauingenieure 6.1. Das Portrait einer Bauingenieurin – Nadia [2] 6.2. Das Portrait einer Bauingenieurin – Monika [2] 6.3. Bernard Schirm [2] 6.4. Berufswelt Bau – Kämpfernaturen gesucht [3] 6.5. Ein Tag im Leben eines Bauingenieurs [3] 7. Stellenanzeigen 7.1. Vertriebsleiter [1] 7.2. Bauleiter [1] 7.3. Versorgungsingenieur [1] 7.4. Bauleiter (Rohbau) [1] 7.5. Konstruktiver Ingenieurbau [1] 7.6. Verkehrsrichtung [1]

	7.7. Bauleiter [1], 8. Filme 8.1. Was machen Ingenieure? [1] 8.2. Bauingenieure gesucht [1] 8.3. Beruf Dachdeckerin [1] 8.4. Wie sind Ingenieure? [1]
Study and examination requirements and forms of examination	• The credits earned through all the testing and pre-exams make up the final grade. The grades are based as follows: pre-exam results, points earned during semester - active participation in class, grammar checks, translations into a foreign language, translations from a foreign language, professional vocabulary checks. Maximum number of points that can be earned in the pre-exam is 20 – the grade is multiplied by four. Students who have not earned enough points are required to take the final exam. • Grading is as follows - 50-62% score = sufficient (2), - 63-75% score = good (3), - 76-88% score = very good (4), - 89-100% score = excellent (5).
Media employed	Whiteboard, projector.
Reading list	Required literature: 1. A. Kralj Štih, Deutch für Bauwirtschaft un Bauleitung, Hydrotechnik un Baustoffe, Kursunterlagen, 2011 Optional literature: 1. A. Prager, Trojezični građevinski rječnik, Masmedia, Zagreb, 2002

CONSTRUCTION MANAGEMENT PROGRAMME

I. SEMESTER

Module name:	**Mathematics 3**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	21802
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	I (Winter)
Person responsible for the module	Tomislav Došlić, Alan Filipin
Lecturer	Nikola Adžaga, Rafael mrđen
Language	Croatian
Relation to curriculum	Master's degree programme for all engineering programmes. Compulsory elective. Semester I.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 45 • Exercises (auditory): 30
Workload	Lecture hours 45 Hours of exercise 15 Other contact hours 30 Self study hours 135
Credit points	7,5 ECTS
Requirements according to the examination regulations	• Regular attendance in lectures and exercises, • Minimum 25 % score in the pre-exam.
Recommended prerequisites	• Understanding the calculus of one and several variables, including ordinary differential equations, and basic linear algebra.
Module objectives/intended learning outcomes	• Understanding the conditions and limits of applicability of linear models, • Ability to recognize and choose a correct model, • Ability to solve (analytically and/or numerically) simple linear models.
Content	• Lectures: 1. Ordinary differential equations [3] 2. Fourier series [3] 3. Partial differential equations and linear models of mathematical physics [20] 4. Numerical methods for solutions of ordinary and partial differential equations [16] • Exercises (auditory) follow the lectures.
Study and examination requirements and forms of examination	• Minimum 50% score in the written exam, • Students passing the pre-exam take only the second part, • Oral exam.
Media employed	Whiteboard, projector
Reading list	Required literature: 1. T. Došlić, D. Pokaz: Matematika 3, available on the course web-page.

	2. T. Slijepčević-Manger: Zbirka zadataka iz Matematike 3, available on the course web-page. Optional literature: 1. E. Kreyszig: Advanced Engineering Mathematics, John Wiley and Sons Ltd., 1999, 2. F. Scheid: Numerical Analysis, Schaum's Outline Series in Mathematics, McGraw-Hill

Module name:	**Stochastic Processes**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	I (Winter)
Person responsible for the module	Tomislav Došlić, Alan Filipin
Lecturer	Rafael Mrđen, Kristina Ana Škreb
Language	Croatian
Relation to curriculum	Master degree programme for all engineering programmes. Compulsore elective. Semester I.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 45 • Exercises (auditory): 30
Workload	Lecture hours 45, hours of exercise 30, other contact hours 30, self study hours 120.
Credit points	7.5 ECTS
Requirements according to the examination regulations	• Regular attendance • Minimum 25 % score in the pre-exam.
Recommended prerequisites	
Module objectives/intended learning outcomes	• Understanding conditions and limits of applicability of stochastic models, • Ability to recognize and choose correct model. • Ability to formulate and solve simple problems in terms of Markov chains and processes.
Content	• Lectures: 1. Basic characteristics and examples of stochastic processes [3], 2. Markov chains with discrete time and finite and countable set of states [27], 3. Markov processes [6], 4. Poisson processes and the theory of queues [6], • Exercises (auditory: follow the lectures.
Study and examination requirements and forms of examination	• Eliminatory written exam - minimum 50 % score, • Students who pass the pre-exam take only the second part, • Oral exam.
Media employed	Whiteboard, projector
Reading list	Required literature: 1. N. Berglund, Processus aleatoires et applications, available as Croatian translation on the course web-page and originally at ArXiv.org. Optional literature: 1. R. Durrett: Essentials of Stochastic Processes, Springer Texts in Statistics, Springer, New York, 1999, 2. D. P. Bertsekas, J. N. Tsitsiklis: Introduction to Probability, On line lecture notes, M.I.T., 2000.

Module name:	**Research methods**
Module level, if applicable	Master's Degree Programme
Code, if applicable	21822
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	I.(Winter)
Person responsible for the module	Anita Cerić
Lecturer	
Language	Croatian
Relation to curriculum	Master's degree programme. Compulsory for all subject areas at Graduation studies. Semestar I.
Type of teaching, contact hours	• Lectures: 15 • Seminars: Students are obliged to write a seminar paper on an assigned topic.
Workload	Lecture hours 15 Other contact hours 10 Self study hours 20
Credit points	1.5 ECTS
Requirements according to the examination regulations	Writing a seminar paper or a positively graded test.
Recommended prerequisites	
Module objectives/intended learning outcomes	• Collecting literature from different sources, • Defining the hypothesis, • Choosing an appropriate research method and methodology, • Using different techniques in data collection, • Writing essays, papers and reviews, • Presenting and discussing research findings.
Content	• Lectures: 1. Collecting literature and information 1 (2) 2. Role of hypothesis and general structure of the thesis 1 (1) 3. Writing papers, critiques and essays 2 (2) 4. Data collection 1 (1) 5. Research methodology 2 (1) 6. Research methods 3 (2) 7. Reporting the results 1 (2) 8. Citing references 2 (3) 9. Bibliography 1 (2) 10. Presentation skills 1 (1)
Study and examination requirements and forms of examination	• Written paper, • Written exam
Media employed	Whiteboard, projector
Reading list	Required literature: 1. Zelenika, R. Metodologija i tehnologija izrade znanstvenog i stručnog djela, Rijeka: Ekonomski fakultet Sveučilišta u Rijeci, 1999 (in Croatian) 2. Cerić, A., Textbook for Civil Engineering Students, 2012, (in Croatian)

	Optional literature: 1. Fellows, R. And Liu, A., Research Methods for Construction, Oxford: The Blackwell Science, 1997 2. 2.Naoum, S.G., Dissertation Research and Writing for Construction Students, Oxford: ButterworthHeinemann, 2007

Module name:	**Construction management II**
Module level, if applicable	Master's Degree Programme
Code, if applicable	21823
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	I (Winter)
Person responsible for the module	Mladen Vukomanović
Lecturer	Sonja Kolarić
Language	Croatian
Relation to curriculum	Master's degree programme. Construction Management Programme. Compulsory. Semester I.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises: 28 (auditory - 10, design - 18) • Seminars: 5 • E-learning: 120
Workload	Lecture hours 30 + 30 Other contact hours and self study hours 120
Credit points	6 ECTS
Requirements according to the examination regulations	• 80 % attendance in lectures and exercises, • Seminar assignment completed and successfully presented. • Two pre-exams.
Recommended prerequisites	• Bachelor degree in civil engineering.
Module objectives/intended learning outcomes	• Theoretical and practical knowledge about the advanced methods in construction management processes, e.g.: theory of relevant cost items in construction projects, various cost calculation methods in construction project, cost estimation in construction projects, different procurement routes, value management etc…
Content	• Lectures: 1. Introduction [2] 2. Drafting alternative solutions in construction management [2] 3. The theory of significant cost items [2] 4. Methods of direct calculation of construction processes [2] 5. Cost calculation by software applications – trends [2] 6. Time/schedule versuscost in construction projects [2] 7. Value management in construction projects [2] 8. Developing work and organization breakdown structures [3] 9. Procurement in construction processes [2] 10. Organization structures and contract management in construction [3] 11. The concept of buildability [2] 12. Multicultural and global environment affects on construction [2] 13. Building Information Management [2] 14. New trends in construction management [2]. • Exercises: 1. Alternative solutions of construction 2. Technology alternatives 3. Technology flowcharts 4. Significant cost item calculation

	5. Direct cost calculation 6. Organization breakdown Structure 7. Work breakdown structure 8. Construction organizational concept 9. Modeling Building Information • (Seminars:) 1. Current trends in construction management
Study and examination requirements and forms of examination	• Written exam (minimum 50% score), • Oral exam.
Media employed	Whiteboard, projector
Reading list	Required literature: 1. Radujković, M.,Construction management II, lectures – hard copy of PPT slides, University of Zagreb,2008, 2. Marušić , J.,Construction management, University of Zagreb, 1994, 3. Lončarić, R., Organization of execution construction projects, HDGI, Zagreb, 1995, 4. Radujković M., Burcar I., Vukomanović M.,Solved assignment examples from Constructionmangement I and Scheduling methods, University of Zagreb, FCE, 2008, 5. Radujković M., Izetbegović J., Nahod M..M., Construction law regulation, University of Zagreb, 2008 Optional literature: 1. Radujković, M et. al.,Planning and control of project, University of Zagreb, 2012, 2. Vukomanović, M. and Radujković, M,Business excellence in construction industry, University ofZagreb, 2011, 3. Harris, F; McCaffer, R. and Edum-Fotwe, F.,Modern Construction Management, 7th Edition, Willey,2013

Module name:	**Building maintenance management**
Module level, if applicable	Master's Degree Programme
Code, if applicable	21824
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	I (Winter)
Person responsible for the module	Anita Cerić
Lecturer	
Language	Croatian
Relation to curriculum	Master's degree programme. Construction Management programme. Compulsory. Semestar I.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 hours • Exercises: 15 hours/ Project assignments • E-learning: All students participate in discussion groups on assigned topics
Workload	Lecture hours 30 Exercise/Project assignments 15 Other contact hours 10 Self study hours 80
Credit points	4.5 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, • Completion of project assignments.
Recommended prerequisites	
Module objectives/intended learning outcomes	• Ability to identify failures on a building using different inspection methods, • Ability to choose an appropriate building maintenance strategy, • Ability to prepare building maintenance project documentation, • Ability to make the priority list of maintenance works using multi-criteria analysis, • Ability to use commercial computer program „Expert Choice“ in decision making processes, • Ability to design building repair and maintenance plan according to energy efficiency standards, • Developing building maintenance management of corporate building portfolios.
Content	• Lectures: 1. Introduction to building maintenance management [2] 2. Maintenance management regulations [2] 3. Regular maintenance, reconstructions and repairs [2] 4. Maintenance management strategies [4] 5. Planning and organisation of maintenance works [4] 6. Maintenance of listed buildings [2] 7. Models for setting priorities in building maintenance [4] 8. IT support for decision making in setting priorities in building maintenance [2] 9. Energy efficiency and building maintenance [2] 10. Building maintenance management and facilities management: interconnections [4]

	11. The role of maintenance management in corporate real estate management [2]. • Exercises: 1. All students are obliged to complete project assignments in 15 hours + homework.
Study and examination requirements and forms of examination	• Final written exam.
Media employed	Whiteboard, projector
Reading list	Required literature: 1. Ceric, A., Building Maintenance Management Textbook, 2012 2. Lee, R. Building Maintenance Management, Oxford, Blackwell Science, 1987 3. Chanter, B. and P. Swallow, Building Maintenance Management, Oxford, Blackwell Science, 1996 4. Barrett, P., Facilities Management, Oxford, Blackwell Science, 2000 Optional literature: 1. Mills, E., Building Maintenance & Preservation, Oxford, Architectural Press, 1996 2. R. Flanagan and C. Jewell, Whole Life Appraisal for Construction, Oxford, Blackwell Science, 2005 3. Pfüner, A., Moderni menadžment nekretnina: Facility Management and Corporate Real Estate Management, Koraci: Zagreb, 2005 (translation from Germany)

Module name:	**Optimisation Methods in Construction**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	21825
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	I (Winter)
Person responsible for the module	Ivica Završki
Lecturer	Matej Mihić
Language	Croatian (Also Available in English)
Relation to curriculum	Master's degree programme, Construction Management Programme. Compulsory, Semester I
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises (auditory, design, laboratory):30
Workload	Lectures hours: 30 Auditory practice hours: 30 Design practice hours: 15 Self study hours: 105
Credit points	6 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, • 2 pre-exams – minimum 25% score in each. • A make up exam.
Recommended prerequisites	• Understanding the basics of organisation and technology in construction, linear algebra, mathematical statistics.
Module objectives/intended learning outcomes	• Ability to solve the problem of linear programing using graphics and simplex method, • Ability to solve the problems of dynamic deterministic and probabilistic programming, • Ability to use the methods of decision making under certainty, under risk and under uncertainty, • Ability to create Monte Carlo simulation.
Content	• Lectures: 1. Introduction [2] 2. Models of linear programing with two variables, graphical solution, graphical sensitivity analysis [2] 3. Transition from graphical to algebraic solution [2] 4. Artificial starting solutions [2] 5. Definition of the dual problem, primal – dual relationship [2] 6. Post-optimal and sensitivity analysis[2] 7. Transportation models and network models [2] 8. Deterministic dynamic programming [2] 9. Deterministic inventory models [2] 10. Nonlinear programing [2] 11. Decision making under certainty, decision under risk, decision under uncertainty [2] 12. Probabilistic dynamic programing [2] 13. Probabilistic inventory models, queuing systems [2] 14. Monte Carlo simulation, generation of random numbers [2]

	15. Simulation languages [2]. • Exercises (auditory): 1. Graphical solution[2] 2. Simplex method [2] 3. Graphical solution [2] 4. Artificial starting solution, special cases in simplex method application [2] 5. Definition of the dual problem, primal – dual relationship, interpretation of duality [2] 6. Post-optimal analysis and sensitivity analysis [2] 7. Transportation problems and network models [2] 8. Deterministic dynamic programing, deterministic inventory models [2] 9. Nonlinear programming [2] (pre-exam) 10. Decision making under certainty, decision under risk, decision under uncertainty[2] 11. Probabilistic dynamic programming, probabilistic inventory models, queuing systems [2] 12. Monte Carlo simulation, generation of random numbers[2] 13. Simulation languages[2] (pre-exam)
Study and examination requirements and forms of examination	• Written exam – minimum 50% score, • Oral exam.
Media employed	Whiteboard, projector
Reading list	Required literature: 1. Z. Lukač, L. Neralić, Operacijskaistraživanja, Element, Zagreb, 2012 2. D. Kalpić, V. Mornar,Operacijskaistraživanja, Zeus, Zagreb, 1996 Optional literature: 1. Lj. Martić: Matematičkemetodezaekonomskeanalize II, Narodnenovine, Zagreb, 1965 2. W. Jurecka, H.J. Zimmermenn,Operation Research in Bauwesen, Springer Verlag, 1972 3. N. Limić,Linearnoinelinearnoprogramiranje, Informator, Zagreb, 1978 4. V. Čerić,Simulacijskomodeliranje, Školskaknjiga, Zagreb, 1993 5. V. Žiljak,Simulacijaračunalom, Školskaknjiga, Zagreb, 1982 6. H.A. Taha: Operations research, Prentice Hall, 2003

Module name:	**Work study**
Module level, if applicable	Master’s Degree Program
Code, if applicable	21826
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	I (Winter)
Person responsible for the module	Anita Cerić
Lecturer	Matej Mihić, Maja-Marija Nahod
Language	Croatian
Relation to curriculum	Master’s degree program. Construction Management Programme. Compulsory. Semester (I).
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises : 15 (auditory - 9, design - 6)
Workload	Estimated workload in hours [4,5 (ECTS) x 30 (hours/ETCS)=]: 135 hours Lecture hours: 30 Exercise hours: 15 Other contact hours: 15 Self study hours: 75
Credit points	4,5 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, • Doing four construction exercises, • Pre-exams in college computer lab.
Recommended prerequisites	• Knowledge about the following major technological processes in construction: earthworks, carpentry work, concrete work, reinforcement work, reinforcement of concrete work, masonry, asphalt works, hydrotechnical work. • Computer literacy.
Module objectives/intended learning outcomes	• Knowledge about the methodological procedures in the preparation of the study of work, • Mastering the calculation of building standards through the application of methods of work-study, • Application ofsimulation methodsinconstruction.
Content	• Lectures: 1. Work organization: Historical development of work organization. Development of Construction. Organization of work. Four Taylor's principles. The principles of work organization. Future studies of work. Two basic fields in development of the science of work. The organization of production: Concept of production. Objectives of production. Scientific discipline of the production. Five typical stages in the development of production [3] 2. The development of the theory of organization: Disadvantages in classical approach to the organization. The neoclassical theory of organization. Modern theories of organization. A systematic approach to the theory of organization. Theories of general management: Newer contributes to the development of general management. Development of general management. Three recent

	approaches to the development of general management. Criticism of the new theories of general management [3] 3. Construction production as construction industry. The characteristics and limitations of the development of civil engineering and construction. Construction in "a broader sense."Construction in the "narrow sense ". Technological processes in production. Work study and productivity. Distribution of technological processes. The basic structure of technological process. The indicators of technological process. The capacity of technological systems. Information in construction: Management of construction. General development of modern information technology and information systems in construction companies. Execution of construction projects: The life cycle of construction endeavour. Regulatory models of construction projects. Regulatory Model in preparation for construction. Regulatory Model in defining projects. Project management: Students are instructed to use the literature [3] 4. Human resources in production: Man in construction. The psychological effects on man. Psychology of work. The person in psychology. Important psychological traits building. Important psychological methods in the study of man as a person [3] 5. The physiological effects on humans. Sociological influences on man. Impacts of the working environment on people [3] 6. Rationalization of production. Modeling of construction production. The procedures for construction production rationalization. The algorithm for the rationalization of construction production [3] 7. The organization of construction: Preparation of construction. Terms of reference for the preparation of construction production. The tasks in the preparation of production. The methodological approach in the design of production preparation. Modeling future production and construction products. Design approach preparation of construction production. Simulation of construction: Definition of simulation. The application of the most popular simulation methods (Queuing theory , Monte Carlo method , the software package Micro - Cyclone , stroboscope and EZStrobe) [3] 8. Organization design (aspects and applications in construction industry) : Introduction and philosophy of multidisciplinary design: a methodological approach to design: systems thinking , system engineering, system dynamics. Planning, construction and engineering design: Integration. Phase and a parallel model multidisciplinary design. Planning based on multiple scenarios [3]. • Exercises (auditory, design): 1. Auditory presentation of systematic analysis of a complex technological process of building production. Students divided in working groups do problem-solving [3] 2. Auditory display standardization methods of construction production. Students numerically solve individual piece of work in the field of standardization of building industry [3] 3. Students learn about the possibilities of using all the available simulation programs: EZStrobe - one example of its application in the construction operational [3] 4. The conclusion of the course and final consultations with students. Attending lectures and exercises in a computer laboratory at the Department of Construction Management (212 classrooms). • Seminars: 1. If student want to improve their final grade, they can write a paper, 2. The paper should be presented and defended before the course teacher and fellow students,

	3. Only in case of more than 10 applicants wanting to write a paper, the presentation can be done electronically on the official Internet site of the Faculty.
Study and examination requirements and forms of examination	• Pre-exams, • Design exercises, • Term paper or • The final exam on the course content.
Media employed	Whiteboard, projector
Reading list	Required literature: 1. J. Izetbegović, V. Žerjav, Organizacija građevinske proizvodnje, Hrvatska udruga za organizaciju građenja i Građevinski fakultet Sveučilišta u Zagrebu, Zagreb, 2009 2. J. Izetbegović,Proučavanje graditeljske proizvodnje, GF-Zagreb, 200., http://www.og.grad.hr 3. I. Tunjić, An excerpt from a graduation thesis, titled Optimisation of construction production, defended in September 2011 at The Faculty of Civil Engineering, Zagreb, mentor J. Izetbegović (EZStrobe mogućnosti modela, preuzeto sa internetske stranice www.ezstrobe.com). Optional literature: 1. V. Žerjav, Process- and Project-Level Issues of Design Management in the Built Environment doctoral thesis, Vienna University of Technology (http://www.ub.tuwien.ac.at/diss/AC07812616.pdf,2012 2. J. Marušić,Organizacija građenja, university textboo, FS, Zagreb, 1994, 3. D. Taboršak,Studij rada, Orgdata, Zagreb,1994

II. SEMESTER

Module name:	**Construction Equipment**
Module level, if applicable	Master’s Degree Program
Code, if applicable	21841
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	II and IV (Summer)
Person responsible for the module	Mladen Vukomanović
Lecturer	Sonja Kolarić, Zvonko Sigmund
Language	Croatian
Relation to curriculum	Master's degree programme Construction Management Programme. Elective. Semester II and IV.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises: 26 (auditory - 10, design – 16) • Seminars: 4 • E-learning: 120
Workload	Estimated workload in hours [6 (ECTS) x 30 (hours/ETCS)=]: 180 hours Lecture hours: 60 Other contact hours: 30 Self study hours: 90
Credit points	6 ECTS
Requirements according to the examination regulations	• 80 % attendance in lectures and exercises, • Completed and presented work assignment.
Recommended prerequisites	• Bachelor degree in civil engineering.
Module objectives/intended learning outcomes	• Knowledge about construction machines for earth works and other types of engineering construction, • Ability to estimate the efficiency of different types of machines, • Ability to organize and plan machinery.
Content	• Lectures: 1. Selection and planning the operation of construction machines[1] 2. Selection and application of construction machinery, selection of machines[1] 3. Application of machinery for earth works[1] 4. Logistics of construction works[2] 5. Logistics, elements of logistics, construction transportation, complexity of logistics[2] 6. Problems in logistics, solving the problems in logistics[2] 7. Working system of construction work and plants[2] 8. Working system construction machines[2] 9. Construction machines reliability system[2] 10. Working system construction plants[2] 11. Construction machines maintenance[2] 12. Productivity of construction machines and transportation machines in the building process[2] 13. Work and technological processes[2]

	14. Time classification of machinery working cycles[2] 15. Efficiency of machinery and earth works transportation systems[2] 16. Construction machines under the conditions of usage, analyses of construction machines usage[1] 17. Working time losses, exchange of construction machines[1] 18. Procurement of construction machines[1]. • Exercises (auditory, design, laboratory): 1. Section of the equipment[4] 2. Designing machine systems[4] 3. Calculation of the efficiency[4] 4. Calculation of equipment cost[4] 5. Calculation of equipment reliability [4] 6. Alternatives in machine systems[6] • Seminars: 1. Current trends in construction equipment: procurement, maintenance, operation, optimization and IT systems.
Study and examination requirements and forms of examination	• Two pre-exams, • Work assignment and 1 presented seminar paper • Or final written and oral exams.
Media employed	Whiteboard, projector
Reading list	Required literature: 1. Linarić, Z, Leksikon strojeva i opreme za proizvodnju građevinskih materijala, University of Zagreb, 2011 2. Linarić, Z., Učinci strojeva i vozila pri zemljanim radovima, Biblioteka Mineral, Business Media Croatia d.o.o., Zagreb, 2008 3. Eduard S., Strojevi u građevinarstvu, Hrvatsko društvo građevinskih inženjera, Zagreb, 1995 4. Žaja, M., Ekonomika proizvodnje, Školska knjiga, Zagreb, 1991 Optional literature: 1. Harris, F; McCaffer, R. and Edum-Fotwe, F.,Modern Construction Management, 7th Edition, Willey, 2013

Module name:	**Management in Civil Engineering**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	59892
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	II (Summer)
Person responsible for the module	Lana Lovrenčić Butković
Lecturer	Josip Sertić
Language	Croatian.
Relation to curriculum	Master's degree program Transportation Engineering Programme Compulsory. Semester I.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises (auditory): 8 • Seminars: 7 • E-learning: 2nd level
Workload	Lecture hours 30 Hours of seminar work 15 Self study hours 90
Credit points	4,5 ECTS
Requirements according to the examination regulations	• Attendance in morethan 75% of lectures, • Minimum 25% score in each of thethree pre-exams, • Writing and presenting a seminar paper, • UsingMerlin.
Recommended prerequisites	• Basic knowledge about the basicsof economyinthe courseBusiness economics(elective course inthe first yearof undergraduatestudies).
Module objectives/intended learning outcomes	• Understanding the purpose and key concepts of management (vision, mission statement, the role and functions of managers/ project managers, • Understanding the role and the relevance of management and its participants, • Learning about business decision making, • Understanding the functioning of the market, • Ability to direct business processes, • Mastering the skills of analytical thinking and presenting the facts through seminar papers, • Communicating complex ideas concisely and clearly in written form.
Content	• Lectures: 1. Basic principles of management 1.1. Introduction [2] 1.2. Who are Managers?[2] 1.3. Management functions[2] 1.4. A Management development[2] 1.5. Schools of Management[2] 2. Management as a Process 2.1. Planning[2] 2.2. Organizing[2] 2.3. Leading[2] 2.4. Controlling[1]

	3. Business decision making 3.1. Defining decision making[1] 3.2. Process of decision making[1] 3.3. Styles and modes of decision making[1] 3.4. Methods of decision making[1] 3.5. Communication in business decision making[1] 4. Basics of management organization 4.1. Companytypes[1] 4.2. Basics of reproduction process[1] 4.3. Business assets[1] 5. Costs, price and price calculation[1] 6. Business results 6.1 Financial reports [1] 6.2 Business success measures (cost-effectiveness, productivity, profitability)[1] 7. Project management[1] 8. Economic system and its surroundings[1] • Auditory exercises : 1. How to write an essay ? 2. How to make a presentation? 3. Who are leaders? 4. Movie – Decision, decision 5. Movie – Project management • Seminars: 1.-7. Students presenting seminar papers– discussion.
Study and examination requirements and forms of examination	• Written exam, • Oral exam.
Media employed	Whiteboard, projector
Reading list	Required literature: 1. Mariza Katavić, Osnove ekonomike za graditelje, Hrvatska sveučilišna naklada, Zagreb, 2009, 2. Lecture notes (handouts on Merlin). Optional literature: 1. H.Weihrich, H.Koontz, Menadžment, (10th ed.) MATE d.o.o. ,Zagreb, 1998, 2. Stephen Lavender, Management for the Construction Industry, Longman and The Chartered Institute of Building, Elookx, England 1996

Module name:	**Construction Project Management**
Module level, if applicable	Master's Degree Programme
Code, if applicable	21830
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	II (Summer)
Person responsible for the module	Mladen Vukomanović
Lecturer	Kristijan Robert Prebanić
Language	Croatian
Relation to curriculum	Master's degree programme. Construction Management Programme. Compulsory. Semester II.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 60 • Exercises: 25 (auditory - 10, design - 15) • Seminars: 5 • E-learning: 180
Workload	1 ECTS is 30 hours Lecture hours 60 + 30 Other contact hours and self study hours 180
Credit points	9 ECTS
Requirements according to the examination regulations	• 80 % attendance in lectures and the exercises, • Work assignment completed, • Successfully presented seminar paper.
Recommended prerequisites	• Bachelor degree in civil engineering.
Module objectives/intended learning outcomes	• Theoretical and practical knowledge about project management, according to key international standards, e.g.: strategies, objectives, deliverables, project life cycle, interested parties, critical success factors, success criteria, project management during the definition and execution phase, project manager, teamwork, risk management, change management, human resource management, quality management, time management, cost management, total quality management, communicat • ion, information management, etc • Competence in applying advanced tools and skills in project management to construction projects. • Knowledge necessary to act as project managers throughout project lifecycle
Content	• Lectures: 1. Introduction [4] 2. Fundamentals of Project management [4] 3. Project management in concept and definition phase [4] 4. Project management in execution phase [4] 5. Project manager [4] 6. Teamwork [4] 7. Risk management [4] 8. Change management [4] 9. Human Resource management [4] 10. Cost/Time/Quality management [4] 11. Communication in construction projects [4]

	12. Knowledge and contract management [4] 13. International Project Management Standards/methodologies/approaches [4] 14. Strategic Management and Project Management [4] 15. New trends in project management [4]. • Exercises (auditory, design): 1. Designing the concept phase [3] 2. Designing the planning phase [3] 3. Designing the execution phase [3] 4. Designing the turnover phase [2] 5. Designing Project manager development plan [2] 6. Teamwork stages and team building assignments [2] 7. Risk management plan [2] 8. Change management process concept [2] 9. Designing communication plan [2] 10. Designing an integrated Strategic Performance Management systems [2] 11. Designing project management plan [2]. • (Seminars:) 1. Seminar I:technical competences in project management, 2. Sseminar II:behavioral competences in project management, 3. Seminar III: international project management standard/methodology.
Study and examination requirements and forms of examination	• Three pre-exams, • Work assignment and 3 presented seminar papers, • Or the final written and oral exam at the end of semester.
Media employed	Whiteboard, projector
Reading list	Required literature: 1. Radujković, M et. al, Planning and control of project0073, University of Zagreb, 2012 2. Vukomanović, M. and Radujković, M.,Business excellence in construction industry, University of Zagreb, 2011 3. Lončarić, R.,Organization of execution construction projects, HDGI, Zagreb, 1995 4. IPMA: IPMA Competence Baseline 3.0., International Project Management Association, Van Haren Publishing, 2006 5. PMI: A guide to the Project Management Book of Knowledge, 4th Edition, 2008 6. Stationery Office; An introduction to PRINCE2: managing and directing successful projects, The Stationery Office Series 2009. 7. APM; APM Body of Knowledge 6th edition, APM Publishing, 2012 Optional literature: 1. Radujković M., Izetbegović J., Nahod M.M., Construction law regulation, University of Zagreb, 2008 2. Radujković, M.: Construction management II, lectures – hard copy of PPT slides, University of Zagreb, 2008 3. Radujković M., Burcar I., Vukomanović M., Solved assignment examples from Construction mangement I and Scheduling methods, University of Zagreb, FCE, 2008 4. Marušić , J.,Construction management, University of Zagreb, 1994 5. Harris, F; McCaffer, R. and Edum-Fotwe, F.,Modern Construction Management, 7th Edition, Willey, 2013 6. Kerzner, H.,Project Management: A Systems Approach to Planning, Scheduling, and Controlling 10th edition, Willey, 2009

Module name:	**Environmental Protection**
Module level, if applicable	Master’s Degree Programme
Code, if applicable	
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	II (Summer)
Person responsible for the module	Živko Vuković
Lecturer	
Language	Croatian
Relation to curriculum	Master’s degree programme. Compulsory elective. Semester II..
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30
Workload	Lecture hours 30 Consultation hours 30 Self study hours 30
Credit points	3 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, • Two pre-exams.
Recommended prerequisites	• Basic knowledge in physics, biology, chemistry and civil engineering.
Module objectives/intended learning outcomes	• Understanding basic ecological processes, • Recognising and explaining basic ecological principles, • Explaining basic technological procedures of wastewater treatment, • Understanding waste management, • Understanding the concept of “sustainable development“.
Content	• Lectures: 1. Introduction [2] 2. Basic ecological concepts (ecology, biotop, biocenose, ecosystem, biodiversity) [3] 3. Global changes in biosphere –changes in atmosphere [2] 4. Pedosphere pollution [2] 5. Hydrosphere pollution [3] 6. The impact of cities [3] 7. The impact of landfills [3] 8. Impact of hydraulic structures [3] 9. Transportation facilities impact [3] 10. Environmental sustainability and sustainable development [3] 11. Measures and environmental protection procedure (political and sociological approach, legal measures, environment planning, economic and financial measures, scientific approach and technological measures, institutional measures [3]
Study and examination requirements and forms of examination	Students with minimum 60 % score in each pre-exam are exempt from the final oral exam.
Media employed	Whiteboard, projector
Reading list	Required literature: 1. Vuković, Ž.: Environment Protection, Manuscript, 2014, Zagreb (in Croatian).

	Optional literature: 1. Raven, P. H., Berg, L. R., Hassenzahl, D. M.: Environment, 7th Edition, Wiley, 2010. 2. Miller, G. T.: Living in the Environment: Principles, Connections, and Solutions, 15th Edition, Thomson Books, 2007.

Module name:	**English Language in Civil Engineering 2**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	93234
Subtitle, if applicable	
Courses, if applicable	Master's's programme 7 classes
Semester(s) in which the module is taught	III (Winter)
Person responsible for the module	Alemka Kralj Štih
Lecturer	
Language	English
Relation to curriculum	Master's Degree Programmes. Elective. Semester III.
Type of teaching, contact hours	Number of hours (in semester): • Exercises: 45
Workload	Lecture hours 45 Other contact hours 10 Self study hours 80
Credit points	4,5 ECTS
Requirements according to the examination regulations	• 75% attendance in lectures, • Making a presentation, • 3 pre-exams.
Recommended prerequisites	• Intermediate level, B 1.
Module objectives/intended learning outcomes	• Developing language competences which include professional terminology in the field of transport facilities and geotechnical engineering, • Independent user – ability to read technical literature independently, • Revision of basic grammar categories in professional language – passive, past tenses, modal verbs, • Confident use of sentences in professional language, developing presentation skills and skills in writing professional papers.
Content	• Auditory exercises: 1. Civil Engineering – Subspecialties [2] 2. A Day in the Life of a Construction Manager [2] 3. Mission to Accomplish [2] 4. Projects [2] 5. Creating a CV – How to write a CV? [2] 6. Writing a letter of application [2] 7. Design Solutions [3] 8. Job Interview Questions [2] 9. 1st colloquium [2] 10. Tender Action [3] 11. Professional Development [3] 12. Planning and building Permission [2] 13. Preparing for the Interview Skills – Techniques, Tips and Advice [2] 14. Selection of Contractors [2] 15. Single presentations – Case studies [2] 16. 2nd colloquium [1] 17. Career Job Hunting – avoiding potential job (interview) disasters – Tips and Advice [2] 18. Joint presentations [2] 19. The Company [2]

	20. Formal and Informal Meetings [2] 21. Construction Site Organization – vocabulary [2] 22. 3rd pre-exam [1]
Study and examination requirements and forms of examination	• The credits earned through all the testing and pre-exams make up the final grade. The grades are based as follows: pre-exam results, points earned during semester - active participation in class, grammar checks, translations into a foreign language, translations from a foreign language, professional vocabulary checks. Maximum number of points that can be earned in the pre-exam is 20 – the grade is multiplied by four. Students who have not earned enough points are required to take the final exam. • Grading is as follows - 50-62% score = sufficient (2), - 63-75% score = good (3), - 76-88% score = very good (4), - 89-100% score = excellent (5).
Media employed	Whiteboard, projector
Reading list	Required literature: 1. A. Kralj Štih: English in Structural Engineering, course materials. Optional literature: 5. D. Bonamy: Technical English 4, Pearson Longman, 2011 6. The Internet pages, program Building Big, Brantacan, ASCE. 7. Z. Vulelija: Ilustrirani rječnik arhitekture i građe inar t a – hrvatsko engleski i englesko hrvatski, Masmedia, Zagreb, 2010 8. A. Prager: Trojezični građevinski rječnik, Masmedia, Zagreb, 2002

Module name:	**German Language in Civil Engineering 2**
Module level, if applicable	Master's Degree Programm
Code, if applicable	93235
Subtitle, if applicable	
Courses, if applicable	Master's Programmes 1 class
Semester(s) in which the module is taught	III (Winter)
Person responsible for the module	Alemka Kralj Štih
Lecturer	
Language	German
Relation to curriculum	Master's Degree Programmes. Elective. Semester III.
Type of teaching, contact hours	Number of hours (in semester): 45 • Exercises (auditory):45
Workload	Lecture hours 45 Other contact hours 10 Self study hours 80
Credit points	4,5 ECTS
Requirements according to the examination regulations	• 75% attendance in exercised, • Preparing one presentation, • 3 pre-exams.
Recommended prerequisites	• German language competence at B1, B2 level.
Module objectives/intended learning outcomes	• Understanding and interpretation of technical texts, • Independent oral communication in technical areas, • Ability to define expert terms, • Writing CV and job application.
Content	• Auditory exercises: 1. Bauplanung und Bauablauf 1.1. Projektmanagement im Ingenieurbau [2] 1.2. Bauhandwerk und Bauindustrie [2] 1.3. Die Geschichte einer Renovierung [2] 2. Beton – Stahlbeton – Spannbeton 2.1. Holz [3] 3. Eine Brücke wandert 3.1. Konstruktion nach einem Modell [2] 3.2. Bauen und Heben im Takt [2] 4. Das Beispiel eines Damms [3] 5. Jobsuche und Berufswelt 5.1. Wie schreibt man korrekt eine E-Mail [1] 5.2. Bewerbungsschreiben- ein Musterbrief [2] 5.3. Ein Lebenslauf [2] 5.4. Intervju – Training [2] 6. Porträts der Bauingenieure 6.1. Das Portrait einer Bauingenieurin – Nadia [2] 6.2. Das Portrait einer Bauingenieurin – Monika [2] 6.3. Bernard Schirm [2] 6.4. Berufswelt Bau – Kämpfernaturen gesucht [3] 6.5. Ein Tag im Leben eines Bauingenieurs [3] 7. Stellenanzeigen 7.1. Vertriebsleiter [1]

	7.2. Bauleiter [1] 7.3. Versorgungsingenieur [1] 7.4. Bauleiter (Rohbau) [1] 7.5. Konstruktiver Ingenieurbau [1] 7.6. Verkehrsrichtung [1] 7.7. Bauleiter [1], 8. Filme 8.1. Was machen Ingenieure? [1] 8.2. Bauingenieure gesucht [1] 8.3. Beruf Dachdeckerin [1] 8.4. Wie sind Ingenieure? [1]
Study and examination requirements and forms of examination	• The credits earned through all the testing and pre-exams make up the final grade. The grades are based as follows: pre-exam results, points earned during semester - active participation in class, grammar checks, translations into a foreign language, translations from a foreign language, professional vocabulary checks. Maximum number of points that can be earned in the pre-exam is 20 – the grade is multiplied by four. Students who have not earned enough points are required to take the final exam. • Grading is as follows - 50-62% score = sufficient (2), - 63-75% score = good (3), - 76-88% score = very good (4), - 89-100% score = excellent (5).
Media employed	Whiteboard, projector
Reading list	Required literature: 1. A. Kralj Štih, Deutch für Bauwirtschaft un Bauleitung, Hydrotechnik un Baustoffe, Kursunterlagen, 2011 Optional literature: 1. A. Prager, Trojezični građevinski rječnik, Masmedia, Zagreb, 2002

Module name:	**Construction Technology 1**
Module level, if applicable	Master's Degree Program
Code, if applicable	21827
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	II (Summer)
Person responsible for the module	Ivana Burcar Dunović
Lecturer	
Language	Croatian
Relation to curriculum	Master's degree program.Construction Management Programme Compulsory. Semester II.
Type of teaching, contact hours	Number of hours (in semester): • Lectures:45 • Exercises: 30 (auditory - 6, design - 24) • E-learning: 100% of lectures and examination is supported with e-learning but it is not normalized
Workload	Estimated workload in hours [7,5 (ECTS) x 30 (hours/ETCS)=]: 225 hours Lecture hours: 75 Other contact hours: 30 Self study hours: 120
Credit points	7,5 ECTS
Requirements according to the examination regulations	• Attendance in minimum 75% lecturesand 100% exercises, • Minimum 25% score in the pre-exam, • Case study.
Recommended prerequisites	• Familiarity with specific literature, prior knowledge, skills or participation in preparatory modules of Bachelor degree program (area: Technology of heavy construction).
Module objectives/intended learning outcomes	• Recognitionoftheterrainandtheproperselectionofmachines for work, • Determining themachines for demolitionandrecyclingfacility, • Identifying the issues of work anddetermining thetechnology and techniqueofundergroundworks on pipelines, • Identifying theissuesanddetermining the type andthedimensionoftechnologyandtechniqueof work on theexcavationofthetunnel, • Determining themethodanddimensionofblastingoperations at thequarry.
Content	• Lectures: 1. Introduction. Principle of module study (principle of teaching, learning and examination of the module). Review of literature [3] 2. Technique and technology of earthworks in soil and rock, construction technique and technology[3] 3. Excavation in soil and rock. Transportation of earth material and embankment works [3] 4. Preliminary (pre)works (pre-production activities) for earth works, preliminary works (preproduction activities) for construction. Logistic of stone-ware[3] 5. Technique, technology and logistic of construction waste treatment. Environmental protection. Construction waste. Collecting of construction

	waste. Construction waste recycling. Use of recycled construction material[3] 6. Technique and Technology of rock blasting. Mining (rock blasting) works. Explosives, detonators, fuse and cord. NONEL – system detonate. Blasting theory. Planning of blasting works. Perimeter blasting[3] 7. Technique and Technology of stone-ware production. Production of construction materials for embankment structures. Crushing and crusher. Screening. Screens surface calculation. Aggregate washing. Mobile crushing and screening plants[3] 8. In site lecture of earthworks (or recycling or blasting or stone-ware production)) [3] 9. Protection of earthworks and structures. Ground and soil stable and consolidation. Jetgrouting. Protection of excavation structures perimeter (slope)[3] 10. Trench-channel slope system of protection. Protection of construction site hole or basin slope. Diaphragm wall[3] 11. Technique and Technology of underground excavations. Technique and Technology of Underground Excavations. NATM (New Austrian Tunneling Method) TBM (Tunnel Boring Machines). Technique and technology of buried pipelines („micro tunneling“)[3] 12. In site lecture of earthworks and structures protection or tunneling[3] 13. Selection and planning of technique and technology for earthworks[3] 14. Productivity of equipment and transportation for earthworks. Earth work costs. Planning of technique and technology for earthworks[3] 15. Timetable and program (contents) of construction (design) practice for students [3]. • Exercises (auditory, design, laboratory): 1. Design of construction technology based on case study.
Study and examination requirements and forms of examination	• Oralexam
Media employed	Whiteboard, projector
Reading list	Required literature: 1. Coursehandoutsavailable on e-learning system 2. Božić, B., Miniranje u rudarstvu, graditeljstvu I geotehnici, UdžbeniciSveučilišta u Zagrebu, Geotehničkifakultet u Varaždinu, Varaždin, 1998, 3. Ester, Z.,Miniranje I,eksplozivnetvari, metode I svojstvaispitivanja, UdžbeniciSveučilišta u Zagrebu, RGN fakultet, Zagreb, 2005, 4. Linarić, Z., Leksikonstrojeva I opremezaproizvonjugrađevinskihmaterijala. Učincizastrojeve I vozilaprizemljanimradovima, biblioteka Mineral, Business Media Croatia, Zagreb, 2007, 5. Linarić, Z.: Postrojenjazaproizvodnjusipkih I povezanihmineralnihgradiva. Drobilane.Tvornicebetona.Asfaltnebaze, biblioteka Mineral, Bussines Media Croatia, Zagreb, 2009, 6. Roje-Bonacci, T.,Potpornegrađevine I građevinskejame, Građevinsko-arhitektonskifakultet u Splitu, Sveučilište u Splitu, IGH d.d. Zagreb, Split 2005 Optional literature: 1. Electronic books: Knjiga 1 (Troškovistrojnograda u građenju; Izborstrojeva I planiranjestrojnograda u građenju)

	Knjiga 2 Tehnologijagrađenja I. Knjiga 3 Sustavigrađevinskihstrojeva Tehnologijaniskogradnja – teaching material (mppprezentacijapredavanja) Tehnologija građenja I – teaching material (mppprezentacijapredavanja). 2. LIFE05 TCY7CRO/OO114,CONWAS, razvojodrživogsustavaupravljanjagrađevinskimotpadom u RepubliciHrvatskoj, www.igh.hr/CONWAS/index.htm;

Module name:	**Supervising and Monitoring of Construction Projects**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	21843
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	II and IV (Summer)
Person responsible for the module	Ivica Završki
Lecturer	
Language	Croatian (Also Available in English)
Relation to curriculum	Master's degree programme, Construction Management Programme. Elective, II and IV Semester
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30
Workload	Lectures hours: 30 Self study hours: 60
Credit points	3 ECTS
Requirements according to the examination regulations	• Attendance in lectures, • 2 pre-exams: minimum 25% score in each pre-exam, make up pre-exam.
Recommended prerequisites	• The basics of construction low, the basics of construction technology.
Module objectives/intended learning outcomes	• Explaining the legislative and contractual bases of supervising and monitoring of construction projects, • Listing and describing responsibilities of supervision engineers during the phases of the project, • Describing the principles of quality control, as well as the cost and time control in construction process, • Explaining the activities of technical consultancy for investors
Content	• Lectures: 1. Normative basis of construction works supervision, laws and rules[2] 2. Contractual basis of supervision. Supervision and other participants in a project. Supervision team structure and mutual relationships [2] 3. The role and the obligations of supervision in the phases of a project: designation, introducing the contractor with work, verification of technical documentation, stakeout study [2] 4. Quantity control, methods of measurement and billing [2] 5. Quality control [2] 6. Time control[2] 7. Cost control, estimate of additional work [2] 8. Interim valuations, final valuation [2] 9. Technical inspection, handover of a building [2] 10. Official communication and documentation [2] 11. Normative basis of technical consultancy. Selection of the consultant, elements of contract on technical consultancy[2] 12. Role of the consultant in the phases of a project [2] 13. Monitoring the project in terms of cost, time and quality. Consulting investors [2] 14. Annexes to the agreement and related documentation [2] 15. Consultant's liability, professional associations and norms [2].

Study and examination requirements and forms of examination	• Written exam, minimum 50% score, • Oral exam.
Media employed	Whiteboard, projector
Reading list	Required literature: 1. Construction Act, Official Gazette 153/13, Zagreb, 2013 Optional literature: 1. L. Fučić, Zakon o prostornomuređenjuigradnjiipratećizakoni, Kigen, Zagreb, 2005

Module name:	**Numerical Mathematics**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	21805
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	II and IV (Summer)
Person responsible for the module	Tomislav Došlić, Alan Filipin
Lecturer	
Language	Croatian
Relation to curriculum	Master's degree programme.Elective.Semestar II and IV.
Type of teaching, contact hours	Number of hours (in semester): 60 • Lectures: 30 • Exercises (auditory): 30
Workload	Lecture hours 28 Exercises hours 30 Other contact hours 2 Self study hours 60
Credit points	6 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises.
Recommended prerequisites	• Familiarity with the calculus, including ordinary differential equations, and basic linear algebra.
Module objectives/intended learning outcomes	• Understanding the conditions and limits of applicability of particular numerical methods, • Ability to choose and successfully apply correct methods.
Content	• Lectures: 1. Sources and types of errors (5) 2. Methods for solving non-linear equations (5) 3. Interpolation and approximation (5) 4. Numerical integration (5) 5. Numerical methods for solutions of ordinary differential equations (5) 6. Numerical linear algebra (5) • Exercises (auditory): follow the lectures.
Study and examination requirements and forms of examination	• Correct solution of a pre-assigned problem, • Oral exam.
Media employed	Whiteboard, projector
Reading list	Required literature: 1. T. Došlić, Numerička matematika, available at the course web-page. Optional literature: 1. E. Kreyszig: Advanced Engineering Mathematics, John Wiley and Sons Ltd., 1999,. 2. F. Scheid: Numerical Analysis, Schaum's Outline Series in Mathematics, McGraw-Hill

Module name:	**Perspective**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	21806
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	II and IV (Summer)
Person responsible for the module	Sonja Gorjanc
Lecturer	Iva Kodrnja, Helena Koncul, Dora Pokaz
Language	Croatian
Relation to curriculum	Master's Degree Programmes. Elective. Semester II and IV.
Type of teaching, contact hours	Number of hours (in semester): 60 • Lectures:30 • Exercises (auditory, design, laboratory): 30
Workload	Lecture hours 30 Hours of laboratories or skills 30 Other contact hours 30 Self study hours 90
Credit points	6 ECTS
Requirements according to the examination regulations	• 100% attendance in lectures and exercises, • 4 projects, • 1 seminar paper, • 1 pre-exam.
Recommended prerequisites	• Familiarity with the methods of parallel projection.
Module objectives/intended learning outcomes	• Mastering basic constructive procedures in perspective, • Acquiring knowledge on methods of construction of perspective image of an object, • Acquiring knowledge on geometric properties of algebraic surfaces of higher order, • Ability to construct perspective image of objects from civil engineering.
Content	• Lectures: 1. Central projection [8] 2. Quadric surfaces [4] 3. Ruled surfaces [6] 4. Computer modeling of surfaces [8] 5. Terrains in perspective [4] • Exercises (constructive, in computer classroom): 1. Central projection [8] 2. Quadric surfaces [4] 3. Ruled surfaces [6] 4. Computer modeling of surfaces [8] 5. Terrains in perspective [4]
Study and examination requirements and forms of examination	• Written exam - minimum 60% score, • Oral exam, • Students who have achieved a positive grade in projects, seminar paper and pre-exam are exempt from the written and oral exam.
Media employed	projector, whiteboard

Reading list	Required literature: 1. P. Kurilj, N. Sudeta, M. Šimić, Perspektiva (Perspective), Arhitektonski fakultet, Zagreb, 2005 Optional literature: 1. V. Niče, Perspektiva (Perspective), Školska knjiga, Zagreb, 1978, 2. B. Kučinić et al., Oble forme u graditeljstvu, Građevinar, Zagreb, 1992, 3. H. Brauner, W. Kickinger, Geometrija u graditeljstvu, Školska knjiga, Zagreb,1980

Module name:	**Basics of Differential Geometry**
Module level, if applicable	Master’s Degree Programmes
Code, if applicable	21804
Subtitle, if applicable	
Courses, if applicable	1 class for lectures 1 class for exercises
Semester(s) in which the module is taught	II. and IV. (sommer)
Person responsible for the module	
Lecturer	Iva Kodrnja, Sonja Gorjanc
Language	Croatian
Relation to curriculum	Master’s degree programme.Elective.Semestar II. and IV.
Type of teaching, contact hours	Number of hours (in semester): 60 • Lectures:30 • Exercises (auditory, design, laboratory): 30
Workload	Lecture hours 30 Hours of exercise 30 Other contact hours 30 Self study hours 90
Credit points	6 ECTS
Requirements according to the examination regulations	• 100% attendance in lectures and exercises, • 2 projects, • 1 seminar paper, • 2 pre-exams.
Recommended prerequisites	• Familiarity with the basics of differential calculus and linear algebra.
Module objectives/intended learning outcomes	• Acquiring basic knowledge about differential geometry of curves and surfaces in Euclidean space, • Ability to solve tasks in differential geometry by using program Mathematica, • Knowledge about the properties of minimal surfaces, • The ability to apply the methods and content of differential geometry in civil engineering.
Content	• Lectures: 1. Curves in Euclidean space [8] 2. Surfaces in Euclidean space [10] 3. Curvatures of surfaces [6] 4. Mapping of surfaces [4] 5. Minimal surfaces [4]. • Exercises (constructive, in computer classroom): 1. Curves in Euclidean space [8] 2. Surfaces in Euclidean space [10] 3. Curvatures of surfaces [6] 4. Mapping of surfaces [4] 5. Minimal surfaces [4].
Study and examination requirements and forms of examination	• Written exam - minimum 60% score, • Oral exam, • Students who have achieved a positive grade in projects, seminar paper and pre-exam are exempt from written and oral exam.

Media employed	Whiteboard, projector
Reading list	Required literature: 1. I. Kamenarović, Diferencijalna geometrija, Sveučilište u Rijeci, Pedagoški fakultet, Rijeka, 1990, 2. J. Beban-Brkić: web-scrip:http://www.grad.hr/itproject_math/Links/jelena/index.html Optional literature: 1. Gray, A.: Modern Differential Geometry of Curves and Surfaces With Mathematica, CRS Press, Boston, London, 1998, 2. On-line Encyclopedia of mathematical concepts: MathWorldWolfram

Module name:	**Waves and Oscillations**
Module level, if applicable	Master's Degree Programme
Code, if applicable	21807
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	II. and IV. (Summer)
Person responsible for the module	Dario Jukić
Lecturer	
Language	Croatian and/or English
Relation to curriculum	Master degree programme, Physics. Elective. II. and IV. Semester.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises: 30 (auditory - 15, laboratory - 15)
Workload	Lecture hours 30 Hours of laboratories 15 Hours of practical exercies 15
Credit points	6 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, • Three pre-exams – minimum 35% score in each, • One make up exam.
Recommended prerequisites	• Undergraduate course mathematics, including differential equations, • Basics of programming and use of Mathematics software.
Module objectives/intended learning outcomes	• Mastering equations on given problems: free vibrations of simple systems – wires, slabs; waves and wire extension in one, two or three dimensions, deformations, • Understanding the physical background of the equations taught in professional and mathematical courses, • Ability to find equations through physical properties of a problem – coupled oscillations and vibrations, acoustic wave spreading, acoustic insulation, • Modeling by applying a harmonic oscillator, • Computer modelling of individual physical models of the problems dealt with in professional and mathematical courses, • Understanding physical properties of forced oscillation and interference, • Understanding the physical basis for measurements in civil engineering.
Content	• Lectures: 1. Basics of deriving equations from given problems (4) 2. Waves and wave propagation in one, two or three dimensions, deformations (5) 3. Physical background for the equations mastered in professional and mathematical courses (5) 4. Finding solutions for the equations through physical properties of problems (5) 5. Modeling by harmonic oscillator (2) 6. Computer modeling of physical models for problems dealt with in professional and mathematical courses (3) 7. Physical properties of forced oscillations, interferences (5) 8. Physical basis of measurements in civil engineering (2).

	• Exercises (auditory, laboratory): 1. Free vibrations of simple systems – wires, slabs (4) 2. Coupled oscillations and vibrations, acoustic wave spreading, acoustic insulation (9) 3. Coupled oscillations and vibrations, acoustic wave spreading, acoustic insulation (7) 4. Modeling: physical models (3) 5. Forced oscillations, interferences (5) 6. Physical measurements (2). • Seminars: included in exercises.
Study and examination requirements and forms of examination	• Pre-exam – students with a minimum 60% score are exempt from a part of the final exam (only final test is mandatory) End of semester grading: • The final test is the requirement for the final exam.
Media employed	Overhead projector, beamer, touchboard, experiments integrated with the lecture presentation.
Reading list	Required literature: 1. F. S. Crawford, Waves: Berkeley physics course v.3, McGraw-Hill college, 1968 Optional literature: 1. A. P. French, Vibrations and Waves, W.W. Norton & Company, New York, 1971

III. SEMESTER

Module name:	**Construction Business Systems**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	21831
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	III (Winter)
Person responsible for the module	Ivica Završki
Lecturer	Matej Mihić
Language	Croatian (also available in English)
Relation to curriculum	Master's degree programme, Construction Management Programme Compulsory, Semester III
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Auditory exercises:15 • Seminars:15
Workload	Lectures hours: 30 Auditory practice hours: 15 Seminars: 15 Self study hours: 120
Credit points	6 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, • 2 pre-exams: minimum 25% score in each pre-exam, make up pre-exam, • Presentation of seminar paper.
Recommended prerequisites	• Understanding the basics of construction technology and knowledge about the basics of Construction Act.
Module objectives/intended learning outcomes	• Explaining basic terms of the organisational theory, • Explaining the procedure of organisational design, • Explaining the characteristics of particular organisational functions in a construction company, • Demonstrating the procedure of organisational design on the example of a construction company.
Content	• Lectures: 1. Basics of general system theory: system, system approach, structure of the system [2] 2. Typology of companies in construction [2] 3. The basics of organisation and organisational theory[2] 4. Organisational structure, presentation of elements of organisational structure [2] 5. Elements of organisational structure in construction company: human resources, machinery and equipment[2] 6. Elements of organisational structure in construction company: material, information[2] 7. Organisational functions in construction company: research and development, human resource management[2]

	8. Organisational functions in construction company: procurement, sales, marketing[2] 9. Organisational functions in construction company: improvement of organisation, quality management[2] 10. Organisational functions in construction company: production[2] 11. Organisational functions in construction company: finances and accountancy, planning [2] 12. Factors of organisational design. Shaping the organisational structure of construction company [2] 13. Organisational changes. Re-engineering [2] 14. Legal forms of companies [2] 15. Forms of cooperation and integration among construction companies[2]. • Exercises (auditory): 1. Organisation of tuition [1] 2. General system theory [1] 3. Companies in construction [1] 4. Theory of organisation [1] 5. Organisational structure [1] 6. Elements of organisational structure [1] (pre-exam) 7. Organisational functions in construction company [4] 8. Shaping the organisational structure [1] 9. Organisational changes. Re-engineering [1] 10. Forms of cooperation among construction companies [1]. (pre-exam) • Seminars: 1. Choosing the seminar topic [1] 2. General system theory [1] 3. Companies in construction [1] 4. Theory of organisation [1] 5. Organisational structure [1] 6. Elements of organisational structure [1] 7. Organisational functions of construction company [4] 8. Shaping the organisational structure [1] 9. Organisational changes, re-engineering [1] 10. Forms of cooperation among construction companies[1].
Study and examination requirements and forms of examination	• Written and oral exam.
Media employed	Whiteboard, projector
Reading list	Required literature: 1. P. Sikavica, T. Hernaus,Dizajniranjeorganizacije, Novi informator, 2011, 2. P. Sikavica, M. Novak: Poslovnaorganizacija, Informator 1999 Optional literature: 1. G. Jones, Organizational Theory, Design and Change, Pearson, 2007, 2. .J. Hatch: Organization Theory, Oxford, 1997 3. M.Žaja,Poslovnisustav, Školskaknjiga, 2001, 4. S.Kapustić: Metodikaorganizacijskogprojektiranja, Zagreb, 1989

Module name:	**Planning and scheduling methods**
Module level, if applicable	Master's Degree Programme
Code, if applicable	21832
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	III. (Winter)
Person responsible for the module	Ivana Burcar Dunović
Lecturer	Kristijan Robert Prebanić
Language	Croatian
Relation to curriculum	Master degree programme. Construction Management Programme.Compulsory. Semester III.
Type of teaching, contact hours	Number of hours (in semester): • Lectures:30 • Exercises: 30 (auditory - 10, design - 20): • E-learning: 100% of lectures and examinations is supported with e-learning but it is not normalized.
Workload	Lecture hours 30 Exercise hours 30 Project hours 60 Other contact hours and Self study 60
Credit points	6 ECTS
Requirements according to the examination regulations	• Attendance in lecturesandexercises, • Developing a casestudyassignmentaccording to plan exercises, • Bookofexercises as plannedlectures.
Recommended prerequisites	• Knowledge about the basic methods of planning for construction projects, • Knowledge about the theoretical knowledge of the construction, such as network planning, resource planning, organizational charts, organizational theory, building regulations, cost analysis, etc…
Module objectives/intended learning outcomes	• Understanding and applying the methods of planning and control of projects, • Drawing up a detailed baseline time schedule baseline , • Developing a plan for the resources and costs, • Analyzing the baseline project plan, • Conducting optimization of the use of resources and shortening the duration of the project, • Designing a system for monitoring and control of the project, • Assessing the state of progress of the project, • Identifying the essential elements of the system of multi project planning.
Content	• Lectures: 1. Introduction to planning and scheduling [2] 2. Methods and techniques of linear planning - the basics [2] 3. Methods and techniques of network planning - the basics [2] 4. CPM network planning methods [3] 5. PERT method for network planning with uncertainty [3] 6. Resource planning [3] 7. Analysis of plans and shortening the duration of the project [3]

	8. Cost planning [3] 9. Monitoring and control [3] 10. Planning at management levels [3] 11. Planning projects of the company [3]. • Exercises (auditory, design): 1. Introduction 2. ExercisesPart I – developmentofbasic plan using MS Project 3. ExercisesPart II – developmentofbasic plan withresourcesusing MS Project 4. ExercisesPart III –making theinitial plan withlevelledresourceswiththe use of MS Project 5. ExercisesPart IV – making a basic plan withlevelledresourcesinmultiprojectenvironmentusingPrimavera Project Manager.
Study and examination requirements and forms of examination	• Written and oral exam.
Media employed	Whiteboard, projector
Reading list	Required literature: 1. Radujković, M. Et al.,Planiranje i kontrola projekata, Zagreb, 2012, 2. Radujković, M., Burcar, I., Vukomanović, M.,Riješeni primjeri zadataka iz Organizacije građenja i Met a planirana, Građevinski fakultet 2008, 3. Radujković, M.,Metode planiranja (mimeographed lecture notes). Optional literature: 1. Osmanagić-Bedenik, N.,Operativnoplaniranje, Školskaknjiga, Zagreb, 2002, 2. O'Brien and Plotnick: CPM in Construction Management, McGraw-Hill, Boston, 2003

Module name:	**Construction Site Practice**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	115176
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	III (Winter)
Person responsible for the module	Ivana Burcar Dunović
Lecturer	
Language	Croatian
Relation to curriculum	Master degree programme. Construction Management Programme.Compulsory. Semester III.
Type of teaching, contact hours	Number of hours (in semester): • Exercises. 60 (auditory - 2, field – 50, design - 8)
Workload	Lecture hours 60 Self study hours 95 Other contact hours25
Credit points	6 ECTS
Requirements according to the examination regulations	• Presence at the construction site, • Presentation of a seminar paper on the selected site.
Recommended prerequisites	• Mastered knowledge about the construction organization.
Module objectives/intended learning outcomes	• Getting along at the site in terms of the organization of work, • Getting along at the site with respect to the procurement of materials, • Getting along at the site in terms of planning works, • Getting along at the site in terms of cooperation with the staff.
Content	• Exercises: 1. Students spend three hours each week at the selected site and observe the processes, events, technology, technique and organization of work.
Study and examination requirements and forms of examination	• Seminar paper grade.
Media employed	
Reading list	

Module name:	**Human resource management**
Module level, if applicable	Master's Degree Programme
Code, if applicable	21834
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	III (Winter)
Person responsible for the module	Anita Cerić
Lecturer	
Language	Croatian
Relation to curriculum	Master's degree programme. Construction management, Elective, Semestar III.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises: 20 (project assignments) • Seminars: 10 • E-learning: discussion groups on relevant topics
Workload	Lecture hours 30 Exercise/Project assignments 30 Other contact hours 20 Self study hours 100
Credit points	6 ECTS
Requirements according to the examination regulations	• Attendance in lectures, • Working on project assignments and seminar papers.
Recommended prerequisites	
Module objectives/intended learning outcomes	• Understanding the importance of HRM, • Identifying contemporary issues in HRM, • Developing HRM strategy in small construction companies, • Applying different techniques for the selection of employees, • Developing communication and negotiation skills as an important factor for many aspects of HRM strategy, • Working on a team building programs in the company, • Understanding HR issues in the international context, • Using IT support for HRM.
Content	• Lectures: 1. Introduction to human resource management [2] 2. Development of human resource management theory (4) 3. The concept of Human resource management [2] 4. The importance of HRM for business success in construction companies [2] 5. Strategic human resource development [4] 6. HRM strategy and corporate strategy [2] 7. Human resource planning [2] 8. The challenges of communication in the construction project environment [2] 9. Communication risk: Application of Principal-Agent Theory [2] 10. Effective teamwork, Motivation and Rewards [4] 11. International human resource aspects [2], 12. IT support for HRM [2].

	• Exercises: 1. students are obliged to work on project assignments. • Seminars: 1. students are obliged to write seminar papers.
Study and examination requirements and forms of examination	• Final written exam.
Media employed	Whiteboard, projector
Reading list	Required literature: 1. Bahtijarević-Šiber, F.,Management ljudskih potencijala. Zagreb: Golden marketing, 1999, 2. Dainty, A., M. Loosemore and H. Lingard, Human Resourse Management in Construction Projects, London: Spon Press, 2003 Optional literature: 1. Dainty, A., D. Moore and M. Murray, Communication in Construction, Oxford: Taylor& Francis, 2006, 2. Emmitt, S. And Gorse, Ch., Communication in Construction Teams, Oxford: Taylor& Francis, 2007.

Module name:	**Construction Technology 2**
Module level, if applicable	Master’s Degree Program
Code, if applicable	21835
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	III (Winter)
Person responsible for the module	Ivica Završki
Lecturer	Zvonko Sigmund
Language	Croatian
Relation to curriculum	Master’s` degree program. Construction Management. Elective. Semester III.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises: 30 (auditory - 4, design - 26)
Workload	Lecture hours: 30 Other contact hours: 30 Self study hours: 120
Credit points	6 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, • Seminar papers, • 2 pre-exams – minimum 25% score in each, make up exam.
Recommended prerequisites	Familiarity with specific literature, prior knowledge, skills or participation in preparatory modules of Bachelor’s's degree program (area of: Building technology,).
Module objectives/intended learning outcomes	• Specifying the scaffolding for a construction, • Specifying the formwork for a construction, • Organising and dimensioningthe production of precast elements, • Organising and dimensioningthe transportation of precast elements, • Organising and dimensioning the assembling of precast elements.
Content	• Lectures: 1. Formworks in general[2] 2. Traditional formwork system [2] 3. Engineered formwork system [2] 4. Sliding formwork [2] 5. Climbing formwork [2] 6. Tunnel formwork [2] 7. Scaffolding in general [2] 8. Tower and heavy scaffolding[2] 9. Precast construction technology in general[2] 10. Precast halls production [2] 11. Precast elements transportation[2] 12. Technology of assembling, selection and dimension of cranes [2] 13. Auxiliary tools for assembling [2] 14. Precast bridges [2] 15. Tools for assembling of bridges [2]. • Auditory exercises: 1. Allocating programs, selecting the manner of their execution and the selection of models [4].

	• Design exercises: 16. Execution of programs and their presentations.
Study and examination requirements and forms of examination	• Written exam - minimum 60% score, • Oral exam.
Media employed	Whiteboard, projector
Reading list	Required literature: 1. Rudolf Lončarić,Organizacijaizvedbegraditeljskihprojekata, Sveučilište u Zagrebu, Zagreb, 1995, Optional literature: 1. Handbook PERI, 2. Handbook DOKA.

Module name:	**Investment Appraisals in Construction**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	115177
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	III (Winter)
Person responsible for the module	Lana Lovrenčić Butković
Lecturer	
Language	Croatian, English
Relation to curriculum	Master's` degree program. Construction Management. Elective. Semester III.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises: 30 • E-learning: 2nd level
Workload	Lecture hours 30 Hours of seminar work 30 Self study hours 120
Credit points	6 ECTS
Requirements according to the examination regulations	• Attendance in minimum 75% lectures, • Attendance in minimum 75%exercises, • Minimum25% score in every pre-exam, • Writing and presenting an investment study.
Recommended prerequisites	Familiarity with specific literature: Mariza Katavić - lecture notes for the module Business Economics – Power point presentation available on web page Dragana Grubišić, Poslovna ekonomija, Ekonomski fakultet sveučilišta u Splitu, Split Prior knowledge : the Module : Business Economics (I Semester I Year)
Module objectives/intended learning outcomes	• Explainingthe foundationsof investingin the companyand thetypesof investments, • Analyzinginvestorsandinvestment, • Analyzing the marketanddevelopingtechnicaland technological analysis, • Designing financial statements, economicandfinancialflowsof the project, • Checkingthe feasibilityof the project, • Conductinga sensitivity analysisof the project.
Content	• Lectures: 1. Investment study – an introduction [2], 2. Types of Investments – joint venture, BOT, foreign direct investments [2], 3. Information about Entrepreneurs – Investors [3], 4. Market Analysis [2], 5. Technical and Technological Elements of Investments [3], 6. Location [2], 7. Environment Protection [2], 8. Dynamics of Investment Realization [3], 9. Economic and Financial Analysis [4], 9.1. Financial flow 9.2. Economic flow

	10. Economic and Market Evaluation [4], 10.1. Static methods of investment appraisal 10.2. Dynamic methods of investment appraisal 11. Sensitivity Analysis [3]. • Exercises: 1. Information about Entrepreneurs – Investors [4] 1.1. Former Business Activities of Investors 1.2. Existing Investors' Property 1.3. Financial Analysis of Current Business 2. Market Analysis [4] 2.1. Purchasing Market 2.2. Sales Market 2.3. Summary of Market Analysis and Assessment of Income Generation 3. Technical and Technological Elements of Investments[4] 3.1. Description of technical and technological process 3.2. The consumption of raw materials and energy 3.3. Technical structure of investment 3.4. Construction characteristics of the building 3.5. Organisation structure and human resources 3.5.1. Analysis of the necessary human resources 3.5.2. Budget of annual gross salaries 4. Location [2] 5. Environment Protection [4] 6. Dynamics of Investment Realization [2] 7. Economic and Financial Analysis [4] 7.1. Investment in fixed assets 7.2. Investments in working capital 7.3. Investment structure (fixed and working capital) 7.4. Resources of financing and loan terms 7.4.1. Resources of financing 7.4.2. Calculation of loan obligations 7.5. Depreciation calculation 7.6. Calculation of costs and price calculation 7.7. Budgeted Profit and Loss Account 7.8. Financial flow 7.9. Economic flow 7.10. Budgeted Balance Sheet 8. Economic and Market Evaluation [4] 8.1. Static methods of investment appraisal 8.2. Dynamic methods of investment appraisal 8.2.1. Investment Payback Period 8.2.2. Net Present Value of Investment 8.2.3. Relative Net Present Value of Investment 8.2.4. Internal Rate of Return 9. Sensitivity Analysis [2].
Study and examination requirements and forms of examination	• Written exam, • Oral exam.
Media employed	Whiteboard, projector
Reading list	Required literature: 1. HBOR, I-V 2. Mariza Katavić, Osnove ekonomike za graditelje, Hrvatska sveučilišna naklada, Zagreb, 2009, 3. Lecture notes (handouts on Merlin)

	Optional literature: 1. Ekonomski Institut Zagreb (1993),Planiranje investicijskih projekata, knjiga I-IV, 2. J.C.Francis, (1986),Investment Analysis and Management, McGraw Hill International, 4th edition, Singapore

IV. SEMESTER

Module name:	**Business Strategies for the Construction Industry**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	114684
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	IV (Summer)
Person responsible for the module	Lana Lovrenčić Butković
Lecturer	
Language	Croatian
Relation to curriculum	Master's degree programme, Construction management. Compulsory. Semestar IV.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 45 • E-learning: 2nd level
Workload	Lecture hours 45 Self study hours 90
Credit points	4,5 ECTS
Requirements according to the examination regulations	• Attendance in minimum 75% lectures, • Minimum25% score in every pre-exam, • Writing and presenting a seminar paper,
Recommended prerequisites	• Basic knowledge onthe basicsof economyinthe courseBusiness economics (elective course inthe first yearof undergraduatestudies).
Module objectives/intended learning outcomes	• Understanding the purpose and key concepts of business strategies and principles of marketing strategies, • Formulating company's mission statement, vision statement and main goals, • Analyzing the business environment and evaluating the contribution of factors affecting the performance of an enterprise, • Creatinga SWOT matrix and a stakeholder analysis, • Formulating business strategies – corporation, generic and function strategies.
Content	• Lectures: 1. Definition of a business strategy ([5] 2. Mission, vision and company's goals[5] 3. Business environment[5] 4. Factors affecting construction industry[5] 5. Business ethics[5] 6. Construction environment analysis[5] 6.1. SWOT analysis 6.2. Stakeholder analysis 7. Organisation structure of construction companies[5] 8. Formulating strategy [5] 8.1. Corporation strategy 8.2. Generic strategy 8.3. Funkcion strategy

	8.3.1. Marketing strategy 9. Students presenting seminars [5].
Study and examination requirements and forms of examination	• Written exam, • Oral exam.
Media employed	Whiteboard, projector
Reading list	Required literature: 1. Mariza Katavić, Osnove ekonomike za graditelje, Hrvatska sveučilišna naklada, Zagreb, 2009, 2. Lecture notes (handouts on Merlin). Optional literature: 1. MH.Weihrich, H.Koontz, Menadžment, (10th ed.) MATE d.o.o., Zagreb, 1998, 2. Stephen Lavender, Management for the Construction Industry, Longman and The Chartered Institute of Building, Elookx, England 1996

Module name:	**Sociology Of Organization**
Module level, if applicable	Master's Degree Programme
Code, if applicable	115178
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	IV (Summer)
Person responsible for the module	Miljenko Antić
Lecturer	
Language	Croatian
Relation to curriculum	Master's degree programme, Construction management. Compulsory. Semestar IV.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Seminars: 15 • E-learning:10
Workload	Lecture 30 Exercise 15 Other concact 30 Self study 60
Credit points	4,5 ECTS
Requirements according to the examination regulations	• Discussion on the Internet and presentations in class 20%, • Activities in class and class attendance 10%, • Pre-exam 20%, • Final exam 50%.
Recommended prerequisites	
Module objectives/intended learning outcomes	• Development of "soft skills", especially ability to change the organizational culture of an organization.
Content	• Lectures: 1. Introduction (3) 2. Definitions of basic terms [2] 3. Group behavior [2] 4. Organizational culture [10] 5. Power in organizations [2] 6. Business ethics [2] 7. Leadership [2] 8. Influence of globalization on organizations [2] 9. Influence of technology on organizations [2] 10. Life circle of organizations [2] 11. Final lecture [1]. • Seminars: 1. Animal organizations [1] 2. Milgram's experiments [1] 3. Modern organizational designs [1] 4. Symbols of organizational cultures [2] 5. Organizational culture of Ben and Jerry [1] 6. Organizational culture of Faculty of Civil Engineering [1] 7. Changing of organizational culture [1]

	8. The main issues in business ethics [2] 9. Power in animal world [1] 10. Psychological and social qualities of great leaders [1] 11. Establishment and development of the company“Amazon” [1] 12. General discussion [2].
Study and examination requirements and forms of examination	• Pre-exam 20%, • Final exam 50%.
Media employed	Whiteboard, projector
Reading list	Required literature: 1. Sikavica, Pere,Organizacija, Zagreb, Školska knjiga, 2011 Optional literature: 1. Handel, Michael J. (ed.),The Sociology of Organizations, London: Sage Publications, 2003 2. Aronson, Elliot, Timothy D. Wilson, Robin M. Akert,Socijalna psihologija, Mate, Zagreb, 2005 3. Zvonarević, Milan,Socijalna psihologija, Školska knjiga, Zagreb, 1989 4. Jones, Gareth R.,Organizational Theory, Design and Change. Upper Saddle River, USA: Pearson Education, 2004 5. Antić, Miljenko, Antita Cerić i Maja Lazić, Organizational culture of the department of construction management and economics, Faculty of Civil Engineering, University of Zagreb, Organization, Technology & Management in Construction, Vol. 2:1, pp.136-144, 2010 6. Buchanan, David i Andrzej Huczynski,Organizational Behavior: An Introductory Text. Harloww: Pearson Education, 1997 7. Haladin, Stjepan,Tehnologija i organizacija: uvod u sociologiju rada i organizacije. Društvo za organizaciju građenja Republike Hrvatske, Zagreb,1993 8. Vecchio, Robert P., Organizational behavior: core concepts, Thomson/South-Western, Mason, Ohio, 2003 9. Kendall, Dina,Sociology in Our Times: The Essentials. Belmont, USA: Wadsworth, 2003 10. Miller, D.C. i V.H. Form,Industrijska sociologija, Panorama, Zagreb, 1996

TRANSPORTATION ENGINEERING PROGRAMME

I. SEMESTER

Module name:	**Mathematics 3**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	21802
Subtitle, if applicable	
Courses, if applicable	I class (84 students) 1 lecture, 2 auditory groups
Semester(s) in which the module is taught	I (Winter)
Person responsible for the module	Tomislav Došlić, Alan Filipin
Lecturer	Nikola Adžaga, Rafael mrđen
Language	Croatian
Relation to curriculum	Master's degree programme for all engineering programmes. Compulsory elective. Semester I.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 45 • Exercises (auditory): 30
Workload	Lecture hours 45 Hours of exercise 15 Other contact hours 30 Self study hours 135
Credit points	7,5 ECTS
Requirements according to the examination regulations	• Regular attendance in lectures and exercises, • Minimum 25 % score in the pre-exam.
Recommended prerequisites	• Understanding the calculus of one and several variables, including ordinary differential equations, and basic linear algebra.
Module objectives/intended learning outcomes	• Understanding the conditions and limits of applicability of linear models, • Ability to recognize and choose a correct model, • Ability to solve (analytically and/or numerically) simple linear models.
Content	• Lectures: 1. Ordinary differential equations [3] 2. Fourier series [3] 3. Partial differential equations and linear models of mathematical physics [20] 4. Numerical methods for solutions of ordinary and partial differential equations [16] • Exercises (auditory) follow the lectures.
Study and examination requirements and forms of examination	• Minimum 50% score in the written exam, • Students passing the pre-exam take only the second part, • Oral exam.
Media employed	Whiteboard, projector
Reading list	Required literature: 1. T. Došlić, D. Pokaz: Matematika 3, available on the course web-page.

	2. T. Slijepčević-Manger: Zbirka zadataka iz Matematike 3, available on the course web-page. Optional literature: 1. E. Kreyszig: Advanced Engineering Mathematics, John Wiley and Sons Ltd., 1999, 2. F. Scheid: Numerical Analysis, Schaum's Outline Series in Mathematics, McGraw-Hill

Module name:	**Stochastic Processes**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	I (Winter)
Person responsible for the module	Tomislav Došlić, Alan Filipin
Lecturer	Rafael Mrđen, Kristina Ana Škreb
Language	Croatian
Relation to curriculum	Master degree programme for all engineering programmes. Compulsore elective. Semester I.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 45 • Exercises (auditory): 30
Workload	Lecture hours 45, hours of exercise 30, other contact hours 30, self study hours 120.
Credit points	7.5 ECTS
Requirements according to the examination regulations	• Regular attendance • Minimum 25 % score in the pre-exam.
Recommended prerequisites	
Module objectives/intended learning outcomes	• Understanding conditions and limits of applicability of stochastic models, • Ability to recognize and choose correct model. • Ability to formulate and solve simple problems in terms of Markov chains and processes.
Content	• Lectures: 1. Basic characteristics and examples of stochastic processes [3], 2. Markov chains with discrete time and finite and countable set of states [27], 3. Markov processes [6], 4. Poisson processes and the theory of queues [6], • Exercises (auditory: follow the lectures.
Study and examination requirements and forms of examination	• Eliminatory written exam - minimum 50 % score, • Students who pass the pre-exam take only the second part, • Oral exam.
Media employed	Whiteboard, projector
Reading list	Required literature: 1. N. Berglund, Processus aleatoires et applications, available as Croatian translation on the course web-page and originally at ArXiv.org. Optional literature: 1. R. Durrett: Essentials of Stochastic Processes, Springer Texts in Statistics, Springer, New York, 1999, 2. D. P. Bertsekas, J. N. Tsitsiklis: Introduction to Probability, On line lecture notes, M.I.T., 2000.

Module name:	**Traffic Noise**
Module level, if applicable	Master's' Degree Programmes
Code, if applicable	21844
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	I (Winter)
Person responsible for the module	Vesna Dragčević
Lecturer	Saša Ahac, Tamara Džambas
Language	Croatian
Relation to curriculum	Master's degree programme, Ttransportation Engineering Programme, Compulsory, Semester I.
Type of teaching, contact hours	Number of hours (in semester): 45 • Lectures: 30 • Exercises (design): 15
Workload	Lecture hours 30 Exercise hours 15 Other contact hours and self study 90 hours
Credit points	4,5 ECTS
Requirements according to the examination regulations	• Lecture and exercise attendance (minimum 75% of lectures and 100% of exercise classes), • 2 pre-exams -(minimum 25% core, 1 additional make up pre-exam, • Completion of design exercises.
Recommended prerequisites	• Understanding the basic principles of road design.
Module objectives/intended learning outcomes	• Describing the effects of traffic noise, noise mitigation and protection measures, • Understanding the generation mechanisms of trafficnoise and protection measures, • Analysing the traffic noise levels according to Croatian and EU regulations, • Application of specialised software for noise prediction, noise mapping and noise barrier optimisation (Lima), • Evaluation of assumptions, arguments and noise protection solutions, • Solving simple traffic noise protection problems (noise barrier design), • Ability to understand scientific and professional papers and to collect and present the data used to solve practical problems in everyday engineering practice.
Content	• Lectures: 1. Introduction: Environmental noise. Historical perspectives [1] 2. Fundamental concepts and definitions used in the field of acoustics [2] 3. Noise sources. Effects of noise [1] 4. The Environmental Noise Directive (2002/49/EC) [2] 5. Noise regulations in Croatia [2] 6. Noise mapping [2] 7. Road traffic noise – basic parameters [1] 8. Noise calculation methods [4] 9. Noise reduction methods related to noise sources [4] 10. Noise protection barriers [2]

	11. Other noise reduction and protection measures [2] 12. Practical examples [3]. • Exercises (design): 1. Digital Terrain Model. Data import. Object attributes [3] 2. Object attributes [2] 3. Noise level calculations [2] 4. Noise protection – barrier optimisation [5] 5. Calculation results [2] 6. Technical description [1].
Study and examination requirements and forms of examination	• Written exam (minimum 50% score for a pass). • Oral exam.
Media employed	Whiteboard, projector
Reading list	Required literature: 1. V. Dragčević, S. Ahac, Prometnabuka – lecture notes, Zagreb, 2008,http://merlin.srce.hr 2. S. Ahac, Ž. Pintar, Prometnabuka – exercise handbook, Zagreb, 2008,http://merlin.srce.hr Optional literature: 1. Općitehničkiuvjetizaradovenacestama, HrvatskecesteiHrvatskeautoceste, Zagreb, 2001 2. Uputstvazakorištenjesoftverskogpaketa (instructions for use of software package) LIMA™ Environmental Noise Calculation and Mapping Software,Version 5.1,Denmark, 2006, 3. Kotzen, Benz,Englih, Colin,Environmental Noise Barriers, London, 1999

Module name:	**Transportation Engineering**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	I (Winter)
Person responsible for the module	Maja Ahac
Lecturer	Željko Stepan
Language	Croatian
Relation to curriculum	Master's degree programme, Transportation Engineering Programme, Compulsory. Semestar I.
Type of teaching, contact hours	Number of hours (in semester): 60 • Lectures: 30 • Exercises (auditory, design, field): 30
Workload	Lecture hours 30 Other contact hours 30 Self study hours 120
Credit points	6 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, • Program development, • Two pre-exams – minimum 40% score in each.
Recommended prerequisites	• Basic driving dynamics settings relevant to the determination of horizontal, vertical and longitudinal road elements.
Module objectives/intended learning outcomes	• Ability to analyze traffic flow on various types of roads using contemporary methods and criteria, • Ability to design various elements of road network, • Ability to determine the basic principles of the development of road traffic system, • Ability to estimate, investigate and apply the existing data on roads and road traffic, • Ability to develop the concept of traffic flow, • Ability to organise, monitor and control traffic, • Ability to manage traffic flows on road networks.
Content	• Lectures: 1. Introduction to traffic [2] 2. Definition of transport technology terms [2] 3. Introduction to the theory of traffic flow: development of motorization and the theory of traffic flow [2] 4. Defining the basic variables of traffic flow: flow, speed and density of traffic flow [2] 5. Relations between basic variables of traffic flow [2] 6. Macroscopic models of traffic flow [2] 7. Microscopic models of traffic flow [2] 8. Trhroughput and level of service: development of the concept, definition of elements and their impact [2] 9. Traffic load on roads: traffic counting, traffic flows in a network, processing and application of data [2] 10. Characteristics of road traffic volume [2]

	11. Throughput of highways [4] 12. Throughput of multi-lane roads [2] 13. Throughput of two-lane roads [2]. • Exercises (auditory, design, laboratory): 1. Introduction to exercises. Elements and forms of intersections [2] 2. Traffic control at intersections [2] 3. Introduction to the program [2] 4. Recording intersections in the field [2] 5. Intersection drafting [2] 6. Traffic counting at intersections [2] 7. Processing data on traffic load [2] 8. Recording light signaling at intersections [2] 9. Developing timing for light signaling [2] 10. Calculation of the level of service of the existing state [2] 11. Calculation the optimal cycle and phase plans [2] 12. Proposal to improve the traffic flow [2] 13. Calculation of the level of service for the new condition of an intersection [2] 14. Drafting a new state of an intersection [2] 15. Program submission [2].
Study and examination requirements and forms of examination	• Grading a program, • Pre-exam results, • Oral exam.
Media employed	Whiteboard, projector
Reading list	Required literature: 1. Highway Capacity Manual, TRB, Washington, D.C., 2000 2. D. L. Gerlough, M.j. Huber, Traffic Flow Theory, A Monograph, TRB, Special Report 165, Washington, D.C., 1975 3. L. J. Pignataro, Traffic Engineering, Theory and Praktice, Prentice-Hall, Inc. Englewood Cliffs, New Jersey, 1973 4. P. Rožić, Mimeographed lecture notes Optional literature: 1. Transportation and Traffic Engineering Handbook, The Institute of Traffic Engineers, Washington, D.C., 1976

Module name:	**Highway design**
Module level, if applicable	Master's Degree Programme
Code, if applicable	21846
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	I (Winter)
Person responsible for the module	Ivica Stančerić
Lecturer	Šime Bezina
Language	Croatian
Relation to curriculum	Master degree programme. Transportation Engineering Programme. Compulsory. Semester I.
Type of teaching, contact hours	Number of hours (in semester): • Lectures:30 • Exercises (auditory, design):30
Workload	Lecture hours 30 Exercise 30 Other contact hours 30 Self study hours 88 Exam hours 2
Credit points	6 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, • Completion of design exercises and design submission.
Recommended prerequisites	• Practical skills in technical drawing – CAD skills.
Module objectives/intended learning outcomes	• Ability to master the principles of geometric design of roads (horizontal and vertical alignment) considering road safety requirements, • Ability to follow-up „stateoftheart“ procedure in the field of road design, • Skill in route planning, • Ability to evaluate multiple road solutions, • Ability to use a software specialized for road design.
Content	Lectures: 1. Introductory course[2] 2. The design rules[4] 3. Modeling solutions. Spatial restriction [2], 4. Digital Elevation Model. Digital Terrain Model [2] 5. Operations with models[2] 6. Horizontal alignment[2] 7. Vertical alignment[2] 8. Road visualization[2] 9. Road cross section [2] 10. Sight distance [3] 11. Earthworks –volume calculation[2] 12. Road contours plan [2] 13. Evaluation of road variants [2] 14. Procedures for making certain project level [1]. Exercises (auditory, design): 1. Introduction [1] 2. Overview of the software for road design[1]

	3. Creating a digital elevation model [2] 4. Geometric road design [2] 5. Situation [8] 6. Long section [2] 7. Cross section [2] 8. Sight distance testing [4] 9. Evaluation of road variants[2] 10. Road visualization [2] 11. Creating drawings [4].
Study and examination requirements and forms of examination	• Oral exam.
Media employed	Whiteboard, projector
Reading list	Required literature: 1. Ž. Korlaet, Uvod u projektiranje i građenje cesta, udžbenik Sveučilišta u Zagrebu, 1995, pp. 208 (textbook by the University of Zagreb), 2. Dragčević, V., Korlaet, Ž.,Osnove projektiranja cesta, udžbenik Sveučilišta u Zagrebu, 2003, pp. 93 (textbook by the University of Zagreb), 3. Pribičević, B., Medak,D.,Geodezija u građevinarstvu, V.B.Z., Zagreb, 2003 (paragraph 13,Geodetski radovi pri projektiranju i trasiranju prometnica, paragraph 14,Određivanje površina i zemljanih masa). 4. Pravilnik o osnovnim uvjetima kojima javne ceste izvan naselja i njihovi elementi moraju udovoljavati sa stajališta sigurnosti prometa (Regulations on the basic conditions for public roads out of settlements have to meet) (NN110, prosinac 2001, Official Gazette, December, 2001) 5. Merlin, web pagehttp://moodle.srce.hr Optional literature: 1. H.Lorenc,Projektovanje i trasiranje puteva i autoputeva, IRO građevinska knjiga, Beograd, 1980

Module name:	**Railways design and construction**
Module level, if applicable	Master's Degree Programme
Code, if applicable	21847
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	I (Winter)
Person responsible for the module	Stjepan Lakušić
Lecturer	Viktorija Grgić, Katarina Vranešić, Maja Ahac, Ivo Haladin
Language	Croatian
Relation to curriculum	Master's degree programme. Transportation Engineering Programme Compulsory. Semester I.
Type of teaching, contact hours	Number of hours (in semester): • Lectures:30 • Exercises (auditory, design): 30
Workload	Lecture hours 30 Exercise 28 Other contact hours 30 Mid-term exams hours 2 Exam hours 2 Self study hours 88
Credit points	6 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises. • Individual railway design assignment • Pre-exams -minimum 25% score in each, 1 additional make up exam.
Recommended prerequisites	• Basic knowledge of transport infrastructure design, • Knowledge of rail track cross sections and clearances, • Basic knowledge of transport infrastructure substructure.
Module objectives/intended learning outcomes	• Knowledge about rail track and vehicle resistance, • Knowledge about train mass, haul force and braking force calculations, • Knowledge about rail track construction elements, • Knowledge about various track design solutions evaluation, • Knowledge about track capacity calculation, • Knowledge about second track construction procedure.
Content	• Lectures: 1. General characteristics of railways: role of railways in transportation system 2. General characteristics of railways: evaluation of railway tracks 3. Structural track elements: free cross section, number and spacing of tracks, track formation 4. Structural track elements: application, significance and dependence of speed related to curve radius, transition curves 5. Structural track elements: cant and superelevation ramps, turning angles, transition lines 6. Structural track elements: vertical alignment slope, fillet, relation between adjacent slopes, vertical alignment in stations 7. Rail track design: route alignment modes, railway design software 8. Rail track design: station positioning, object application

	9. Design stages: feasibility study, preliminary design, main and detailed design 10. Variant solution evaluation: methods for variant evaluation, exploitation costs 11. The basics of haul calculation: forces on a train in operation, basic resistance forces 12. The basics of haul calculation: additional train resistance forces 13. Reconstruction of single track railway lines: basic principles of reconstruction, decisions on route design parameters 14. Second track design: second track design modes, placement in respect to other track objects 15. High speed tracks: specific features, horizontal and vertical alignment elements Exercises (design): 1. General about Bentley Power Rail Track: initial settings, working with graphical models. Digital terrain model: new model definition, importing terrain data, model triangulation, model display options 2. Digital terrain model: contour line display, raster management (topographic map import). Horizontal alignment: step calculation and zero line construction 3. Horizontal alignment: Zero line control, calculation of track and station design elements, horizontal alignment model creation, horizontal track element definition, tangential polygon of horizontal alignment, saving, opening and display of horizontal alignment model. 4. Horizontal alignment: editing tangential polygon of horizontal alignment, definition of horizontal curve parameters 5. Horizontal alignment: editing tangential polygon of horizontal alignment, construction of horizontal curves and transition lines 6. Horizontal alignment: stationing, horizontal alignment display 7. Vertical alignment: creation of new sub-project of vertical alignment, vertical terrain profile creation, tangential polygon of vertical track alignment, vertical point of interest definition - start/end of stations, saving opening and displaying vertical alignment model. 8. Vertical alignment: vertical alignment restrictions, editing tangential polygon of vertical alignment 9. Vertical alignment: editing tangential polygon of vertical alignment, definition of vertical profile curves 10. Vertical alignment: definition of vertical points of interest - objects and level crossings 11. Station horizontal alignment: definition of transition lines, track spacing, turnout alignment calculation 12. Station horizontal alignment: creation and placement of turnouts on horizontal alignment 13. Station horizontal alignment: shunt limit definition, point of interest report 14. Project report creation: layout preparation, technical description creation 15. Programme submission.
Study and examination requirements and forms of examination	• Written exam – minimum 50% score, • Oral exam.
Media employed	Whiteboard, projector, individual PC workstations for students

Reading list	Required literature: 1. Lakušić, S., Ahac, M.,Projektiranje i građenje željeznica – lectures, Zagreb, 2017, http://merlin.srce.hr 2. Lakušić, S., Ahac, M.: Projektiranje i građenje željeznica–exercise handbook, Zagreb, 2017, http://merlin.srce.hr Optional literature: 1. Marušić, D.,Projektiranje i građenje željezničkih pruga, Građevinski fakultet Split, Split, 1994 (Faculty of Civil Engineering, Split).

II. SEMESTER

Module name:	**Management in Civil Engineering**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	21829
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	II (Summer)
Person responsible for the module	Lana Lovrenčić Butković
Lecturer	
Language	Croatian.
Relation to curriculum	Master's degree program Transportation Engineering Programme Compulsory. Semester I.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • E-learning: 2nd level
Workload	Lecture hours 30 Hours of seminar work 15 Self study hours 45
Credit points	3,0 ECTS
Requirements according to the examination regulations	• Attendance in morethan 75% of lectures, • Minimum 25% score in each of thethree pre-exams, • Writing and presenting a seminar paper,011 • Using Merlin.
Recommended prerequisites	• Basic knowledge about the basicsof economyinthe courseBusiness economics(elective course inthe first yearof undergraduatestudies).
Module objectives/intended learning outcomes	• Understanding the purpose and key concepts of management (vision, mission statement, the role and functions of managers/ project managers, • Understanding the role and the relevance of management and its participants, • Learning about business decision making, • Understanding the functioning of the market, • Ability to direct business processes, • Mastering the skills of analytical thinking and presenting the facts through seminar papers, • Communicating complex ideas concisely and clearly in written form.
Content	• Lectures: 1. Basic principles of management 8.1. Introduction [2] 8.2. Who are Managers? [2] 8.3. Management functions [2] 8.4. A Management development [2] 8.5. Schools of Management [2] 9. Management as a Process 9.1. Planning [2] 9.2. Organizing [2] 9.3. Leading [2]

	9.4. Controlling [1] 10. Business decision making 10.1. Defining decision making [1] 10.2. Process of decision making [1] 10.3. Styles and modes of decision making [1] 10.4. Methods of decision making [1] 10.5. Communication in business decision making [1] 11. Basics of management organization 11.1. Companytypes [1] 11.2. Basics of reproduction process [1] 11.3. Business assets [1] 12. Costs, price and price calculation [1] 13. Business results 13.1. Financial reports [1] 13.2. Business success measures (cost-effectiveness, productivity, profitability) [1] 14. Project management[1] 15. Factors affecting the performance of a company [1]
Study and examination requirements and forms of examination	• Written exam, • Oral exam.
Media employed	Whiteboard, projector
Reading list	Required literature: 1. Mariza Katavić, Osnove ekonomike za graditelje, Hrvatska sveučilišna naklada, Zagreb, 2009, 2. Lecture notes (handouts on Merlin). Optional literature: 1. H.Weihrich, H.Koontz, Menadžment, (10th ed.) MATE d.o.o. ,Zagreb, 1998, 2. Stephen Lavender, Management for the Construction Industry, Longman and The Chartered Institute of Building, Elookx, England 1996

Module name:	**Applied Geology**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	21717
Subtitle, if applicable	
Courses, if applicable	1. Applied Geology, 2. Hydrogeology and Engineering Geology
Semester(s) in which the module is taught	II (Summer)
Person responsible for the module	Meho-Saša Kovačević
Lecturer	Meho-Saša Kovačević
Language	Croatian, English
Relation to curriculum	Master's degree programme. Compulsory elective. Semestar II.
Type of teaching, contact hours	Number of hours (in semester): • Lectures:30
Workload	Lecture hours 30 Other contact hours 10 Self study hours 50
Credit points	3 ECTS
Requirements according to the examination regulations	• Attendance in 75% lectures, • Minimum 25% score in the pre-exam.
Recommended prerequisites	• Kowledge of basic chemical elements and compounds.
Module objectives/intended learning outcomes	• Ability to distinguish between igneous, metamorphic and sedimentary rocks, • Ability to identify layers, faults and overthrust, • Knowledge about the process of the formation of karst and various karst formations and learning about the problems which constructors encounter during construction of tunnels in karst, • The ability to use geological maps – recognition of geological symbols, determination of the geological age of rocks, their composition and other important geological phenomena of a terrain, • Knowledge of basic engineering-geological rock mass classification.
Content	• Lectures: 1. Introduction [2] 2. General information about the geosciences, Geology general, stratigraphic; Constitution of Earth; Geoid; Mineralogy; Mineral; Crystal [2] 3. Isotropic and anisotropic minerals; pyrogenic, pneumatogenic, hydrothermal, hydatogenic; Axis, center plane of symmetry; crystal systems; properties of crystals, crystal connection; tetrahedral coordination, coordination number; Polymorphism; Isomorphism [2] 4. The properties of minerals, Mineral groups; oxides and hydroxides, carbonates, sulfates, silicates [2] 5. Introduction to Petrology; Rock phenocrysts, Monomineral; igneous rocks; types of igneous rocks, structure and texture of igneous rocks; Acidity of magma; Bowen series of crystallization; Table of igneous rocks [2] 6. Sedimentary rocks, sediment transport, mineral composition of sedimentary rocks , structures and textures of sedimentary rocks; General overview of sedimentary rocks, metamorphic rocks, metamorphic zones; types of metamorphic rocks [2]

	7. Tectonics, rock exposures, outcrops, thickness of layers, anticlines and synclines, faults, over thrust, types of cracks [2] 8. Pre-exam [2] 9. Egzodynamic processes; insolation, hydrogeology, water, the hydrologic cycle, porosity, permeability, laminar and turbulent flow; types of aquifers; Ghyben Herzberg law; Ice and Snow, Wind, organisms [2] 10. Pre-exam [2] 11. Karst; external karst formations; interior karst formations [2] 12. Types of caves, speleothems, groundwater [2] 13. Landslides; Endodynamics; orogeny, epirogensis [2] 14. Volcanoes, Earthquakes; Earthquake scales, seismicity [2] 15. Geological maps, RMR and Q classification of rocks in the construction domain; determining the age of rocks [2]
Study and examination requirements and forms of examination	Written and oral exam.
Media employed	Whiteboard, projector
Reading list	Required literature: 1. Herak, M., Geology, 1990 2. Šestanović, S., Basics of Geology and Petrology, 2001 Optional literature: 1. West, T.,Geology Applied to Engineering, 1994 2. Monroe, J. & Wicander, R., Physical geology, 2006 3. Plummer,C., McGeary,D. & Carlson, C., Physical Geology, 2010

Module name:	**Environmental Protection**
Module level, if applicable	Master's Degree Programme
Code, if applicable	
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	II (Summer)
Person responsible for the module	Živko Vuković
Lecturer	Živko Vuković
Language	Croatian
Relation to curriculum	Master's degree programme. Compulsory elective. Semester II..
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30
Workload	Lecture hours 30 Consultation hours 30 Self study hours 30
Credit points	3 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, • Two pre-exams.
Recommended prerequisites	• Basic knowledge in physics, biology, chemistry and civil engineering.
Module objectives/intended learning outcomes	• Understanding basic ecological processes, • Recognising and explaining basic ecological principles, • Explaining basic technological procedures of wastewater treatment, • Understanding waste management, • Understanding the concept of "sustainable development".
Content	• Lectures: 1. Introduction [2] 2. Basic ecological concepts (ecology, biotop, biocenose, ecosystem, biodiversity) [3] 3. Global changes in biosphere –changes in atmosphere [2] 4. Pedosphere pollution [2] 5. Hydrosphere pollution [3] 6. The impact of cities [3] 7. The impact of landfills [3] 8. Impact of hydraulic structures [3] 9. Transportation facilities impact [3] 10. Environmental sustainability and sustainable development [3] 11. Measures and environmental protection procedure (political and sociological approach, legal measures, environment planning, economic and financial measures, scientific approach and technological measures, institutional measures [3]
Study and examination requirements and forms of examination	Students with minimum 60 % score in each pre-exam are exempt from the final oral exam.
Media employed	Whiteboard, projector
Reading list	Required literature: 1. Vuković, Ž.: Environment Protection, Manuscript, 2014, Zagreb (in Croatian).

	Optional literature: 1. Raven, P. H., Berg, L. R., Hassenzahl, D. M.: Environment, 7th Edition, Wiley, 2010. 2. Miller, G. T.: Living in the Environment: Principles, Connections, and Solutions, 15th Edition, Thomson Books, 2007.

Module name:	**Pavements Structures**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	21848
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	II (Summer)
Person responsible for the module	Tatjana Rukavina
Lecturer	Šime Bezina, Josipa Domitrović
Language	Croatian
Relation to curriculum	Master's degree programme, Transportation Engineering, Compulsory, Semestar II.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises (design): 30
Workload	Lecture hours 30 Hours of laboratories or skills 30 Other contact hours 20 Self study hours 100
Credit points	6 ECTS
Requirements according to the examination regulations	• Attendance inminimum 75% lectures and 100% exercises, • 2 pre-exams – minimum 25% score in each, • One make up exam, • Program submission.
Recommended prerequisites	• Basicknowledgein the field ofgeomechanics, • Basic knowledge about construction materials, • Understanding theconceptsof stress, strainandinternal forces.
Module objectives/intended learning outcomes	• Understanding thebehaviorof individualcomponentsas well as thepavement structureas a whole, • Analyzing andsolvingproblems related to thedesign and construction ofpavementsfrom theengineeringpoint of viewby use ofthe latest knowledgeandsolutions, • Designing pavementsinaccordancewith domesticandinternationalengineering practices, • Using a specialized software for pavement design (BISAR, CIRCLY, PAVERS), • Critical evaluation, analysisandappropriate selection ofthe appropriate types ofpavements inaccordancewith the purpose oftraffic areas, • Participating in works related tothe constructionandmaintenance of pavementsin a creative way. • Following the scientific literature in the field of pavement design and construction, and applying the acquired knowledge in further education.
Content	• Lectures: 1. Introduction (basic terms and definitions, types of pavements, historical development) [2] 2. Construction materials (aggregates, mixtures, binders, additives, water) [4] 3. Generally on flexible pavements [1] 4. Subgrade [1]

	5. Unbound pavement base layers [2] 6. Hydraulically bound pavement base layers [2] 7. Asphalt layers (basic terms, classification, asphalt mixtures) [1] 8. Production,transportationand construction ofasphalt mixtures [2] 9. Physical andmechanical properties ofasphalt mixtures [2] 10. Types of asphalt mixtures (for base, bind, surface and protective layers) [2] 11. Types of asphalt mixtures (asphalt concrete, split mastic asphalt, porous asphalt, thin asphalt layers, mastic asphalt) [2] 12. Generally on rigid pavements [2] 13. Design of flexible pavements [2] 14. Design of rigid pavements [2] 15. Pavement properties (surface) [1],Pavement properties (structural) [1] 16. Pavement maintenance (reconstruction, rehabilitation, recycling) [1] • Exercises (design): 1. Introduction to pavement design [2] 2. Methods for flexible pavement design (AASHO method) [6] 3. Methods for flexible pavement design (HRN.U.C4.012) [6] 4. Pavement stress-strain analysis (BISAR) [6] 5. Pavement stress-strain analysis (CIRCLY) [6] 6. Calculation of frost depth [2] 7. Program submission [2]
Study and examination requirements and forms of examination	• Written exam – minimum 50% score, • Oral exam.
Media employed	Whiteboard, projector
Reading list	Required literature: 1. B.Babić, Pavement design, University of Zagreb, Zagreb, 1997, 2. B. Babić, Z. Horvat, Pavement construction and maintenance, University of Zagreb, Zagreb,1983, 3. T. Rukavina, J. Domitrović, Pavement structures (lectures, exercise guide), Zagreb, 2012, http://merlin.srce.hr Optional literature: 1. General technical requirements for road works, Croatian Roads & Croatian Motorways, Zagreb, 2001 2. Roberts, F. L., Kandhal, P. S., Brown, E. R., Lee, D. Y. Kennedy, T. W. Hot Mix Asphalt- Materials, MixtureDesign, and Construction, NAPA Education Foundation Lanham, Maryland, 1996 3. AASHTO Guide for Design of Pavement Structures, Published by American Association of State Highway and Transportation Officials, Washington D.C., USA, 1993 4. N. Thom, Principles of pavement engineering, Thomas Telford Ltd, UK, 2008

Module name:	**Permanent way**
Module level, if applicable	Master's Degree Programme
Code, if applicable	21849
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	II (Summer)
Person responsible for the module	Stjepan Lakušić
Lecturer	Maja Ahac, Viktorija Grgić, Ivo Haladin, Katarina Vranešić
Language	Croatian
Relation to curriculum	Master's degree programme.Transportation Engineering Programme. Compulsory. Semester II.
Type of teaching, contact hours	Numberofhours (insemester): • Lectures: 45 • Exercises (auditory, design): 15
Workload	Lecture hours 43 Exercise 15 Other contact hours 30 Mid-term exams hours 2 Exam hours 2 Self study hours 88
Credit points	6 ECTS
Requirements according to the examination regulations	• Lecture and exercise attendance, • Program design, • Pre-exams - minimum 25% score in each, 1 additional make up exam.
Recommended prerequisites	• Knowledge about materials mechanical properties testing methods, • Knowledge about the concepts of stress, deformation and internal forces, • Knowledge about the concepts of structure stability and dynamic loading.
Module objectives/intended learning outcomes	• Detailed knowledge about rail track permanent way elements: rails, sleepers, ballast bed, fastening systems (material properties, testing methods, behaviour during exploitation), • Knowledge about permanent way calculation methods, • Detailed knowledge about ballasted and ballast less rail track structures, • Detailed knowledge about rail welding methods, weld testing and continuous welded rails, • Detailed knowledge about rail track characteristics in horizontal curves, • Detailed knowledge about rail track turnouts (manufacturing, installation, safety features).
Content	• Lectures: 1. Basic concepts of permanent way elements: rails, fastenings, sleepers, ballast [2] 2. Rails: shape, strength, testing and inspection [2] 3. Rails: deterioration, lubrication[2] 4. Fastenings: tasks and fastenings testing, rigid and elastic as tenings [2] 5. Sleepers: timber sleepers, reinforced-concrete sleepers, manufacturing and testing [4] 6. Ballast: tasks, shapes and dimensions of ballast prism, bearing increase of ballast prism [4]

	7. Track arrangement: track gauge, super elevation, transition curve and gradient [4] 8. Permanent way design: static and dynamic track design [4] 9. Ballast less permanent way structures: structure requirements, application [4] 10. Continuous welded rails (CWR): temperatures and stresses [4] 11. Rail welding procedures: termite welding, electrical resistance welding, weld testing [4] 12. High speed railways: characteristics, horizontal and vertical alignment elements [3] 13. Turnouts: elements, types, function, crossings (frogs) and guiderails [6] • Exercises (auditory and design): 1. Station track plan calculation [1] 2. Calculation of characteristic points of turn outs [1] 3. Defining turn out geometry [1] 4. Routing of turn outs on the horizontal alignment of the main transit track [1] 5. Developing elements of horizontal alignment of side tracks [1] 6. Defining shunt position [1] 7. Developing the report for the characteristic points of turnouts [1] 8. Developing situation and survey plan of station layout [1] 9. Construction of curved transition gradient [1] 10. Control of non-compensated later al acceleration [1] 11. Graphical representation of non-compensated lateral acceleration [1] 12. Control of continuous welded rail stability at high temperatures [1] 13. Control of continuous welded rail stability at low temperatures [1] 14. Calculation of rail stresses according to Zimmermann-Diehl [1] 15. Developing a technical report [1].
Study and examination requirements and forms of examination	• Written exam - minimum 50% score, • Oral exam.
Media employed	Whiteboard, projector
Reading list	Required literature: 1. G.Prister, B. Pollak, Gornji ustroj i specijalne željeznice, Građevinski institut, Zagreb, 1988, 2. S. Lakušić, Gornji ustroj željeznica, lecture notes, Faculty of Civil Engineering, http://www.grad.unizg.hr/predmet/guz. Optional literature: 1. C.Esveld, Modern Railway Track, SecondEdition, MRT Productions, Zaltbommel, 2001, 2. Pravilnik o održavanju gornjeg ustroja željezničkih pruga HŽ (Službeni vjesnik, br. 20/91) (Regulations on the maintenance of permanent way, Official Gazette, no. 20/91).

Module name:	**Earthworks**
Module level, if applicable	Master’s Degree Programmes
Code, if applicable	
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	II (Summer)
Person responsible for the module	Vesna Dragčević
Lecturer	Saša Ahac, Tamara Džambas
Language	Croatian
Relation to curriculum	Master's degree programme.Transportation Engineering Programme. Compulsory. Semester II.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises (design): 30
Workload	Lecture hours 30 Exercise hours 30 Other contact hours and self study hours120
Credit points	6 ECTS
Requirements according to the examination regulations	• Lecture and exercise attendance (minimum 75% of lectures and 100% of exercise classes), • 2 pre-exams -minimum 25% score in each, one make up exam, • Completion of design exercises and design submission.
Recommended prerequisites	• Knowledge about the rules and criteria for road design, • Basic knowledge about road cross section elements.
Module objectives/intended learning outcomes	• Designing road earthwork elements: cuts and embankments, road drainage, design and protection of slopes, retaining walls, • Solving simple road drainage and cut and embankment slope stability problems on suburban roads, • Understanding the behavior of earthwork components and structures as a whole, as well as the importance of sufficient and accurate performance of investigations and timely execution of certain construction phases, • Using the specialized software for road design MXROAD and slope stability calculation W-SLOPE (GEOSTUDIO), and other common computational tools for drawing and presentation and document creation, • Conducting works related to road construction and maintenance, and thereby solving engineering problems in a creative way, • Following scientific literature in the field of road design and construction, and applying the acquired knowledge to further education.
Content	• Lectures: 1. General information about earthwork structures [1] 2. Earthwork elements – basic terms and definitions [1] 3. Cross sections [1] 4. The choice of cross section [1] 5. Previous works in road construction – investigative and preliminary works [2] 6. Soil classification procedures for the purposes of road construction [1] 7. Soil classification procedures according to freezing sensitivity [1] 8. The selection of slope inclination [1]

	9. Cut and embankment slope shaping [1] 10. Slope protection - soil and mixed materials [2] 11. Slope protection - rock materials [1] 12. Slope protection with geosynthetic materials [1] 13. Surface drainage [1] 14. Subsurface drainage [1] 15. Culverts [2] 16. Retaining walls [2] 17. Calculation and balancing of masses [2] 18. Mass curve, Mass haul [2] 19. Cut construction, embankment construction [2]. • Exercises (design): 1. Examination of cut and embankment slope stability [4] 2. Detailed elaboration of road cross section [4] 3. Typical cross sections [6] 4. Longitudinal and cross section of one culvert [4] 5. Retaining wall cross section in cut [2] 6. Retaining wall cross section in an embankment [2] 7. Calculation of masses [2] 8. Mass curve and balancing of masses [4] 9. Technical report [1] 10. Design submission [1].
Study and examination requirements and forms of examination	• Written exam - minimum 50% score, • Oral exam.
Media employed	Whiteboard, projector
Reading list	Required literature: 1. V. Dragčević, T. Rukavina, Donjiustrojprometnica, Sveučilište u Zagrebu, Zagreb, 2006, 2. V. Dragčević, Ž. Korlaet, Osnoveprojektiranjacesta,Sveučilište u Zagrebu, Zagreb, 2003, 3. D. Brajković, I.Stančerić,S. Ahac, Donjiustrojprometnica–priručnikzavježbe, Zagreb, 2008 http://merlin.srce.hr Optional literature: 1. Općitehničkiuvjetizaradovenacestama, HrvatskecesteiHrvatskeautoceste, Zagreb, 2001,(Technical conditions for roadworks, Croatian roads and Croatian highways, Zagreb, 2001), 2. Instructions for use of MxRoad software package 3. J. Mikulić, a. Stipetić, Željezničkepružnegrađevine, InstitutIGH, Zagreb, 1999

Module name:	**Road Intersections**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	21851
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	II (Summer)
Person responsible for the module	Ivica Stančerić
Lecturer	Šime Bezina, Tamara Džambas
Language	Croatian
Relation to curriculum	Master's degree programme.Transportation Engineering Programme. Compulsory. Semester II.
Type of teaching, contact hours	Numberofhours (insemester): • Lectures:30 • Exercises (auditory, design):30
Workload	Lecture hours 30 Exercise hours 30 Contact hours and self study hours 120
Credit points	6 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, • Completion of design exercises and design submission.
Recommended prerequisites	• Practical skills for technical drawing – CAD skills.
Module objectives/intended learning outcomes	• Ability to understand traffic flow at road intersections and interchanges, • Ability to meet safety requirements at road intersections and interchanges, • Ability to use existing national and international guidelines for road intersections and interchanges design, • Ability to follow professional and scientific literature for the design of road intersections and interchanges, • Ability to choose the type of intersection with respect to the status and traffic conditions on the road network, • Ability to shape individual intersection elements (islands, curbes, left and right turn lane) based on the assumptions related to driving speed and vehicle movement geometry, • Ability to make intersection projects, • Ability to make horizontal and vertical signalization projects on intersections.
Content	• Lectures: 1. Traffic flowat intersections, channelization [2] 2. Intersection classification and selection criteria [2] 3. Intersection types [2] 4. Intersection design [2] 5. Traffic lane design at intersections [2] 6. Intersection elements (traffic island, curbes) design [2] 7. Horizontal and vertical alignment, visibility and sight distance at intersections [2] 8. Design vehicles and their trajectories[2] 9. Interchange types [2] 10. Interchange design [2]

	11. Interchange ramp design [2] 12. Roundabout and hybrid intersection design [2] 13. Guidelines and standards for intersection and interchange design [2] 14. Road markings – horizontal signalization [2] 15. Vertical signalization and light signal sat intersections [2] • Exercises (auditory, design): 1. Intersection design guide lines [2] 2. Design of intersection elements (traffic islands) [6] 3. Design of traffic lanes at intersections (minor direction)[4] 4. Design of traffic lanes at intersection(major direction) [4] 5. Off tracking control [4] 6. Horizontal and vertical signalization at intersections [4].
Study and examination requirements and forms of examination	• Written exam - minimum 50% score, • Oral exam.
Media employed	Whiteboard, projector
Reading list	Required literature: 1. Ž. Korlaet, Cestovna čvorišta (mimeographed lecture notes), 2009, 2. I. Stančerić, T.Džambas, Cestovna čvorišta u razini (mimeographed program notes for the course Road intersections, 2014), 3. Priručnik za izradu vježbi i diplomskih radova iz kolegija Cestovna čvorišta za studente sveučilišnog diplomskog studija – Prometni smjer (Pravilnik o prometnim znakovima, signalizaciji i opremi na cestama (NN 33/05, NN 64/05 i 155/05), Horizontalna signalizacija – JUS U.S4.221 – U.S4.234), 2009, (Handbook for exercises and graduate papers in the course Road intersections for graduate students, Regulations on traffic signs, signalization and road equipment), 4. Merlin, web pagehttp://moodle.srce.hr Optional literature: 1. A. Klemenčić, Oblikovanje cestovnih čvorišta izvan razine, Građevinski institut Zagreb, Zagreb, 1982, pp.110.

III. SEMESTER

Module name:	**Research methods**
Module level, if applicable	Master's Degree Programme
Code, if applicable	21822
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	III.(Winter)
Person responsible for the module	Anita Cerić
Lecturer	
Language	Croatian
Relation to curriculum	Master's degree programme. Compulsory for all subject areas at Graduation studies. Semestar III..
Type of teaching, contact hours	• Lectures: 15 • Seminars: Students are obliged to write a seminar paper on an assigned topic.
Workload	Lecture hours 15 Other contact hours 10 Self study hours 20
Credit points	1.5 ECTS
Requirements according to the examination regulations	Writing a seminar paper or a positively graded test.
Recommended prerequisites	
Module objectives/intended learning outcomes	• Collecting literature from different sources, • Defining the hypothesis, • Choosing an appropriate research method and methodology, • Using different techniques in data collection, • Writing essays, papers and reviews, • Presenting and discussing research findings.
Content	• Lectures: 1. Collecting literature and information 1 (2) 2. Role of hypothesis and general structure of the thesis 1 (1) 3. Writing papers, critiques and essays 2 (2) 4. Data collection 1 (1) 5. Research methodology 2 (1) 6. Research methods 3 (2) 7. Reporting the results 1 (2) 8. Citing references 2 (3) 9. Bibliography 1 (2) 10. Presentation skills 1 (1)
Study and examination requirements and forms of examination	• Written paper, • Written exam
Media employed	Whiteboard, projector
Reading list	Required literature: 1. Zelenika, R. Metodologija i tehnologija izrade znanstvenog i stručnog djela, Rijeka: Ekonomski fakultet Sveučilišta u Rijeci, 1999 (in Croatian)

	2. Cerić, A., Textbook for Civil Engineering Students, 2012, (in Croatian) Optional literature: 1. Fellows, R. And Liu, A., Research Methods for Construction, Oxford: The Blackwell Science, 1997 2. 2.Naoum, S.G., Dissertation Research and Writing for Construction Students, Oxford: ButterworthHeinemann, 2007

Module name:	**Traffic Tunnels**
Module level, if applicable	Master's Degree Programme
Code, if applicable	115180
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	III (Winter)
Person responsible for the module	Saša Ahac
Lecturer	Željko Stepan
Language	Croatian
Relation to curriculum	Master degree programme. Transportation Engineering Programme. Compulsory module. Semester III.
Type of teaching, contact hours	Number of hours (in semester): • Lectures:30 • Exercises (auditory, design):30
Workload	Lecture hours 30 Exercise 30 Other contact hours 30 Self study hours 88 Exam hours 2
Credit points	6 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, • Writing and presentation of a research paper on the topics of traffic tunnels, • Completion of design exercises and design submission.
Recommended prerequisites	• Practical skills for technical drawing – CAD skills, • Understanding equilibrium of forces in the plane.
Module objectives/intended learning outcomes	• Ability to monitor scientific literature inthefieldoftunneldesignandconstructionandapplicationofacquiredknowledgeinpractice, • Theoretical knowledge about trockmass classification methods, • Knowledge about historical and modern tunnel excavation methods, • Knowledge about tunnel support systems, • Ability to design tunnels for road, railway and metro, • Ability to work in the tunnel construction field.
Content	• Lectures: 1. Introductory course[2] 2. Features of international and Croatian tunnels [4] 3. Parameters for the design of road, railway and metro tunnels[4] 4. Rock mass classification - RMR, Q [2] 5. Rock mass classification -NATM[3] 6. Excavation methods and rock support systems–traditional and modern [6] 7. ADECCO – rock excavation method[4] 8. Tunnel portals[2], 9. Tunnel safety systems [3]. • Exercises (auditory, design): 1. Introduction [2] 2. Tunnel lining design[4]

	3. Rock load estimation for tunnel according to Protodyakonov's theory[4] 4. Load calculation [3] 5. Grafo-statical testing of tunnel lining[4] 6. Tabular and graphical representation of tensions in tunnel lining[3] 7. Cross section [2] 8. Excavation method (scheme and implementation phases)[4] 9. Design of safety niches[2] 10. Textual description of tunnels [2].
Study and examination requirements and forms of examination	• Oral exam.
Media employed	Whiteboard, projector
Reading list	Required literature: 1. Ž. Stepan, Mimeographed lecture notes, 2012, 2. J. Mikulić, A. Stipetić, Željezničke pružne građevine (Railway track construction), IGH, Zagreb. 1999, (Tunnels, pp. 150-197) 3. I. Banjad, Tuneli (Tunnels), GF, Zagreb, 1986, (Methos of tunnel construction, pp.163-194) 4. D. Marušić, Projektiranje i građenje željezničkih pruga, (Design and construction of railroads), Građevinski fakultet Sveučilišta u Splitu, 1994. (Usponi u tunelu pp.135-137) , 5. P. Lunardi, 2000. Design&constructingtunnels - ADECO-RS approach, T&Tinternationalspecialsupplement, May 2000, http://www.rocksoil.com/ingindex3.html 6. I. Majstorović, Ž. Stepan, Mimeographed lecture notes on programs in transportation tunnels, 2009, 7. Merlin, web pagehttp://moodle.srce.hr Optional literature: 1. I.Vrkljan, Podzemne građevine i tuneli (Underground buildings and tunnels)(mimeographed lecture notes, textbook),. Građevinski fakultet Sveučilišta u Rijeci, Institut IGH d.d., Zagreb, 2003, 2. The World's LongestTunnel Page, http://www.lotsberg.net 3. AlpTransitGotthard AG, http://www.alptransit.ch/

Module name:	**Airports**
Module level, if applicable	Master's Degree Programme
Code, if applicable	21853
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	III (Winter)
Person responsible for the module	Tatjana Rukavina
Lecturer	Josipa Domitrović
Language	Croatian
Relation to curriculum	Master's degree programme.Transportation Engineering Programme. Compulsory. Semester III.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises (design): 15
Workload	Lecture hours 30 Hours of laboratories or skills 15 Other contact hours 15 Self study hours 75
Credit points	4,5 ECTS
Requirements according to the examination regulations	• Attendance in minimum 75% lectures and 100% exercises, • Pre-exam – minimum 25% score, • One make up pre-exam, • Program submission.
Recommended prerequisites	• Basic knowledge in the field of geomechanics, • Basic knowledge about construction materials, • Understanding the concepts of stress, strain and internal forces.
Module objectives/intended learning outcomes	• Participation in the preparation of project documentation for all essential elements in airport maneuvering area, geometry, lighting, signalling, as well as pavements (flexible or rigid), • Analysing and solving problems related to the design and construction of airports from the engineering point of view by applying the latest knowledge and solutions, • Designing pavements for airport manoeuvre in area in accordance with the international engineering practices, • Using specialized software for pavement design (PAVERS), • Critical evaluation, analysis and appropriate selection of the appropriate types of pavements in accordance with the purpose of maneuvering areas, • Creative participation in works related to the construction and maintenance of airport maneuvering area, • Following scientific literature in the field of airport pavement design and construction, and application of acquired knowledge in further education.
Content	• Lectures: 1. Introduction (history of aviation) [2] 2. Civil air traffic and its organization [4] 3. Air traffic system, airports and its elements [1] 4. Terms used in standards and recommendations – according to ICAO [1] 5. Basics of meteorology for research, position in grand exploitation of airports [2]

	6. Airports-definition, development, division, classification and codification according toICAO [2] 7. Airport maneuvering area, runway, shoulder [1] 8. Stop way, clearway, declared distances, runway safety area [2] 9. Taxiway [2] 10. Apron [2] 11. Obstacle restrictions[2] 12. Marking of the airport maneuvering area [2] 13. Obstacles and marking of obstacles [2] 14. Airport pavement classification (loads, methods of classification) [2], 15. Airport pavement design (flexible and rigid) [1]. • Exercises (design): 1. Introduction to airport pavement design [2] 2. ACN-PCN classification, determination of relevant aircraft; determination of relevant pavement thickness (flexible and rigid)[4] 3. Classification according to LCN method [2] 4. Determining equivalent number of passes for relevant aircraft [2] 5. Preliminary design of flexible and rigid pavements [2] 6. Design of rigid pavement in accordance with Westergaard method [2] 7. Program submission [1].
Study and examination requirements and forms of examination	• Written exam -minimum 50% score, • Oral exam.
Media employed	Whiteboard, projector
Reading list	Required literature: 1. Z. Horvat, Airports I, Zagreb, 1982, 2. A. Prager, Airports I – amendments, Zagreb, 1990, 3. S. Pavlin, Airports I, Faculty of Transport and Traffic Sciences, Zagreb, 2006, 4. T. Rukavina, J. Domitrović, Airports (lectures, exercises guide), Zagreb, 2012, http://merlin.srce.hr Optional literature: 1. Aerodromes, Annex 14 to the Convention on International Civil Aviation, ICAO, 1999 2. Airport Pavement Design and Evaluation, Federal Aviation Administration, 1995

Module name:	**Road Equipment**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	21854
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	III (Winter)
Person responsible for the module	Vesna Dragčević, Ivica Stančerić
Lecturer	
Language	Croatian
Relation to curriculum	Master's degree programme.Transportation Engineering Programme. Compulsory. Semester III.
Type of teaching, contact hours	Number of hours (in semester): • Lectures:45
Workload	Lecture hours 45 Other contact hours and self study hours 90
Credit points	4,5 ECTS
Requirements according to the examination regulations	• Attendance in lectures (minimum 75%), • Writing a research paper on the topics of road equipment, • Research paper presentation.
Recommended prerequisites	• Knowledge about road design rules, • Knowledge about road cross section elements.
Module objectives/intended learning outcomes	• Ability to describe types, operations and maintenance of road equipment (traffic signs, safety fences, pavement marking equipment, trafficcal ming equipment, lighting), • Ability to understanddesignandinstallationmethodologyofroadequipmentrespectingth e behaviour of road users (physical and psychological characteristics of driver), traffic conditions and vehicle characteristics, • Evaluation of assumptions, argument sand design solutions, • Ability to monitor scientific and professional literature related to the design and installation of road equipment and to apply acquired knowledge for further specialization.
Content	• Lectures: 1. Introduction. Road equipment. Basic principles for installing traffic signs [2] 2. Traffic performance [2] 3. Vehicle movement. Stopping sight distance. Visibility [3] 4. Vertical signs. Road signs –form and setting up [6] 5. Road markings – visibility and design recommendations [3] 6. Road markings – materials and colors, construction [3] 7. Horizontal and vertical signs application examples[3] 8. Traffic lights [2] 9. Variable Message Signs [2] 10. Equipment for road pavement marking [2] 11. The guardrails [4] 12. Other types of fences and comfort pads [3] 13. Other road equipment [3] 14. Road lighting [3]

	15. Animal crossings [2] 16. Wind protection barriers [2].
Study and examination requirements and forms of examination	• Written exam -minimum 50% score, • Oral exam.
Media employed	Whiteboard, projector
Reading list	Required literature: 1. V. Dragčević, S. Stančerić, Prometna oprema, predavanja, (Road Equipment, mimeographed lecture notes(, Zagreb, 2009, http://moodle.srce.hr 2. Zakon o sigurnosti prometa na cestama (Law on Road Traffic Safety, Official Gazette, 6772008), NN 67/2008, 3. Pravilnik o prometnim znakovima, signalizaciji i opremi na cestama (Regulations on traffic signs, signalisation and road equipment, Official Gazette)(NN 33/05, NN 64/05 i 155/05) 4. Horizontalna signalizacija (Horizontal signalisation) - JUS U.S4.221 - U.S4.234, Priručnik za izradu vježbi i diplomskih radova iz kolegija Cestovna čvorišta za studente sveučilišnog diplomskog studija (handbook) - Prometni smjer. Optional literature: 1. Opći tehnički uvjeti za radove na cestama, Hrvatske ceste i Hrvatske autoceste, Zagreb, 2001, (General technical requirements for road works, Croatian Roads and Croatian Highways, 2001)

Module name:	**Traffic Systems**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	21855
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	III (Winter)
Person responsible for the module	Maja Ahac
Lecturer	
Language	Croatian
Relation to curriculum	Master's degree programme.Transportation Engineering Programme. Compulsory. Semester III.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 45
Workload	Lecture hours 45 Other contact hours 15 Self study hours 75
Credit points	4,5 ECTS
Requirements according to the examination regulations	• Attendance in lectures, • Two pre-exams – minimum 40% score in each.
Recommended prerequisites	• Practical knowledge in the field of traffic flows, • Practical knowledge in the field of transportation technology.
Module objectives/intended learning outcomes	• Ability to determine the main features of basic elements in transportation systems and various types of transport, • Participation in the analysis of the performance of entire transport system and its elements, • Ability to design various elements in transport system, • Ability to analyze the basic principles of functioning and development of road traffic system, • Ability to evaluate and investigate the existing data on road traffic system and their application, • Participation in developing the concepts of transport system functions, • Participation in creating and maintaining transport systems.
Content	• Lectures: 1. Traffic: definitions, divisions, historical development [3] 2. Main characteristics of vehicle, roads and travelling [4] 3. Main characteristics of drivers and pedestrians [4] 4. General traffic characteristics [4] 5. Traffic loads [4] 6. Traffic flows [4] 7. Urban areas [4] 8. Urban public transportation [4] 9. Regional traffic [2] 10. Paratransit[2] 11. Pedestrian traffic [2] 12. Cycle traffic [2] 13. Traffic safety [2] 14. Traffic studies [2] 15. Traffic planning [2].

Study and examination requirements and forms of examination	• Pre-exams, • Oral exam.
Media employed	Whiteboard, projector
Reading list	Required literature: 1. W.R. McShane, R.P. Roess, Traffic Engineering, Prentice-Hall, Inc. Englewood Cliffs, New Jersey, 1990 2. J. Pađen, Metode prostorno-prometnog planiranja, (Methods of urban transport planning), Informator, Zagreb, 1978 3. J.V. Korte, Osnove projektiranja gradskog i međugradskog putnog saobraćaja (Basics of design of urban and interurban traffic), Građevinska knjiga, Beograd, 1968 4. L.J. Pignataro, Traffic Engineering, Theory and Practise, Prentice-Hall, Inc. Englewood Cliffs, New Jersey, 1973 5. P. Rožić, Mimeographed lecture notes. Optional literature: 1. Trasportation and Traffic Engineering Handbook, the Institute of Traffic Engineers, Washington, D.C., 1976

Module name:	**Drainage of Transportation Facilities**
Module level, if applicable	Master’s Degree Programmes
Code, if applicable	21856
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	III (Winter)
Person responsible for the module	Saša Ahac
Lecturer	Saša Ahac
Language	Croatian
Relation to curriculum	Master's degree programme.Transportation Engineering Programme. Elective. Semester III.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises (design): 15
Workload	Lecture hours 30 Exercise hours 15 Other contact hours and self study hours 90
Credit points	4,5 ECTS
Requirements according to the examination regulations	• Lecture and exercise attendance (minimum 75% of lectures and 100% of exercise classes). • Two pre-exams - minimum 25% score, • One make up exam, • Completion of design exercises.
Recommended prerequisites	• Good understanding of the road design principles, • Holistic approach to drainage design.
Module objectives/intended learning outcomes	• Knowledge on surface and sub-surface drainage design in urban and rural areas, • Solving basic drainage problems on urban and rural roads, • Analysis of rainfall runoff and groundwater flow influence on road safety, bearing capacity and stability of superstructure and substructure elements, • Application of specialised road design software MX ROAD in drainage design, • Evaluation of assumptions, arguments and design solutions for drainage of transportation facilities, • Ability to understand scientific and professional papers and to collect and present the data used to solve practical problems in everyday engineering practice.
Content	• Lectures: 1. Hydrological conditions, data and procedures, Hydraulic criteria [6] 2. Protection from rainfall runoff and groundwater flow [2] 3. Pavement surface drainage [2] 4. Pavement surface drainage systems [4] 5. Subgrade drainage systems [2] 6. Urban drainage [4] 7. Culverts [4] 8. Design discharge [2] 9. Environmental considerations and criteria [2]. • Exercises (design):

	1. Detailed cross sections [5] 2. Horizontal alignment [1] 3. Vertical alignment [2] 4. Surface drainage design [3] 5. Sub-surface drainage design [3] 6. Technical description [1].
Study and examination requirements and forms of examination	• Written exam - minimum 50% score, • Oral exam.
Media employed	Whiteboard, projector
Reading list	Required literature: 1. RAS, Entwässerung, FGSV, Boon, 1987, 2. RAS, TabellenfürBemessung von Entwässerungsrinnrn undmulden in befestigenVerkehrsflächen, FGSV, Bonn, 1987, 3. Richard K. Untermann, Principles and practices of grading, drainage and road alignment: An ecologic approach, Prentice-Hall, Inc., 1978 Optional literature: 1. Opći tehnički uvjeti za radove na cestama, Hrvatske ceste i Hrvatske autoceste, (General technical requirements for road works, Croatian Roads and Croatian Highways, 2001), Zagreb, 2001

Module name:	**Traffic buildings**
Module level, if applicable	Master's Degree Program
Code, if applicable	21881
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	III (Winter)
Person responsible for the module	Silvio Bašić, Nikolina Vezilić Strmo
Lecturer	Ivana Senjak
Language	Croatian
Relation to curriculum	Master's degree programme, Transportation Engineering, Elective. Semestar III.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises: 15 (auditory: 1, design: 14)
Workload	Lecture hours: 45 Other contact hours: 30 Self study hours: 60
Credit points	4,5 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, • Two pre-exams – minimum 25% score in each.
Recommended prerequisites	Familiarity with specific literature, prior knowledge.
Module objectives/intended learning outcomes	• Ability to use professional literature and apply acquired knowledge in further training, • Ability to analyze the methodology of planning and design of traffic buildings, • Planning traffic buildings and designing traffic systems inside and out of traffic buildings, • Ability to evaluate the assumptions, arguments and design solutions related to the location and selection of traffic building type, • Ability to evaluate organisational principles and select optimal type of traffic buildings and creative application of acquired knowledge, • Ability to present professional topic related to planning and design of traffic buildings.
Content	• Lectures: 1. Introduction – city and traffic [1] 2. Basic characteristics of traffic building architecture [1] 3. Pedestrian underpasses and overpasses [1] 4. Car parks [1] 5. Multi storey car parks [1] 6. Petrol stations in towns. Service stations [1] 7. Accompanying facilities along highways, motels [1] 8. Bus stations in city traffic [1] 9. Bus stations in intercity traffic [1] 10. Typology of railway stations [2] 11. Typology of airport buildings [2] 12. Accompanying facilities in ports [1] 13. Accompanying facilities in marinas [1].

	• Exercises: 1. Auditory – instructions for making programs, pre-exam [1] 2. Design – program making [14].
Study and examination requirements and forms of examination	• Written exam.
Media employed	Whiteboard, projector
Reading list	Required literature: 1. S. Bašić, G. Poljanec, Prometne zgrade (Traffic Buildings), mimeographed lecture notes Optional literature: 1. E. Eufert, Osnove projektiranja (Basics of Design), golden marketing, 2002

Module name:	**Soil improvement methods**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	21857
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	III (Winter)
Person responsible for the module	Tatjana Rukavina
Lecturer	
Language	Croatian
Relation to curriculum	Master's degree programme, Transportation Engineering, Elective. Semestar III.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises (design): 15
Workload	Lecture hours 30 Hours of laboratories or skills 15 Other contact hours 15 Self study hours 75
Credit points	4,5 ECTS
Requirements according to the examination regulations	• Attendance in minimum 75% lectures and 100% exercises, • Seminar paper (writing and presenting).
Recommended prerequisites	• Basic knowledge in the field of pavement geomechanics, • Basic knowledge about construction materials.
Module objectives/intended learning outcomes	• Ability to understand the effects of materials used in improving soil characteristics (cement, lime, bitumen, geosynthetic materials, various commercial products) and ability to evaluate the advantages and disadvantages of their use in certain circumstances, • Ability to analyze and solve problems related to design and construction of pavements on poor load bearing soil in accordance to European regulations, • Ability to participate in design of mixture used to enhance poor load bearing soil performance in accordance with domestic and international engineering practice, • Ability to analyze and select appropriate types of soil stabilization, • Ability to apply engineering approach for design and construction of pavements on poor load bearing soils using knowledge on properties of weak soil and applied additives, • Ability to participate in works related to soil improvement in a creative way, • Ability to follow scientific literature in the field of soil improvement, and to apply the acquired knowledge in further education.
Content	• Lectures: 1. Introduction (purpose, definition, application areas, stabilization, application for pavement infrastructure) [2] 2. Concept of unstable soil and unstable soil types[3] 3. Selection of procedures (determining parameters in decision making on soil improvement methods)[2] 4. Mechanically stabilized soil [4]

	5. Stabilization with lime [5] 6. Soil stabilization with a mixture of fly ash with lime or cement [3] 7. Soil stabilization with bitumen [2] 8. Thermal soil stabilization procedures [3] 9. Soil stabilization with geosynthetics [2] 10. Other ways of soil stabilization [4]. • Exercises (design): 1. Introduction (seminar paper theme) [1] 2. Preparation of seminar [8] 3. Presentation of seminar [4] 4. Submission of seminar paper [2]
Study and examination requirements and forms of examination	• Seminar paper grade (writing and presentation), • Oral exam.
Media employed	Whiteboard, projector
Reading list	Required literature: 1. B. Babić, Z. Horvat, Pavement construction and maintenance, University of Zagreb, Zagreb,1983, 2. B. Babić, Geosynthetics in transportation infrastructure, HSGI, Zagreb, 1995, 3. T. Rukavina, Mimeographed lecture notes, 4. Generaltechnical specifications for road works, IGH, Zagreb, 2001 Optional literature: 1. F. G. Bell, Engineering Treatment of Soils, Taylor & Francis, 2005

Module name:	**English Language in Civil Engineering 2**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	93234
Subtitle, if applicable	
Courses, if applicable	Master's's programme 7 classes
Semester(s) in which the module is taught	III (Winter)
Person responsible for the module	Alemka Kralj Štih
Lecturer	
Language	English
Relation to curriculum	Master's Degree Programmes. Elective. Semester III.
Type of teaching, contact hours	Number of hours (in semester): • Exercises: 45
Workload	Lecture hours 45 Other contact hours 10 Self study hours 80
Credit points	4,5 ECTS
Requirements according to the examination regulations	• 75% attendance in lectures, • Making a presentation, • 3 pre-exams.
Recommended prerequisites	• Intermediate level, B 1.
Module objectives/intended learning outcomes	• Developing language competences which include professional terminology in the field of transport facilities and geotechnical engineering, • Independent user – ability to read technical literature independently, • Revision of basic grammar categories in professional language – passive, past tenses, modal verbs, • Confident use of sentences in professional language, developing presentation skills and skills in writing professional papers.
Content	• Exercises: 1. A Career in Transportation Engineering [2] 2. Road Structure [2] 3. Construction of a Road [2] 4. A Career in Geotechnical Engineering [3] 5. Tunnels and Tunneling Tools [2] 6. How to write a CV? [3] 7. The CV and Job Interview Questions [3] 8. Preparing for the Interview Skills – Techniques, Tips and Advice [3] 9. Single presentations on Transportation Issues [3] 10. Transportation System Issues and Challenges [3] 11. The Light at the End of the Tunnel – Revision of vocabulary [4] 12. What's so Special About Geotechnical Engineering? [3] 13. General Considerations in Foundation Design [2] 14. Special Foundation Problems [2] 15. Deep Foundations [3] 16. Presentations [3]
Study and examination requirements and forms of examination	• The credits earned through all the testing and pre-exams make up the final grade. The grades are based as follows: pre-exam results, points earned during semester - active participation in class, grammar checks, translations into a foreign language, translations from a foreign language,

	professional vocabulary checks. Maximum number of points that can be earned in the pre-exam is 20 – the grade is multiplied by four. Students who have not earned enough points are required to take the final exam. • Grading is as follows - 50-62% score = sufficient (2), - 63-75% score = good (3), - 76-88% score = very good (4), - 89-100% score = excellent (5).
Media employed	Whiteboard, projector
Reading list	Required literature: 1. A. Kralj Štih: English in Transportation and Geotechnical Engineering, course materials. Optional literature: 1. D. Bonamy: Technical English 4, Pearson Longman, 2011 2. The Internet pages, program Building Big, Brantacan, ASCE. 3. Z. Vulelija: Ilustrirani rječnik arhitekture i građe inar t a – hrvatsko engleski i englesko hrvatski, Masmedia, Zagreb, 2010 4. A. Prager: Trojezični građevinski rječnik, Masmedia, Zagreb, 2002

Module name:	**German Language in Civil Engineering 2**
Module level, if applicable	Master's Degree Programm
Code, if applicable	93235
Subtitle, if applicable	
Courses, if applicable	Master's Programmes 1 class
Semester(s) in which the module is taught	III (Winter)
Person responsible for the module	Alemka Kralj Štih
Lecturer	
Language	German
Relation to curriculum	Master's Degree Programmes. Elective. Semester III.
Type of teaching, contact hours	Number of hours (in semester): 45 • Exercises (auditory):45
Workload	Lecture hours 45 Other contact hours 10 Self study hours 80
Credit points	4,5 ECTS
Requirements according to the examination regulations	• 75% attendance in exercised, • Preparing one presentation, • 3 pre-exams.
Recommended prerequisites	• German language competence at B1, B2 level.
Module objectives/intended learning outcomes	• Understanding and interpreting technical texts, • Independent oral skills in technical field, ability to explain professional terms, • Writing a CV and job applications.
Content	• Auditory exercises: 1. Die Geschichte des Kuppelbaus [3] 2. Wie schreibt man einen Lebenslauf? [3] 3. Bewerbungsschreiben [3] 4. Wie man sich auf ein Interview vorbereitet [3] 5. Die größte Drehbrücke der Welt [3] 6. Bewerbungsschreiben [3] 7. Die Geschichte der Tunnelkonstruktion [3] 8. Kräfte und Gegenkräfte [3] 9. Einige Festigkeitsarten [3] 10. Elastizität und Verformung [3] 11. Der Straßenbau [3] 12. Gebäude im Erdbeben [3] 13. Der Flughafen [3]
Study and examination requirements and forms of examination	• The credits earned through all the testing and pre-exams make up the final grade. The grades are based as follows: pre-exam results, points earned during semester - active participation in class, grammar checks, translations into a foreign language, translations from a foreign language, professional vocabulary checks. Maximum number of points that can be earned in the pre-exam is 20 – the grade is multiplied by four. Students who have not earned enough points are required to take the final exam. • Grading is as follows - 50-62% score = sufficient (2), - 63-75% score = good (3),

	- 76-88% score = very good (4), - 89-100% score = excellent (5).
Media employed	Whiteboard, projector
Reading list	Required literature: 1. A. Kralj Štih: Deutsch für Konstruktionen, Geotechnik, Verkehr un Theorie un M ellierung der Konstruktionen, Kursunterlagen, 2011 Optional literature: 1. A. Prager: Trojezični građevinski rječnik, Masmedia, Zagreb, 2002

IV. SEMESTER

Module name:	**Pavement Management**
Module level, if applicable	Master’s Degree Programmes
Code, if applicable	21858
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	IV (Summer)
Person responsible for the module	Tatjana Rukavina
Lecturer	Josipa Domitrović
Language	Croatian
Relation to curriculum	Master’s degree programme, Transportation Engineering, Compulsory, IV Semestar.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30
Workload	Lecture hours 30 Other contact hours 15 Self study hours 45
Credit points	3 ECTS
Requirements according to the examination regulations	• attendance in minimum 75% lectures, • Seminar paper.
Recommended prerequisites	• Basic knowledge in the field of pavement design and construction, • Basic knowledge about construction materials, • Basic knowledge in the field of pavement geomechanics.
Module objectives/intended learning outcomes	• Understanding and actively participating in the implementation of pavement management systems from inspection and assessment to the final selection and application of appropriate solutions, • Ability to analyze and solve problems related to the pavement maintenance from the engineering point of view by applying the latest know-how and solutions, • Ability to apply the acquired knowledge to the creation of pavement management system in accordance with the international practice by using one of the specialized software types(Micro PAVER), • Ability to assess (under the supervision of a mentor), analyze and select appropriate ways of pavement maintenance in accordance with the existing practice by respecting the principles of rational pavement management, • Ability to apply engineering approach to the maintenance of pavement using knowledge about materials, construction technology and pavement performance gained in other courses that are directly related to the subject matter of pavements(Pavements, Airports, Methods of soil improvement), • Ability to participate creatively in works related to the pavement maintenance, • Ability to follow scientific literature in the field of pavement maintenance, and to apply the acquired knowledge in further education.
Content	• Lectures: 1. Introduction [2] 2. Fundamentals on pavement management systems[2]

	3. Pavement maintenance (definitions, objectives and economic aspects)[2] 4. Pavement condition features (types of pavement distresses, methods of data acquisition, pavement condition evaluation on the basis of collected data) [4] 5. Asphalt pavement maintenance [4] 6. Concrete pavement maintenance [2] 7. Reconstruction of asphalt pavements (reinforcement, total replacement of the existing pavement, a combination of reinforcement and total replacement) [3] 8. Reconstruction of concrete pavements [2] 9. Cuts and other damages/repairs caused by works on utility infrastructure [4] 10. Structure and elements of management systems [4] 11. Pavement management models (Micro PAVER, HDMIII system dTIMS/VIAPMS) [3].
Study and examination requirements and forms of examination	• Oral exam.
Media employed	Whiteboard, projector
Reading list	Required literature: 1. M. Sršen, Pavement maintenance, HSGI, Zagreb, 2000, 2. V. Dragčević, Ž. Korlaet, T. Rukavina, Flexible pavement distress catalogue, GF, Zagreb, 2004, 3. M. Keller, Pavement management, GF, Transportation Days 2009, Zagreb, 2009, 4. T. Rukavina, M.Ožbolt, Pavement Management System - Data Collection, Management of Transport Infrastructure, Transportation Days 2009, Zagreb, 2009, 5. T. Rukavina, Mimeographed lecture notes. Optional literature: 1. OECD (Scientific Expert Group): Road Maintance Management Systems in Developing Countries, Organization for Economic Co-operation and Development, Paris, 1995

Module name:	**Parking Lots**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	21860
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	IV (Summer)
Person responsible for the module	Ivica Stančerić
Lecturer	
Language	Croatian
Relation to curriculum	Master's degree programme: Transportation Engineering. Elective. Semestar IV.
Type of teaching, contact hours	2 hours per week - lecture 1 hours per week - exercise
Workload	Lecture hours 30 Exercise hours 15 Contact hours and self study hours 90
Credit points	4,5 ECTS
Requirements according to the examination regulations	Written and oral examination
Recommended prerequisites	
Module objectives/intended learning outcomes	Module offers theoretical knowledge and practical skills about roadside ancillaries, traffic areas and parking spaces design.
Content	Urban and traffic baselines. Parking lots capacity. Parking systems, organization, management. Parking types and parking facilities types. Design elements of parking places, parking by driving ahead and back, dimensions of parking places, widths of driving lanes, exploitability of surface. Construction performance and equipment, pavement, drainage, signalization, lightning, safety equipment. Parking places for special purposes, bus and lorry stations, shopping centres, sports facilities, airports, P+R systems, bicycles and motorcars. Parking objects-garages, systems of internal organization, road network connections, design elements, ramps, control systems, control and charging systems, safety measures. Recommended Literature: Empfelungen für Anlagen des ruhenden Verkehrs, EAR 91, FGSV, Bonn, 1995., str. 99. Organisation und Anzahl der Stellplätze für den Individualverkehr, RVS 03.07.11., FSV, Wien, 2008.
Study and examination requirements and forms of examination	Knowledge and skills for design of roadside ancillaries and other traffic areas and parking spaces
Media employed	Whiteboard, projector
Reading list	Parkieren, Anordnung und Geometrie der Parkierungsanlagen, SN 640291a,VSS, Zürich 2006.

Module name:	**Track Maintenance**
Module level, if applicable	Master's Degree Programme
Code, if applicable	21861
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	IV (Summer)
Person responsible for the module	Stjepan Lakušić, Ivo Haladin
Lecturer	Viktorija Grgić, Katarina Vranešić
Language	Croatian
Relation to curriculum	Master's degree programme. Transportation Engineering Programe. Elective. Semester IV.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 45
Workload	Lecture hours 43 Other contact hours 15 Mid-term exams hours 2 Exam hours 2 Self study hours 73
Credit points	4,5 ECTS
Requirements according to the examination regulations	• Lecture attendance. • Writing a seminar paper on topics of track maintenance.
Recommended prerequisites	• Knowledge about track construction types, • Knowledge about turn out working principles, • Knowledge about track substructure.
Module objectives/intended learning outcomes	• Knowledge about rail track maintenance system, • Knowledge about rail track condition control, • Knowledge about rail track superstructure maintenance, • Knowledge about rail track substructure maintenance, • Knowledge about turnout maintenance, • Knowledge about control and reconstruction of railway facilities, • Knowledge about high speed rail ways maintenance.
Content	• Lectures: 1. Basic concepts on track maintenance [2] 2. Track condition inspection: track geometry, rails [4] 3. Track condition inspection [4] 4. Track maintenance work types: track maintenance, track reconstruction[6] 5. Permanent way maintenance: manual maintenance and maintenance [6] 6. Track material regeneration: rails, turnouts, fastenings, sleepers, ballast [4] 7. Turnout maintenance: point blades, frogs, wing and guardrails [4] 8. Track substructure maintenance: track formation level, sub-base, drainage ditches [4] 9. Railway facility inspection: inspection of bridges, culverts, tunnels, level crossings [4] 10. Maintenance and reconstruction of railway facilities [4] 11. Track maintenance for high speed railways [3].

Study and examination requirements and forms of examination	• Written exam - minimum 50% core, • Oral exam.
Media employed	Whiteboard, projector
Reading list	Required literature: 1. Esveld, C.,Modern Railway Track, Second Edition, MRT Productions, Zaltbommel, 2001, 2. Mikulić, J., Stipetić, A.,Željezničke pružne građevine, Institut građevinarstva hrvatske, Zagreb, 1999 Optional literature: 1. Pravilnik o održavanju gornjeg ustroja željezničkih pruga HŽ(Regulations on maintance of track railroads), (Pravilnik 314); Pravilnik o održavanju donjeg ustroja željezničkih pruga HŽ(Regulations on subrstructure railroads) (Pravilnik 315)

Module name:	**Urban Railways**
Module level, if applicable	Master's Degree Programme
Code, if applicable	114791
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	IV (Summer)
Person responsible for the module	
Lecturer	Maja Ahac, Viktorija Grgić, Katarina Vranešić, Maja Ahac, Stjepan Iakušić
Language	Croatian
Relation to curriculum	Master's degree programme. Transportation Engineering Programe. Elective. Semester IV.
Type of teaching, contact hours	Number of hours (in semester): • Lectures:30 • Exercises (auditory, design): 15
Workload	Lecture hours 43 Other contact hours 15 Mid-term exams hours 2 Exam hours 2 Self study hours 73
Credit points	4,5 ECTS
Requirements according to the examination regulations	• Lecture and exercise attendance, • Program design.
Recommended prerequisites	• Knowledge about track design and construction procedures, • Knowledge about track superstructure, • Knowledge about public transport systems.
Module objectives/intended learning outcomes	• Knowledge about public transport system purpose, • Knowledge about tramway public transport system, • Knowledge about metro public transport system, • Knowledge about light rail public transport system, • Knowledge about suburban transport system, • Knowledge about construction types of tracks in urban environment, • Knowledge about urban rail traffic noise and vibrations mitigation measures.
Content	• Lectures: 1. Basic concepts on urban railways[2] 2. Tramway track[4] 3. Light rail track [4] 4. Metro track [4] 5. Suburban rail track [4] 6. Rail vehicles types in urban environment [2] 7. Construction types of tracks in urban environment [3] 8. Construction of tracks in urban environment[3] 9. Urban rail traffic noise and vibrations[2] 10. Revitalization of urban railways [2]. • Exercises (auditory, design): Creating program assignment on the topic of rail traffic in urban areas. Topics for the program are as follows: 1. Reconstruction of tram stops (extension, relocation, modernization),

	2. Preliminary design of pedestrian under passes, 3. Preliminary design of new tramlines in Zagreb and Osijek, 4. Preliminary design of revitalization of urban railways, 5. Preliminary design of rail road crossing denivelation, 6. Rail traffic noise and vibration analysis in urban environments.
Study and examination requirements and forms of examination	• Written exam - minimum 50% score, • Oral exam.
Media employed	Whiteboard, projector
Reading list	Required literature: 1. Lakušić, S.,Tramvajski kolosijeci (Tram rails), Građevinski fakultet Zagreb, Faculty of Civil Engineering, Zagreb, 2006, 2. Light RailIn Germany, Federal Ministry of Transport, VDV Group, 2000 Optional literature: 1. Garbutt, P.,World metro system, 2. Taplin, M., Russel, M.,Tramsin Western Europe, Capital Transport. 3. Bennet, D.,Metro, Octopus Publishing, 2004

Module name:	**Urban transportation facilities**
Module level, if applicable	Master's Degree Programme
Code, if applicable	21859
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	IV (Summer)
Person responsible for the module	Vesna Dragčević
Lecturer	Željko Stepan
Language	Croatian
Relation to curriculum	Master degree programme. Transportation Engineering Programme. Elective. Semester IV.
Type of teaching, contact hours	Number of hours (in semester): Lecture hours 30 Exercise 15
Workload	Lecture hours 30 Exercise 15 Other contact hours 15 Self study hours 73 Exam hours 2
Credit points	4,5 ECTS
Requirements according to the examination regulations	During the semester: The Student should make transportation model. There are 3 mid-term for control parts of model (Network model; Demand model; Impact model). At the end of semester: The students give completed transportation model on last exercise. The students have oral examination for grade from 2 to 5.
Recommended prerequisites	Familiarity with specific literature, prior knowledge about urban planning, traffic facilities
Module objectives/intended learning outcomes	The students learn about network and their attributes. The students learn about demand modeling-land use, four step generation model. The students learn about calibration and validation of model. The students learn about cost benefit analysis and stating priorities
Content	Parts of this module are: Urban traffic systems, Road facilities and their attributes, Route alignment of transportation routes, basic network, frontage roads, residential streets, access roads. Connections of urban and external system. Road intersections. Traffic demand planning. Matrix of journey generation, Distribution of travel demand. Modal split, Network model, Demand model, Impact model, Plan evaluation, driving velocities, network saturation, harmful matters emission, noise, Cost benefit analysis
Study and examination requirements and forms of examination	Students will be able to make transportation model: theoretical knowledge: Base knowledge about object hierarchy of transportation model. Knowledge about attributes of network, demand, zones, impact.

	practical knowledge: Data acquisition, building, calibration and validation of model, forming and analysis scenarios. Printout of results graphical and textual.
Media employed	Whiteboard, projector
Reading list	Obligatory: 1. D. Pološki: Ispis predavanja, interna skripta, 2008 (In Croatian) 2. VISUM manual (In English or German) Suggested literature: 1. Highway Capacity Manual 2000

Module name:	**Numerical Mathematics**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	21805
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	IV (Summer)
Person responsible for the module	Tomislav Došlić, Alan Filipin
Lecturer	Tomislav Došlić, Alan Filipin
Language	Croatian
Relation to curriculum	Master's degree programme.Elective.Semestar IV.
Type of teaching, contact hours	Number of hours (in semester): 60 • Lectures: 30 • Exercises (auditory): 30
Workload	Lecture hours 28 Exercises hours 30 Other contact hours 2 Self study hours 60
Credit points	6 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises.
Recommended prerequisites	• Familiarity with the calculus, including ordinary differential equations, and basic linear algebra.
Module objectives/intended learning outcomes	• Understanding the conditions and limits of applicability of particular numerical methods, • Ability to choose and successfully apply correct methods.
Content	• Lectures: 1. Sources and types of errors (5) 2. Methods for solving non-linear equations (5) 3. Interpolation and approximation (5) 4. Numerical integration (5) 5. Numerical methods for solutions of ordinary differential equations (5) 6. Numerical linear algebra (5) • Exercises (auditory): follow the lectures.
Study and examination requirements and forms of examination	• Correct solution of a pre-assigned problem, • Oral exam.
Media employed	Whiteboard, projector
Reading list	Required literature: 1. T. Došlić, Numerička matematika, available at the course web-page. Optional literature: 1. E. Kreyszig: Advanced Engineering Mathematics, John Wiley and Sons Ltd., 1999,. 2. F. Scheid: Numerical Analysis, Schaum's Outline Series in Mathematics, McGraw-Hill

Module name:	**Perspective**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	21806
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	IV (Summer)
Person responsible for the module	Sonja Gorjanc
Lecturer	Iva Kodrnja, Helena Koncul, Dora Pokaz
Language	Croatian
Relation to curriculum	Master's Degree Programmes. Elective. Semester IV.
Type of teaching, contact hours	Number of hours (in semester): 60 • Lectures:30 • Exercises (auditory, design, laboratory): 30
Workload	Lecture hours 30 Hours of laboratories or skills 30 Other contact hours 30 Self study hours 90
Credit points	6 ECTS
Requirements according to the examination regulations	• 100% attendance in lectures and exercises, • 4 projects, • 1 seminar paper, • 1 pre-exam.
Recommended prerequisites	• Familiarity with the methods of parallel projection.
Module objectives/intended learning outcomes	• Mastering basic constructive procedures in perspective, • Acquiring knowledge on methods of construction of perspective image of an object, • Acquiring knowledge on geometric properties of algebraic surfaces of higher order, • Ability to construct perspective image of objects from civil engineering.
Content	• Lectures: 1. Central projection [8] 2. Quadric surfaces [4] 3. Ruled surfaces [6] 4. Computer modeling of surfaces [8] 5. Terrains in perspective [4] • Exercises (constructive, in computer classroom): 1. Central projection [8] 2. Quadric surfaces [4] 3. Ruled surfaces [6] 4. Computer modeling of surfaces [8] 5. Terrains in perspective [4]
Study and examination requirements and forms of examination	• Written exam - minimum 60% score, • Oral exam, • Students who have achieved a positive grade in projects, seminar paper and pre-exam are exempt from the written and oral exam.
Media employed	Whiteboard, projector

Reading list	Required literature: 1. P. Kurilj, N. Sudeta, M. Šimić, Perspektiva (Perspective), Arhitektonski fakultet, Zagreb, 2005 Optional literature: 1. V. Niče, Perspektiva (Perspective), Školska knjiga, Zagreb, 1978, 2. B. Kučinić et al., Oble forme u graditeljstvu, Građevinar, Zagreb, 1992, 3. H. Brauner, W. Kickinger, Geometrija u graditeljstvu, Školska knjiga, Zagreb,1980

Module name:	**Basics of Differential Geometry**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	21804
Subtitle, if applicable	
Courses, if applicable	1 class for lectures 1 class for exercises
Semester(s) in which the module is taught	IV. (summer)
Person responsible for the module	
Lecturer	Iva Kodrnja, Sonja Gorjanc
Language	Croatian
Relation to curriculum	Master's degree programme.Elective.Semestar II.
Type of teaching, contact hours	Number of hours (in semester): 60 • Lectures:30 • Exercises (auditory, design, laboratory): 30
Workload	Lecture hours 30 Hours of exercise 30 Other contact hours 30 Self study hours 90
Credit points	6 ECTS
Requirements according to the examination regulations	• 100% attendance in lectures and exercises, • 2 projects, • 1 seminar paper, • 2 pre-exams.
Recommended prerequisites	• Familiarity with the basics of differential calculus and linear algebra.
Module objectives/intended learning outcomes	• Acquiring basic knowledge about differential geometry of curves and surfaces in Euclidean space, • Ability to solve tasks in differential geometry by using program Mathematica, • Knowledge about the properties of minimal surfaces, • The ability to apply the methods and content of differential geometry in civil engineering.
Content	• Lectures: 1. Curves in Euclidean space [8] 2. Surfaces in Euclidean space [10] 3. Curvatures of surfaces [6] 4. Mapping of surfaces [4] 5. Minimal surfaces [4]. • Exercises (constructive, in computer classroom): 1. Curves in Euclidean space [8] 2. Surfaces in Euclidean space [10] 3. Curvatures of surfaces [6] 4. Mapping of surfaces [4] 5. Minimal surfaces [4].
Study and examination requirements and forms of examination	• Written exam - minimum 60% score, • Oral exam, • Students who have achieved a positive grade in projects, seminar paper and pre-exam are exempt from written and oral exam.

Media employed	Whiteboard, projector
Reading list	Required literature: 1. I. Kamenarović, Diferencijalna geometrija, Sveučilište u Rijeci, Pedagoški fakultet, Rijeka, 1990, 2. J. Beban-Brkić: web-scrip:http://www.grad.hr/itproject_math/Links/jelena/index.html Optional literature: 1. Gray, A.: Modern Differential Geometry of Curves and Surfaces With Mathematica, CRS Press, Boston, London, 1998, 2. On-line Encyclopedia of mathematical concepts: MathWorldWolfram

THEORY AND MODELLING OF STURCTURES PROGRAMME

I. SEMESTER

Module name:	**Mathematics 3**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	21802
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	I (Winter)
Person responsible for the module	Tomislav Došlić, Alan Filipin
Lecturer	Nikola Adžaga, Rafael mrđen
Language	Croatian
Relation to curriculum	Master's degree programme for all engineering programmes. Compulsory elective. Semester I.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 45 • Exercises (auditory): 30
Workload	Lecture hours 45 Hours of exercise 15 Other contact hours 30 Self study hours 135
Credit points	7,5 ECTS
Requirements according to the examination regulations	• Regular attendance in lectures and exercises, • Minimum 25 % score in the pre-exam.
Recommended prerequisites	• Understanding the calculus of one and several variables, including ordinary differential equations, and basic linear algebra.
Module objectives/intended learning outcomes	• Understanding the conditions and limits of applicability of linear models, • Ability to recognize and choose a correct model, • Ability to solve (analytically and/or numerically) simple linear models.
Content	• Lectures: 1. Ordinary differential equations [3] 2. Fourier series [3] 3. Partial differential equations and linear models of mathematical physics [20] 4. Numerical methods for solutions of ordinary and partial differential equations [16] • Exercises (auditory) follow the lectures.
Study and examination requirements and forms of examination	• Minimum 50% score in the written exam, • Students passing the pre-exam take only the second part, • Oral exam.
Media employed	Whiteboard, projector
Reading list	Required literature: 1. T. Došlić, D. Pokaz: Matematika 3, available on the course web-page.

	2. T. Slijepčević-Manger: Zbirka zadataka iz Matematike 3, available on the course web-page. Optional literature: 1. E. Kreyszig: Advanced Engineering Mathematics, John Wiley and Sons Ltd., 1999, 2. F. Scheid: Numerical Analysis, Schaum's Outline Series in Mathematics, McGraw-Hill

Module name:	**Research methods**
Module level, if applicable	Master's Degree Programme
Code, if applicable	21822
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	I.(Winter)
Person responsible for the module	Anita Cerić
Lecturer	
Language	Croatian
Relation to curriculum	Master's degree programme. Compulsory for all subject areas at Graduation studies. Semestar I.
Type of teaching, contact hours	• Lectures: 15 • Seminars: Students are obliged to write a seminar paper on an assigned topic.
Workload	Lecture hours 15 Other contact hours 10 Self study hours 20
Credit points	1.5 ECTS
Requirements according to the examination regulations	Writing a seminar paper or a positively graded test.
Recommended prerequisites	
Module objectives/intended learning outcomes	• Collecting literature from different sources, • Defining the hypothesis, • Choosing an appropriate research method and methodology, • Using different techniques in data collection, • Writing essays, papers and reviews, • Presenting and discussing research findings.
Content	• Lectures: 1. Collecting literature and information 1 (2) 2. Role of hypothesis and general structure of the thesis 1 (1) 3. Writing papers, critiques and essays 2 (2) 4. Data collection 1 (1) 5. Research methodology 2 (1) 6. Research methods 3 (2) 7. Reporting the results 1 (2) 8. Citing references 2 (3) 9. Bibliography 1 (2) 10. Presentation skills 1 (1)
Study and examination requirements and forms of examination	• Written paper, • Written exam
Media employed	Whiteboard, projector
Reading list	Required literature: 1. Zelenika, R. Metodologija i tehnologija izrade znanstvenog i stručnog djela, Rijeka: Ekonomski fakultet Sveučilišta u Rijeci, 1999 (in Croatian) 2. Cerić, A., Textbook for Civil Engineering Students, 2012, (in Croatian) Optional literature:

	1. Fellows, R. And Liu, A., Research Methods for Construction, Oxford: The Blackwell Science, 1997 2. 2.Naoum, S.G., Dissertation Research and Writing for Construction Students, Oxford: ButterworthHeinemann, 2007

Module name:	**Mechanics of Materials**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	21862
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	I (Winter)
Person responsible for the module	Joško Krolo, Diana Šimić Penava
Lecturer	Janko Košćak, Ivan Duvnjak
Language	Croatian
Relation to curriculum	Master's Degree Programme. Construction Materials Programme. Compulsory. Semestar I.
Type of teaching, contact hours	Number of hours (in semester): • Lectures:30 • Exercises: 15 (auditory - 4, design - 11)
Workload	Lecture hours 30 Exercise hours 6 Experimental practice in laboratory hours 9 Other contact hours 10 Self study hours 80
Credit points	4,5 ECTS
Requirements according to the examination regulations	• Attending lectures and exercises, • One Colloquium: student should solve at least 25%, • Writing a seminar paper.
Recommended prerequisites	• Knowledge about differential and integral calculus. Knowledge about mechanics (statics and kinematics). Understanding the concepts of stress and strain. Knowledge about calculation stresses and strains in the elements loaded internal forces (longitudinal and transverse, to torque and bending moment).
Module objectives/intended learning outcomes	• Knowledge about strength, stiffness and stability of engineering structures. Dimensioning engineering structural members, • Ability to solve different engineering problems in the field of mechanics of body deformability, • Understanding the types of testing mechanical properties of materials, methods and standards for testing. • Understanding the structure of matter, structurally sensitive and insensitive properties, selective and additive theory, • Understanding and interpreting the method of determining the mechanical properties of materials, • Understanding the strength of materials under cyclic loading, • Identifying the meaning of rheology and fracture mechanics, • Understanding the concept of hardness of materials and test methods. • Understanding the manners of non-destructive testing of materials and applying them, • Applying the experimental stress and strain analysis in determining the physical and mechanical properties of materials.
Content	• Lectures:

	1. The impact of a construction material structure on mechanical properties of a material, probabilistic character of mechanical properties and sensitivity structure, the theory of selectivity and the theory of addition. 2. Modeling and measurement effect. Load, time temperature. Testing methodology, testing devices. Devices for strain measuring. Interpretation of testing results. Mechanical properties of material in static loads. Conventional work chart of a material in stretching and pressure. Characteristics of a material deformability. Ductility material. Brittle materials. 3. Real material chart. Anisotropy of mechanical properties. Idealization of work material chart. Elastoplastic material with strengthening ideally elastoplatic material, solid plastic material, solid and plastic material with reinforcement. 4. Impact of external factor on mechanical properties of material in static load. Backward stresses. Basic forms of material destruction in stretching and pressure. Long-term static loading. Statically durable strength of material. Creeping of material. Relaxation of stress. 5. Strength of material in dynamic loading. Types of dynamic loading. Impact strength of material ductility. External factors affecting the impact strenth of material. Testing procedures. Strength of material in cyclically changeable loading. 6. Fatigue in material. Determination of dynamic strength of material. The impact of factors on durable dynamic strength of material. Coefficient of safety and allowed stress. 7. Fracture mechanics and strength of material. Basic shapes of crack development. Stress intensity factor. Criteria of fracture. Ductility of fracture. Material sensitivity on cuts and cracks. 8. Rheological properties of material. Rheological condition equation of material. The principle of superposition of time and temperature. Rheological models. Hardness of material. Procedures of hardness testing: ripping, indenting and rebound. Hardness correlation of material and strength of material. • Exercises (auditory, design, laboratory): 1. Auditory– Strength of material in cyclically variable load. Fatigue of materials. Determination of the dynamic strength of materials. Fracture mechanics. The hardness of the material. Nondestructive testing. 2. Laboratory–σ-εdiagram under static and dynamic loading. Bauschingerov effect. Elastic hysteresis. Determination of the tensile strength of brittle materials. Testing of pressure. Effect of sample size on the strength of the material. Testing of shear. Bending test. Testing of alternate folding. Testing of twisting. Charpy impact strength and Föpplu. Fatigue of materials. Hardness: Martens, Brinell, Poldi, Schmidt hammer. Fracture mechanics. Acoustic procedures. Determination of stress in the wire.
Study and examination requirements and forms of examination	• The written part of the exam: at least 50%, • Oral exam.
Media employed	Whiteboard, projector
Reading list	Required literature: 1. J. Krolo, D. Šimić: Mehanika materijala, Sveučilište u Zagrebu, Građevinski fakultet, Zagreb, 2011. 2. Šimić, V.: Otpornost materijala II, Školska knjiga, Zagreb, 2002. Optional literature: 1. Bazjanac, D., Nauka o čvrstoći, Tehnička knjiga, Zagreb, 1973.

	2. Timošenko, S., Otpornost materijala II, Građevinska knjiga, Beograd, 1965. 3. Timošenko, S., Mechanics of Materials, Van Hostrand Reinhold Company, New York, 1972.

Module name:	**Nonlinear Analysis of Rod Structures**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	21863
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	I (Winter)
Person responsible for the module	Mladen Meštrović, Krešimir Fresl
Lecturer	Krešimir Fresl
Language	Croatian
Relation to curriculum	Master's degree programme. Theory and Modelling of Structures. Compulsory. Semestar I.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises: 15 (auditory – 10, design – 5)
Workload	Lecture hours 30 Exercises 15 Other contact hours 15 Self study hours 75
Credit points	4.5 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, • Solving various problems.
Recommended prerequisites	• Understanding and capability of applying equilibrium equations in 2D and 3D • Knowledge of basic theoretical methods of linear static analysis for determination reactions, internal forces and displacements on statically determinate and indeterminate structures, • Basic mathematical knowledge of differential equations.
Module objectives/intended learning outcomes	• Ability to solve nonlinear problems, • Understanding the nonlinearity of structures, • Ability to apply computational analysis of nonlinear problems in structural analysis.
Content	• Lectures: 1. Idealization in linear statics of bar structures [2] 2. Exact theory of geometry displacement and equilibrium on a deformed rod[2] 3. Relationships between linear and nonlinear theory [2] 4. Differential relations of forces and loadings in geometric nonlinearity [2] 5. Relations between forces and displacements of bar ends in geometric nonlinearity [2] 6. Equations of equilibrium knots [2] 7. The concept of imperfection, derivations and solutions of differential equations of bars [2] 8. Linearization of computation [2] 9. P-delta analysis [2] 10. Physical nonlinearity, basic concepts [2] 11. Idealization in material nonlinearity [2] 12. Approximation of physically nonlinear tasks [2] 13. General bilinear approximation [2]

	14. Interaction of internal forces in physical nonlinearity, simultaneous geometric and physical nonlinearity [2] 15. Iterative computation of bearing capacity by differential equations method, the general equation of a moment in plastic hinges [2]. • Exercises (auditory): 1. Idealization in linear statics of bar structures [2] 2. Realationships between linear and nonlinear theory, differential realtions of forces and loadings in geometric nonlinearity [4] 3. Realtions between forces and is placements of bar ends in geometric nonlinearity equations of equilibrium knots [2] 4. The concept of imperfection, derivations and solutions of differential equations of bars, linearization of computation, P-delta analysis [3] 5. Physical nonlinearity, basic concepts idealization in material nonlinearity [2] 6. Approximation of physically nonlinear tasks, general bilinear approximation [2]
Study and examination requirements and forms of examination	• Final seminar paper, • Oral exam.
Media employed	Whiteboard, projector
Reading list	Required literature: 1. H.Rothert, V.Gensichen: Nichtlineare Stabstatik, Springer, 1987, 2. M. Meštrović,mimeographed lecture notes, http://www.grad.hr/predmeti/nssk 3. K. Fresl: Bilješke s predavanja, http://master.grad.hr/nastava/gs

Module name:	**Experimental Methods 1**
Module level, if applicable	Master's Degree Programme
Code, if applicable	93346
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	I (Winter)
Person responsible for the module	Domagoj Damjanović
Lecturer	Janko Košćak
Language	Croatian
Relation to curriculum	Master degree programme, Theory and Modelling of Structuress, Compulsory, Semestar I.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises (auditory, laboratory): 30
Workload	Lecture hours 30 Exercise 30 Other contact hours 10 Self study hours 110
Credit points	6,0 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, • Writing a seminar paper.
Recommended prerequisites	• Knowledge about basic elements in statistics and probability theory, • Knowledge on data analysis and determination of basic statistical parameters, • Knowledge about calculation of stresses and strains caused by longitudinal and shear forces, torque and bending moment.
Module objectives/intended learning outcomes	• Determining measurement errors, the precision of equipment and measurement uncertainty, • Designing an experiment through basic stages of preparation, implementation and analysis of results, • Selecting the equipment and methodology for implementation of experimental research on structural materials, elements and structures, • Experimental determination of displacement, strain, banking, curvature and basic dynamic parameters, • Analysis of structures and structural elements using modern experimental techniques.
Content	• Lectures: 1. Introduction, historical overview of the development of metrology [2] 2. International and Croatian metrology infrastructure, standardization and norms [2] 3. Errors of measurement, measurement uncertainty, accuracy of measurement equipment [2] 4. The measurement of physical quantities, measurement systems and their characteristics [2] 5. Equipment and measurement methods of displacement and strain [2] 6. Equipment and methods for measuring force, pressure and temperature [2] 7. Methods of measurement on models and prototypes [2]

	8. Testing models and materials for manufacturing models [2] 9. Dimensional analysis [2] 10. Experimental determination of creep parameters, shrinkage and relaxation. [2] 11. Methods for determining residual stress and strain [2] 12. Instrumentation and methods of measurement during static or dynamic loading [2] 13. Experiments under static loading [2] 14. Experiments under dynamic loading [2] 15. Evaluation of real structures under loading [2]. • Exercises (laboratory): 1. Introduction to and an overview of measuring instrumentation and data acquisition systems [2] 2. Introduction to and an overview of testing machines and their software and data acquisition software [2], 3. Determination of measurement errors, measurement uncertainty for specific measurement instruments and systems [4], 4. Preparation of and testing models under static loading [6] 5. Preparation of and testing structural elements or structures under static loading [4] 6. Preparation of and testing models for testing under dynamic loading [6] 7. Preparation of and testing structural elements or structures under dynamic loading [4].
Study and examination requirements and forms of examination	• Written exam – minimum 50% score, • Oral exam.
Media employed	Whiteboard, projector
Reading list	Required literature: 1. Lj. Herceg, Eksperimentalne metode – mimeographed lecture notes,http://www.grad.unizg.hr/predmet/eksmet1_a 2. D. Damjanović: Eksperimentalne metode – lecture notes, http://www.grad.unizg.hr/predmet/eksmet1_a 3. J. Krolo, D. Šimić,Mehanika materijala, Sveučilište u Zagrebu, Građevinski fakultet, Zagreb,(Civil Engineering Faculty, Zagreb University), 2011 Optional literature: 1. A. Kiričenko et al., Mjerenje deformacija i analiza naprezanja konstrukcija, DIT-Zagreb, 1982 2. Thomas G. Beckwith, Roy D. Marangoni, John H. Lienhard,Mechanical measurements, AddisonWeslwy Publishing company, New York, 1995, 3. John P. Bentley,Principles of measurementsystems, Pearson education, Edinburgh, 1995 4. V. Brčić, R. Čukić, Eksperimentalne metode u projektiranju konstrukcija, Građ. knjiga, Beograd, 1988 5. Papoulis, A.,Probability, random variables and stohastic processes, McGraw-Hill, Singapore, 1987

Module name:	**Metal Structures 2**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	21785
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	I (Winter)
Person responsible for the module	Darko Dujmović
Lecturer	Ivan Lukačević, Davor Skejić
Language	Croatian
Relation to curriculum	Master degree programme, Structural Engineering, Compulsory. Semester I. Master degree programme, Theory and Modelling of Structures, Compulsory. Semester I. Master degree programme, Construction Materials, Elective. Semester III.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises (design): 30
Workload	(Estimated) workload divided into face-to-face teaching and independent study, in hours. (1ECTS is 30 hours) Lecture hours 30 Numerical exercises hours 30 Midterm written examination hours 2 Self study hours 112 Other contact hours 4 Final written and oral examination hours 2
Credit points	6 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, • Preparation of 9 program assignments, • Written pre-exam.
Recommended prerequisites	Basics of metal structures (undergraduate study).
Module objectives/intended learning outcomes	• Practical knowledge and skills required for the design of structural elements of steel structures and for the application of basic principles of conceptual design, • Analysing the action effects and combination of action for steel structures, • Identifying the advantages of steel in construction and stressing its potentials in thefuture, • Analysing and dimensioning structural elements of steel structures by using modern methods and the European standards criteria (EN).
Content	• Lectures: 1. Introduction [2] 2. Characteristics of steel structures [2] 3. Architecture and steel [2] 4. Economic parameters of steel constructions [2] 5. Basics of design procedure [2] 6. Actions on structures [2] 7. Beams subjected to bending and axial force [2]

	8. Uniform built-up compression members [2] 9. Fatigue – dimensioning [2] 10. Basic approaches of plasticity theory [2] 11. Cold-formed thin-walled structures [2] 12. Design of plate elements and welded plate girders [2] 13. Spatial structural systems [2] 14. Structural systems of multi-storey buildings [2] 15. Details in steel structures [2] • Design exercises: 1. Revision of the examples in design of tension members within the course Metal structures [2] 2. Revision of the examples in design of compression members within the course Metal structures [2] 3. Design examples of beams subjected to axial force and bending [4] 4. Design examples with uniform built-up compression members [4] 5. Fatigue design of steel members[4] 6. Examples of application of plastic theory [2] 7. Design examples with thin-walled structures [4] 8. Design examples with plate elements and girders [4] 9. Preliminary design of spatial structures[4].
Study and examination requirements and forms of examination	• Final written exam: numerical and theoretical tasks (minimum 50% score), • Oral exam.
Media employed	Whiteboard, projector
Reading list	Required literature: 1. Androić, B., Dujmović, D., Džeba, I.,Čelične konstrukcije 1, IA Projektiranje, Zagreb 2009., 2. Androić, B., Dujmović, D., Džeba, I.,Čelične konstrukcije 2, IA Projektiranje, Zagreb 2008., 3. Androić, B., Dujmović, D., Džeba, I.,Metalne konstrukcije 4, IA Projektiranje, Zagreb 2003., 4. Lecture notes. Optional literature: 1. Trahair, N.S., Bradford, M.A., Nethercot, D.A., Gardner, L.,The Behaviour and Design of Structures to EC 3, Taylor and Francis, London 2008 2. Beg, D., Kuhlmann, U., Davaine, L.; Braun, B.,Design of Plated Structures, Ernst und Sohn, Berlin 2011

II. SEMESTER

Module name:	**Theory of Elasticity and Plasticity**
Module level, if applicable	Master's Degree Programme
Code, if applicable	96426
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	II (Summer)
Person responsible for the module	Domagoj Damjanović, Ivan Duvnjak
Lecturer	
Language	Croatian
Relation to curriculum	Master's degree programme, Theora and Modelling of Structures Compulsory, Semestar II.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 45 • Exercises (auditory): 30
Workload	Lecture hours 45 Exercise 30 Other contact hours 10 Self study hours 140
Credit points	7,5 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, • Writing a seminar paper.
Recommended prerequisites	• Knowledge about differential and integral mathematics, partial differential equations, vectors and tensors analysis, • Good knowledge on general theoretical mechanics and numerical mathematics, • Knowledge about static, dynamic and strength of materials theory.
Module objectives/intended learning outcomes	• Recognizing appropriate boundary value problems of the theory of elasticity and plasticity, • Explaining differential equations of equilibrium and compatibility in stress and strain analysis, • Adequate formulation of boundary value problem. Solving problems using displacements or stress components, • Choosing the optimal method for solving appropriate boundary value problems, • Understanding the methods for solving boundary value problems in 2D and 3D region. • Understanding the behavior law of materials in elastic and plastic region.
Content	• Lectures: 1. Vector and tensor analysis[6] 2. Deforming models of material continuum [3] 3. Finite deformation tensors and infinitesimal deformation tensors [6] 4. External and internal forces on solids, stress tensor and its properties [6] 5. Thermodynamics of real solids, constitutive equations – general Hooke's low [3]

	6. Definition, formulation and solution of boundary value problems using displacement or stress components[3] 7. Virtual work equations and energy principles[3] 8. Analitical and numerical methods for solving problem in theory of elasticity [3] 9. Plane problems, Airy's function, harmonic and biharmonic functions [3] 10. 3D problems of the theory of elasticity (torsion, thin plates, infinite solid and semi-infinite solid) [3] 11. Introduction to plasticity, yield criteria, plasticity parameters [3] 12. Viscoelastic and viscoplastic models of materials, creep and relaxation [3]. Exercises (auditory): 1. Transformations of vectors and tensors, principal stress and principal strains [4] 2. Analitical and numerical methods for solving boundary value problems (Ritz method, Galerkin's, finite elements, finite differences, Fourier's series and complex-variable methods [12] 3. Solving plane problems, Airy's function, polynoms and infinite series [4] 4. Solving 3D problems (torsion of beams, thin plates and semi-infinite solid) [4] 5. Solving plastic problems, creep and relaxations [4].
Study and examination requirements and forms of examination	• Seminar paper, written and oral exam.
Media employed	Whiteboard, projector
Reading list	Required literature: 1. M. Rak,Teorija elastičnosti i plastičnosti (http://www.grad.unizg.hr) Optional literature: 2. T. Herman,Teorija elastičnosti iplastičnosti, Element, Zagreb, 2008 3. Z Kostrenčić,Teorija elastičnosti, Školska knjiga, Zagreb, 1982 4. S Timošenko, J.Gudier,Teorija elastičnosti, Građevinska knjiga, Beograd, 1962 5. I. Alfirević,Uvod u tenzore i mehaniku kontinuuma, Golden marketing, Zagreb, 2006 6. J. Brnić,Elastomehanika i plastomehanika, Školska knjiga, Zagreb, 1996 7. G.E. Mase,Theory and Problems of Continuum Mechanics, McGrow-Hill Company, 1970 8. Y.A. Amanzade,Theory of Elasticity, MIR, Publishers Moscow, 1979

Module name:	**Dynamics of Structures and Earthquake Engineering**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	93347
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	II (Summer)
Person responsible for the module	Damir Lazarević
Lecturer	Marija Demšić, Marta Šavor Novak
Language	Croatian
Relation to curriculum	Master's Degree Programme. Theory and Modeling Structures. Compulsory. Semester II.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 45 • Exercises: 30 (auditory - 15, construction – 6, design - 9)
Workload	Lecture hours 45 Hours of exercise 30 Other contact hours 45 Self study hours 105
Credit points	7,5 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, • Soving 3 program assignments, • 1 pre-exam, minimum 25% score, or a make up exam.
Recommended prerequisites	• Competence in basic differential equation solving procedures, • Competence in the basics of computer engineering (Sage program software or the like), • Understanding the calculation procedures for statically determinate and indeterminate structures.
Module objectives/intended learning outcomes	• Recognizing and understanding the problems related to various dynamic actions on buildings, • Applying knowledge on selection procedures of mathematical models for dynamic calculus of a structure: selection of degrees of freedom in dynamic systems, analysis of mass, rigidity and flexibility, • Applying knowledge on maths in solving problems of own a shapes and frequencies, • Applying the calculus of system response with more degrees of freed on to the effect of the known dynamic load, • Understanding and application of spectrum calculus for frameworks and buildings related to earthquake effects, • Applying software to calculate response to structure action.
Content	• Lectures: 1. Simple harmonic oscillator, an overview of theory for free and forced vibration response with and without damping. Types of dynamic loadings in structural engineering: earthquake, wind, waves, explosions, machine operation [3] 2. Occurrence and effect of resonance. Duhamel integral. Response spectrum function [2] 3. Generalized system with one degree of freedom. Energy approach [2]

	4. Finite degrees of freedom systems vibration. Definition of coordinates (discrete, generalized), static condensation of system, matrix formulation of motion equations, influence of axial forces on dynamical characteristics of system (use of computer software)[4] 5. Generalized coordinates and Hamilton's principle in forming Lagrange's equations of motion[3] 6. Free-vibration systems with finite degree of freedom, solution of eigenvalue problem, eigenvectors orthogonality and normal coordinates. Matrix iteration methods[6] 7. Dynamic response of finite degree of freedom system using modal superposition method. Buildings with symmetric and irregular plan disposition[2] 8. Dynamic response of finite degree of freedom system using step by step methods, use of accelogrammes for determining earthquake load[4] 9. Spectral analysis of buildings[2] 10. Dynamics of engineering objects. Application of finite element method[2] 11. Dynamic response of distributed mass systems (bending and axial deformations of a beam). Free-vibrations of plates, beams, console and a frame[4] 12. Nonlinear vibrations. Sources of system nonlinearity. Mathematical modeling and determination of numerical solution using Runge-Kutta method (simple pendulum, Duffing equation). Parametric vibration[3] 13. Earthquake phenomenon, seismic zones and fundamentals of earthquake load, response spectrum functions, equivalent static load[2] 14. Basic rules and principles of earthquake building design in seismically active area[2] 15. Wind and earthquake: corresponding regulations and the application of design rules [3]. • Exercises (auditory): 1. One degree of freedom systems, definition of system mass, rigidly and flexibility[2] 2. Free-vibration response of one degree of freedom system with and without damping[2] 3. Forced-vibration response of one degree of freedom systems. Force transmission and vibration Isolation[2] 4. Rayleigh method. Symmetry in multidegree of freedom systems[2] 5. Free-vibration response of multi degree of freedom systems. Analysis of vibration mode shapes and vibration frequencies[3] 6. Forced vibrations of multi degree of freedom systems[2] 7. Distributed parameter systems response [2]. • Exercises (construction): 1. Multi degree of freedom system in plane examples of modeling [2] 2. Multi degree of freedom system in plane modeling by computer applications [4] • Exercises (design): 1. Response spectrum creating. Response spectrum analysis of plane frame[4] 2. Modeling and response spectrum analysis of multi story buildings with symmetric and unsymmetrical plan [5].

Study and examination requirements and forms of examination	• Seminar paper, • Written exam, • Oral exam.
Media employed	Whiteboard, projector
Reading list	Required literature: 1. A.Mihanović, Dinamika konstrukcija, Građevinski fakultet Sveučilišta u Splitu (Faculty of Civil Engineering, Split), 2. V.Raduka: Lecture notes, accessible online. Optional literature: 1. A.K.Chopra, Dynamics of Structures, Theory and Application to Earthquake Engineering, Prentice Hall, 1995, 2. W. Clough, J. Penzien: Dynamics of Structures, McGraw-Hill, 1993

Module name:	**Finite Element Method**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	93348
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	II (Winter)
Person responsible for the module	Mladen Meštrović
Lecturer	
Language	Croatian
Relation to curriculum	Master's degree programme. Theory and Modelling of Structure. Elective. Semestar II.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises: 30 (auditory - 10, design - 20)
Workload	Lecture hours 30 Exercises 15 Other contact hours 30 Self study hours 105
Credit points	6 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, • Solving different problems.
Recommended prerequisites	• Understanding and ability to apply equilibrium equations in 2D and 3D, • Knowledge about the basic theoretical methods of linear elasticity, • Basic mathematical knowledge about the principle of virtual work and variational methods, • Basic mathematical knowledge about partial differential equations.
Module objectives/intended learning outcomes	• Understanding the approach to solving structural problems with FEM, • Understanding computation with standard software packages, • Knowledge about the application of FEM for computational analysis in structural analysis.
Content	• Lectures: 1. Numerical integration, 1D and 2D [2] 2. Solving system of linear equations, banded[2] 3. Optimization of discretization[2] 4. Basic equation of elasticity, variational formulation [4] 5. Rod finite element[2] 6. Beam finite element, application on [4] 7. Shell elements[4] 8. Plate elements [4] 9. Elements for heat equation, critical force and freqencies [4] 10. About error of FEM [2]. • Exercises (auditory, design, laboratory): 1. Numerical integration, 1D and 2D[2], 2. Solving system of linear equations, banded matrices [4] 3. Rod finite element [4] 4. Beam finite element, application on frames[4] 5. Shell elements [6] 6. Plate elements [6]

	7. Elements for heat equation, critical force and frequencies [4].
Study and examination requirements and forms of examination	• Final seminar paper, • Oral exam.
Media employed	Whiteboard, projector
Reading list	Required literature: 1. R.D. Cook, D.S. Malkus, M.E. Plesha, R.J. Witt, Concepts and Applications of Finite Element Analysis, 4th Edition, John Wiley & sons, 2001 2. T.J.R. Hughes, The Finite Element Method: linear Static and Dynamic Analysis, Dover, 2000 3. W.B. Kraetzig, Y.Basar,Tragwerke 3, Theorie und Anwendung der Methode der Finiten Elemente, Springer, 1997 4. H.Werkle: Finite elemente in der Baustatik, Vieweg, 1995 5. J. Sorić: Metoda konačnih elemenata, Golden Marketing-Tehnička knjiga, 2004 6. M. Meštrović: Mimeographed lecture notes, http://www.grad.hr/predmeti/mke

Module name:	**Theory of Composites**
Module level, if applicable	Master's Degree Programme
Code, if applicable	21867
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	II (Summer)
Person responsible for the module	Joško Krolo, Ana Skender
Lecturer	Ana Skender
Language	Croatian
Relation to curriculum	Master degree programme, Theory and Modelling of Structuress, Compulsory, Semestar II.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises (auditory, design, laboratory):15 • Pre-exams:3
Workload	Lecture hours: 30 Hours of laboratories or skills: 15 Face-to-face teaching: 10 Independent study: 80
Credit points	4,5 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, • Pre-exam, • Seminar paper.
Recommended prerequisites	• Familiarity with specific literature, prior knowledge of Strength of materials, skills or participation in preparatory modules.
Module objectives/intended learning outcomes	• Understanding the role of constituents in overall response of lamina (micromechanics) and how a set of laminae with different configurations affect the overall properties and response of laminates (macro mechanics). Students will be able to apply these concepts to analyze and design composite structures for engineering applications.
Content	• Lectures: 1. Introduction to composite materials: matrix and reinforcement [6] 2. Polymer matrix composites [3] 3. Micromechanical Analysis of a Lamina: Rule of Mixtures, Halphin-Tsai expressions and elasticity approach [3] 4. Macro mechanical Analysis of a Lamina [3] 5. Macro mechanical Analysis of Laminates: A, B and D matrices [3] 6. Macro mechanical Analysis of Laminates: different cases of laminates[4] 7. Failure, Analysis and Design of Laminates [8] • Exercises (auditory, design, laboratory): 1. Auditory exercises following lectures • Seminar: 1. Design of a laminate.
Study and examination requirements and forms of examination	• Written and/or oral final exam.
Media employed	Whiteboard, projector

Reading list	Required literature: 1. Kollár, L. P.; Springer, G. S.,Mechanics of Composite Structures, Cambridge University Press, 2003, 2. Kaw, A. K.,Mechanics of Composite Materials, 2nd edn, CRC Press, Taylor & Francis Group, 2006, 3. Smojver, I., Mechanics of Composite Materials, Faculty of Mechanical Engineering and Naval Architecture, Zagreb, 2006 Optional literature: 1. Šimunić, Ž.: Polymers in Civil Engineering, University of Zagreb, Faculty of Civil Engineering, Zagreb,2006

Module name:	**Concrete and Masonry Structures 2**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	59832
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	II (Summer)
Person responsible for the module	Tomislav Kišiček
Lecturer	Nikola Perković, Tvrtko Renić, Martina Carić
Language	Croatian, English,
Relation to curriculum	Master degree programme, Theory and Modelling of Structuress, Compulsory, Semestar II.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises: 15 (auditory - 9, design - 6)
Workload	Lecture hours 30 Hours of laboratories or skills Exercise 30 Other contact hours 20 Self study hours 55
Credit points	4,5 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, • Developing a program, • Two pre-exams, minimum 25% score required one make up exam.
Recommended prerequisites	• Theoretical and practical knowledge about the basics of the dimensioning reinforced concrete and masonry elements and structures.
Module objectives/intended learning outcomes	• Knowledge and skills necessary for designing structural elements of reinforced and masonry structures, • Knowledge and skills necessary for application of basic principles of conceptual design, • Ability to analyze the behaviour of structural elements and bearing systems made of reinforced concrete and masonry structures and ability to dimension them according to the ultimate bearing resistance states and usability, • Ability to analyze structural elements of reinforced concrete and masonry structures using contemporary methods and European standards.
Content	• Lectures: 1. Revision of masonry structures from undergraduate course Concrete and masonry structures. Structural details of masonry (beginning), [2] 2. Types of walls, thickness and bonds. Reinforcement details. Connecting walls. Wall niches and channels. Thermal and long-term displacements. Walls in the ground. Calculus examples. Bricklaying. Materials and their storage. Preparation of mortar and filling concrete. Making masonry and concreting the fill. Construction of newly constructed wall. Permitted deviations from the designed values. Masonry control categories. Other structural measures at masonry. Fixing equipment on masonry [2] 3. Masonry in buildings in seismic areas. Materials and masonry bond. Performance rules. Special rules for simple buildings [2] 4. Masonry buildings in seismic areas (continued). Calculus models. Calculus examples. Simple rules for calculating masonry buildings [2]

	5. Rules for seismic areas. Stability and robustness. Loads, strengths and limitation of dimensions. Wall thickness. Rules for stiffening walls, wall columns and chimneys. Walls exposed mainly to wind load. Non-bearing interior walls. Wall niches and channels. Outer walls of one-storey houses and fittings. Simplified calculus procedures and simple rules for masonry buildings. Calculus examples. Strengthening of masonry. Buildings damaged by an earthquake [2] 6. Building heritage. Connection of masonry structure elements. Investigation work. Strengthening of masonry buildings. Calculus examples [2] 7. Introduction to new European standards EN 1996 and EN 1998 (relating to masonry structures). Masonry structures under fire. (1st pre-exam: Masonry structures – bearing capacity of masonry on the force of earthquake) [2] 8. Revision of concrete structures in the undergraduate course Concrete and masonry structures. Connection of boards and beams. Beams of variable height. Limit states of usability. Creep and shrinkage of concrete [2] 9. Deflections in concrete slabs and beams. Calculation of deflection according to EC2 [2], 10. Cracks. Minimal reinforcement of slabs and beams for limiting cracks. Calculus of cracks according to EC2 [2] 11. Breach. Torsion of reinforced concrete section. Wall brackets. (2nd pre-exam: concrete structures – calculus of cracks and deflection of a reinforced concrete slab) [2] 12. Slender columns. Elements under longitudinal force and bending moment[2] • Exercises (auditory, design: 1. Introduction to the exercise curriculum. Introduction to the task and its execution. Definition of a bearing structure on a building and the analysis of the impact on the structure and marking respective positions which are to be calculated (auditory) [1] 2. Calculation of Fert ceilings and reinforced roof rafters (auditory) [1] 3. Calculation of staircases with the elaborate of reinforcement (auditory) [1] 4. Design exercise [1] 5. Calculation of reinforced concrete slab for a typical storey, bearing in two directions. Slab modeling by computer software. Developing the details of reinforcing ceilings and connection with tie beams (auditory) [1] 6. Ceiling beam calculation in a typical storey (auditory) [1] 7. Design exercise [1] 8. Calculation of vertical and horizontal loads on masonry due to wind pressure perpendicular to the wall (auditory) [1] 9. Introduction to the seismic analysis of buildings. Seismic analysis of a building and calculation of relevant seismic impacts on masonry for various types of masonry (confined and reinforced), (auditory) [1] 10. Design exercise [1] 11. Calculation of resistance of walls to horizontal action on the wall plane (auditory) [1] 12. Design exercise [1] 13. Calculation of vertical and horizontal load on masonry in basements, calculation of

	foundations (auditory) [1] 14. Design exercise [1] 15. Design exercise [1].
Study and examination requirements and forms of examination	• Written exam – minimum 55% score, • Oral exam.
Media employed	Whiteboard, projector
Reading list	Required literature: 1. SorićZ., Kišiček T., Betonske konstrukcije 2. Projektiranje betonskih konstrukcija prema europskim normama EN, Građevinskog fakulteta Sveučilišta u Zagrebu, Zagreb, 2012, mimeographed lecture notes, Faculty of Civil Engineering, Zagreb 2. Sorić Z., Kišiček T., Galić J., Betonske i zidane konstrukcije 2 – Betonske konstrukcije prema EC2 – 2. dio, skripta Građevinskog fakulteta Sveučilišta u Zagrebu, 308 str., Zagreb, 2009, 2010, 2011, mimeographed lecture notes, Faculty of Civil Engineering, Zagreb, 3. SorićZ., Betonske konstrukcije 1. Betonske konstrukcije prema Europskoj prednormi (HRN ENV 1992-1-1), 220 pp., Zagreb 2010, 4. Sorić Z.; Kišiček T., Betonske konstrukcije 1. Projektiranje betonskih konstrukcija prema europskim normama EN, 324 str., Zagreb 2010,2011, 5. Sorić Z., Zidane konstrukcije I, (second edition), Zagreb, April, 2004, 6. Sorić Z. Betonske i zidane konstrukcije 2 – Zidane konstrukcije, mimeographed lecture notes, Građevinskog fakulteta Sveučilišta u Zagrebu, 2008, 2009, 2010, or 2011, 7. Sorić Z.,Betonske i zidane konstrukcije 1 – Zidane konstrukcije, mimeographed lecture notes, Građevinskog fakulteta Sveučilišta u Zagrebu, 2008, 2009, 2010 or 2011, Faculty of Civil Engineering, Zagreb, 8. SorićZ.,Zidane konstrukcije, 11. poglavlje – Projektiranje zidanih konstrukcija prema europskim normama EN, 177 pp., Zagreb 2009, 2010, 2011

III. SEMESTER

Module name:	**Space Structures**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	104128
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	III (Winter)
Person responsible for the module	Damir Lazarević, Josip Atalić
Lecturer	
Language	Croatian
Relation to curriculum	Master's degree programm. Theory and Modelling of Structure. Compulsory. Semestar III.
Type of teaching, contact hours	Number of hours (in semester): • Lectures:30 • Exercises (design):30
Workload	Lecture hours 30 Hours of computer research 30 Other contact hours 15 Self study hours 105
Credit points	6 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, • Completion of homework assignment, • Completion of term project.
Recommended prerequisites	• Knowledge about differential and integral calculus (including ordinary and partial differential equations) and linear algebra, • Knowledge about analytical and numerical linear analysis procedures for frame structures, • Understanding fundamental components of boundary value problems (continuum, geometric equations, equilibrium equations, constitutive laws and boundary conditions).
Module objectives/intended learning outcomes	• Applying principles of engineering and continuum mechanics, • Applying knowledge related to technical and engineering informatics, • Understanding load-bearing capacity principles of space structures, • Designing static systems of space structures with large spans, • Implementing structural analysis procedures, • Creating suitable numerical models, • Evaluating the results of structural analyses, • Understanding scientific and professional literature in the field of structural analysis.
Content	• Lectures: 1. Structural achievements and design principles throughout history [1] 2. Mathematical models of structural systems – set of necessary approximations [2] 3. Methods for solving boundary value problems [1] 4. Strong formulation [1] 5. Weak formulation [2]

	6. Approximation of displacement function [2] 7. Week formulation in discrete form [1] 8. Rayleigh – Ritz method [2] 9. Some problems of finite element method [2] 10. Verification of numerical analyses [2] 11. Errors in the creation of numerical models and their analysis [2] 12. Kinematic constraints [2] 13. Grillage structures [2] 14. Plates [2] 15. Wall girders [2] 16. Folded structures [2] 17. Shells [2]. • Exercises (design): 1. Modeling frame elements [2] 2. Types of area elements in numerical models [2] 3. Application of frame and (or) area elements [2] 4. Modeling of plates [6] 5. Modeling of wall girders [2] 6. Soil interaction [2] 7. Modeling of solid elements [2] 8. Modellng of folded structures [2] 9. Modeling of domes [2] 10. Modelling of silos [2] 11. Modeling of light weight structures [2] 12. Structural design report [4].
Study and examination requirements and forms of examination	• Oral exam.
Media employed	Whiteboard, projector
Reading list	Required literature: 1. Lazarević D., Dvornik J. Plošni nosači, lecture notes 2. http://www.grad.unizg.hr/predmet/plonos/predavanja 3. Timošenko S., Woinowsky–Krieger S.,Teorija ploča i ljuski, Građevinska knjiga, Beograd, 1962 4. Girkman K., Površinski sistemi nosača, Građevinska knjiga, Beograd, 1965 5. Salvadori M.,Nosive konstrukcije u arhitekturi, UPI-2M, Zagreb, 1995 6. Senjanović I.,Teorija ploča i ljuski, Sveučilišna naklada Liber, Zagreb, 1973 Optional literature: 1. Sorić J.,Metoda konačnih elemenata, Golden Marketing, Tehnička knjiga, Zagreb, 2004, 2. Gordon J. E., Structures, or why things don't fall down, Da Capo Press, Inc, New York 1978, 3. Gordon J. E., The New Science of Strong Materials, or Why You Don't Fall through the Floor, second edition, Princeton University Press, Princeton, 1988

Module name:	**Structural Testings**
Module level, if applicable	Master's Degree Programme
Code, if applicable	104129
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	III (Winter)
Person responsible for the module	Domagoj Damjanović
Lecturer	Marko Bartolac, Janko Košćak
Language	Croatian
Relation to curriculum	Master's degree programme. Theory and Modelling of Structures. Compulsory. Semestar III.
Type of teaching, contact hours	Number of hours (in semester): • Lectures:30 • Exercises (laboratory): 30
Workload	Lecture hours 30 Exercise 30 Other contact hours 10 Self study hours 110
Credit points	6,0 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, • Writing a seminar paper.
Recommended prerequisites	• Knowledge about procedures for calculating the internal forces, • Knowledge about calculation of stresses and strains caused by longitudinal and shear forces, torque and bending moment, • Knowledge about basic analysis methods and dimensioning of structures (concrete, metal, wood).
Module objectives/intended learning outcomes	• Analysis of structures and structural elements based on experimental testing results, • Understanding the behavior of structures under static and dynamic loading, environmental influences and rheological changes in materials, • Selection and application of equipment, procedures and methods for structural testing, • Planning procedures for determination of structural safety, • Validation of structures and structural elements based on experimental results of testing, • Evaluating the ability of structure to carry the loading anticipated by design, • Using and applying standards in testing of materials, structural elements and structures.
Content	• Lectures: 1. Introduction. Purpose of structural testing. Classification of test research and investigation. Inspection. Laboratory. Statics and dynamics. Short term and long term testing [2] 2. Mechanical and geometric parameters measured during structural testing. Absolute displacement of structural point. Change in the distance of structural points (strain). Banking angle. Curvature [2]

	3. Measuring mechanical and geometric parameters. Equipment and tools. Augmentation. Precision. Reliability. Hysteresis. Sensitivity. Measurement range. Errors [2] 4. Measuring equipment for mechanical and geometric parameters. Displacement. Strain. Banking. Curvature. Force. Calibration [2] 5. Strain measurement. Types of sensors: mechanical, optical and mechanical, optical, acoustic, electric [2] 6. Electrical resistance strain gauges. Types. Installation and connection. Measuring instruments. Temperature compensation Devices for force measurement [2] 7. Measuring strain and analysis of plane state stress. Uniaxial stress state. Biaxial stress state. Biaxial stress state with known major directions of stress. General biaxial stress state. Rosette. Triaxial strain and stress state [2] 8. Analysis of strain and stress of structures and structural elements. Photoelasticimetry. Moire method. Procedure with brittle coating [2] 9. Analysis of strain and stress of structures and structural elements. Geodesic surveys. Modelling [2] 10. Determination of mechanical parameters of materials of existing structures. Ultrasound. Sclerometer. Radiographic recording. Drilling cores [2] 11. Static testing of structures. Design. Implementation [2] 12. Static testing of structures. Modes of loading. Result evaluation. Norms and conditions of structure validity [2] 13. Dynamic testing of structures. Design. Implementation. Modes of loading and measured parameters [2] 14. Dynamic testing of structures. Dynamic parameters. Experimental modal analysis. Results evaluation [4]. • Exercises (laboratory): 1. Presentation and overview of instruments for static and dynamic testing[2] 2. Measuring the same value using mechanical portable comparator (determining the accuracy of the instrument). Calibrating load cell (determining the constants of the instrument). Calibrating LVDT for displacement measurements(determination of the constant of the instrument) [4] 3. Strain and deflection measurement on truss model [2] 4. Strain and deflection measurement on model of wall with opening [2] 5. Photo elasticity method [2] 6. Vibration measurement [2] 7. Demonstration and presentation of static testing of structural elements and models of structures [4] 8. Demonstration and presentation of dynamic testing of structural elements and models of structures [4] 9. Modal analysis and determination of modal parameters [4] 10. Testing of real structure (in field) or visit to a structure that has a permanent monitoring system installed [2]
Study and examination requirements and forms of examination	• Written exam – minimum 50% score, • Oral exam.
Media employed	Whiteboard, projector
Reading list	Required literature: 1. Lj. Herceg,Ispitivanje konstrukcija – mimeographed lecture notes, http://www.grad.unizg.hr/predmet/ispkon

	2. D. Damjanović,Ispitivanje konstrukcija – lecture notes, http://www.grad.unizg.hr/predmet/ispkon 3. A. Kiričenko et al., Mjerenje deformacija i analiza naprezanja konstrukcija, DIT-Zagreb, Zagreb, 1982, 4. D. Aničić,Ispitivanje konstrukcija, Osijek, 2002 Optional literature: J. Krolo, D. Šimić,Mehanika materijala, Sveučilište u Zagrebu, Građevinski fakultet, Faculty of Engineering, Zagreb, 2011, I. Alfirević, S. Jecić,Fotoelasticimetrija, Liber, Zagreb, 1983, V. Brčić, R. Čukić, Eksperimentalne metode u projektiranju konstrukcija, Građ. knjiga, Beograd, 1988, Thomas G. Beckwith, Roy D. Marangoni, John H. Lienhard,Mechanical measurements, AddisonWeslwy Publishing company, New York, 1995

Module name:	**Methods of Theory of Elasticity and Plasticity**
Module level, if applicable	Master's' Degree Programme
Code, if applicable	104130
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	III (Winter)
Person responsible for the module	Domagoj Damjanović
Lecturer	Ivan Duvnjak, Marina Frančić Smrkić
Language	Croatian
Relation to curriculum	Master's degree programme. Theory and Modelling of Structure. Elective. Semestar III.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises (auditory): 15
Workload	Lecture hours 30 Exercise 15 Other contact hours 10 Self study hours 80
Credit points	4,5 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, • Seminar paper.
Recommended prerequisites	• Knowledge about differential and integral mathematics, partial differential equations, vectors and tensors analysis, • Good knowledge on general theoretical mechanics and numerical mathematics, • Knowledge about statics, dynamics and strength of materials theory.
Module objectives/intended learning outcomes	• Recognizing appropriate boundary value problems of the theory of elasticity and plasticity, • Appropriate formulation of boundary value problem. Solving problems using displacements or stress components, • Understanding analytical and numerical methods in the theory of elasticity and plasticity, • Choosing optimal methods for solving appropriate boundary value problems, • Application methods for solving boundary value problems in 2D and 3D region.
Content	• Lectures: 1. External and internal forces on solid, stress and strain tensors with properties [3] 2. Differential equations in theory of elasticity and their solving. [3] 3. Definition, formulation and solution of boundary value problems using displacement or stress components [3] 4. Virtual work equations and energy principles [3] 5. Analytical and numerical methods for solving problem in theory of elasticity [6] 6. Plane problems, Airy's function, harmonic and biharmonic functions [3] 7. 3D problems of the theory of elasticity (torsion, thin plates, infinite solid and semi-infinite solid) [6]

	8. Methods of solving boundary value problems in plasticity (creep and relaxations) [3]. • Exercises (auditory): 1. Determination of principal stress and strains and their directions [2] 2. Analytical and numerical methods for solving boundary value problems (Ritz method, Galerkin's, finite-elements, finite-differences, Fourier's series and complex-variable methods [4] 3. Solving plane problems, Airy's function, polynoms and infinite series [3] 4. Solving 3D problems (torsion of beams, thin plates and semi-infinite solid) [4] 5. Solving plastic problems, creep and relaxations [2].
Study and examination requirements and forms of examination	• Seminar paper, • Oral exam.
Media employed	Whiteboard, projector
Reading list	Required literature: 1. M. Rak, Metode teorije elastičnosti i plastičnosti (http://www.grad.unizg.hr) Optional literature: 1. T. Herman,Teorija elastičnosti i plastičnosti, Element, Zagreb, 2008 2. Z Kostrenčić, Teorija elastičnosti, Školska knjiga, Zagreb, 1982 3. S Timošenko, J.Gudier,Teorija elastičnosti, Građevinska knjiga, Beograd, 1962 5. I. Alfirević,Uvod u tenzore i mehaniku kontinuuma, Golden marketing, Zagreb, 2006 6. J. Brnić,Elastomehanika i plastomehanika, Školska knjiga, Zagreb, 1996 7. G.E. Mase,Theory and Problems of Continuum Mechanics, McGrow-Hill Company, 1970

Module name:	**Polymers**
Module level, if applicable	Master's Degree Programme
Code, if applicable	21875
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	III (Winter)
Person responsible for the module	Ana Skender
Lecturer	
Language	Croatian
Relation to curriculum	Master's degree programme. Theory and Modelling of Structure. Elective. Semestar III.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises: 9 • Midterm exams: 3 • Field trip: 3
Workload	Lecture hours: 30 Hours of laboratories or skills: 15 Face-to-face teaching: 10 Independent study: 80
Credit points	4,5 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, • Pre-exam.
Recommended prerequisites	• Familiarity with specific literature, prior knowledge of Strength of materials, skills or participation in preparatory modules.
Module objectives/intended learning outcomes	• Knowledge about basic types of polymeric materials and their properties as well as appropriate production processes, • Understanding the advantages of using polymeric materials and composites in civil engineering over conventional materials; • Learning about different application areas of polymeric materials and composites in civil engineering with the emphasis on bridge construction; • Learning about the principles of quality control and certification of structural elements based on examples like structural bearings and expansion joints.
Content	• Lectures: 1. General information on polymers: history; polymeric materials in civil engineering; composition; procedures of polymers: polymerisation, polycondensation, polyaddition, combined procedures; classification of polymeric materials on the basis of physical properties, conditions of processing, application [3] 2. Major types of polymeric materials in construction of buildings[3] 3. Processing: vulcanisation; extrusion; calendaring; pouring; pressing; sintering; blowing; laminating; rolling; injection [3] 4. Properties. Mechanical properties: static and dynamic load; long-term and short-term load; fatigue; temperature depended properties; residual stresses and brittle fracture; permanent deformations; boundary states at

	unidirectional and multidirectional stresses; time depended properties; theory of linear and non-linear viscoelasticity; rheological models; testing procedures. Non-mechanical properties: density, thermal properties, diffusion, electrical properties, chemical resistance, toxicity, optical properties, resistance to biological influences. Testing procedures. Ageing. Characteristics under fire. Bonding [3] 5. Reinforced polymeric materials: types; properties; production [3] 6. Foam polymeric materials: types; properties; production [3] 7. Application of polymeric materials in civil engineering: wall and roof elements; pipes and fitting elements; domes, shells and membranes; geosynthetic materials; sandwich elements; polymeric mortars and concretes; surface protection; waterproofing; environmental protection; supports; sealings; vibration and earthquake resistant isolation; design, production and installation. Polymeric materials in structure repair and maintenance [9] 8. Quality control of polymeric products in civil engineering [3]. • Exercises (auditory, design, laboratory): 1. Experimental testing of polymeric materials and structural elements. • Field trip: 1. Visiting companies that produce polymeric materials and composites used in civil engineering.
Study and examination requirements and forms of examination	written and/or oral final exam
Media employed	Whiteboard, projector
Reading list	Required literature: 1. Ž. Šimunić, Polymers in Civil Engineering, University of Zagreb, Faculty of Civil Engineering, Zagreb, 2006 2. Ž. Šimunić, A. Dolanjski, Elastomeric bearings, University of Zagreb, Faculty of Civil Engineering, Zagreb, 2007 Optional literature: 1. N.G. McCrum, C. P. Buckley, B. Bucknall, Principles of Polymer Engineering, 2nd ed., Oxford University Press, New York, 1997, 2. F. Naeim, F.,J. Kelly, Design of Seismic Isolated Structures, Wiley & Sons, Inc., New York, 1999

Module name:	**Basis of Fracture Mechanics**
Module level, if applicable	Master’s Degree Programmes
Code, if applicable	104132
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	III (Winter)
Person responsible for the module	Joško Krolo, Marko Bartolac
Lecturer	Janko Košćak
Language	Croatian
Relation to curriculum	Master’s degree programme. Theory and Modelling of Structure. Elective. Semestar III.
Type of teaching, contact hours	Number of hours (in semester): Lectures: 30 Exercises: 15 (auditory - 9, laboratory - 6)
Workload	Lecture hours 30 Exercise hours 8 Experimental practice in laboratory hours 7 Other contact hours 10 Self study hours 80
Credit points	4,5 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, • 1 pre-exam – minimum25% score, • Seminar paper.
Recommended prerequisites	• Understanding the conceptsof stress andstrain analysis, • Knowledge about the calculation of stresses and strainsin the elements subjected tointernal forces, • Knowledge about the content ofmechanicsof materials.
Module objectives/intended learning outcomes	• Knowledge about the historical development offracture mechanics, • Recognizing the importanceof fracture mechanicsandthe danger of the presence ofcracksinstructural elements, • Understanding the influence ofcrackson stress concentration, • Understanding the differencebetween thelinear elastic(LEFM) andelastoplasticfracture mechanics(EPFM), • Understanding theexperimental methodsof determiningfracture mechanics parameters, • Ability to analyze cracks and other defects in the structure of materials and their impact on safety of engineering structures.
Content	• Lectures: 1. Introduction and historical development of fracture mechanics[3] 2. Physics of fracture. The ideal strength of the material. Ductility and brittleness. Modes of propagation of cracks. Basic definitions[2] Linear Elastic Fracture Mechanics (LEFM) 3. Basic equations. The influenceof crackson stress concentration[2] 4. Griffith’sconditionforcrack development (energyapproach) and Irwin'smodification. Energy release rate(G). Crack instabilityand"R" curves[2] 5. Basic shapesof crack development. The fields of stress and displacementin the environment of the crack tip[2]

	6. Stress intensity factor(K) andits meaning. The functions ofgeometry(shape factors)[2] 7. Fracture criteria. Fracture toughness. Material toughness. The relationshipbetween stress intensity factorandenergy release rate[2] 8. Experimental methodsfor determiningthe parameters of LEFM[2] Elastic-Plastic Fracture Mechanics (LEFM) 9. Plasticity field in the crack tip.Dugdale'smodelforelastic-plasticmaterials[2] 10. Crack tip opening displacement (CTOD). Rice's contour integral. The relationship betweenCTODandRice's contour integral[3] 11. Stable and unstablecrack development. Fracturecriteria[2] 12. Experimental methodsfor determiningthe parameters of EPFM.[2] 13. Fracture mechanics ofmetals, ductile fracture. Fracture mechanics ofnon-metals(plastics, ceramics, concreteandstone). Quasibrittle fracture[2] 14. Assignments forseminar papers [3]. • Exercises (auditory): 1. Solvingsimplenumerical examplesin the field oflinear elasticfracture mechanics[9]. • Exercises (laboratory): 1. Experimental methods for determining the parameters of LEFM [6]. • Pre-exam: all lectures.
Study and examination requirements and forms of examination	• Written exam – minimum 50% score, • Oral exam.
Media employed	Whiteboard, projector
Reading list	Required literature: 3. T. L. Anderson,Fracture mechanics: Fundamental and Aplications, CRC Press LLC, N.W. Corporate Blvd., Boca Raton, Florida,2000 4. J. Krolo, D. Šimić, Mechanics of Materials, University of Zagreb, Faculty for Civil Engineering, Zagreb, 2011 Optional literature: 4. J. Brnić, G. Turkalj, Science of Strength II, Zigo, Rijeka, 2006, 5. D. Šumarac, D. Krajčinović, Basic of Fracture Mechanics, Naučna knjiga, Beograd, 1990, 6. J. F. Knott, Fundamentals of Fracture Mechanics, Butterworths, Cambridge University, 1981

Module name:	**Programming of Computational Procedures for Structural Analysis**
Module level, if applicable	Master’s Degree Programme
Code, if applicable	104133
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	III (Winter)
Person responsible for the module	Krešimir Fresl
Lecturer	
Language	Croatian
Relation to curriculum	Master’s degree programme. Theory and Modelling of Structure. Elective. Semestar III.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises (computer room): 15
Workload	Lecture hours 30 Seminars 15 Other contact hours 15 Self study hours 75
Credit points	4,5 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, • Homework assignments.
Recommended prerequisites	• Knowledge about linear methods of analysis of structures, primarily the displacement method, • Understanding the structure of computer programs (variables, branching, loops, and functions).
Module objectives/intended learning outcomes	• Understanding and explaining the structure of programs for analysis of structures, • Understanding and explaining the consequences of inevitable approximations in structure modelling and limited (finite) accuracy of numerical calculations, • Developing a simple computer program for the analysis of structures, • Changing, adapting and upgrading a computer program for the analysis of structures accessible in source code, • Cooperation within a team which develops a complex computer program for the analysis of structures.
Content	• Lectures: 1. Program paradigms and programming languages, syntax and semantics, Turing machine [2] 2. Basic data types and basic operations [1] 3. Presentation of real numbers (IEEE norm), algebraic operations, rounding and accuracy [4] 4. Program flow control: loops and branching [2] 5. Mathematical and programming functions [2] 6. Vectors and matrices (full and sparce): 6.1 Data structures (arrays, lists, trees, dictionaries) [2] 6.2 Implementation of the operation of linear algebra [3] 7. Structure of the implementation of displacement method:

	7.1 Topological relations in a network of rod elements [1] 7.2 Stiffness matrices of elements and structure, loading vector [2] 7.3 Coordinate systems and coordinate transformation [2] 7.4 Equilibrium equations and assembling the stiffness matrix of a structure [3] 7.5 Solving systems of equations [1] 7.6 Forces on the ends of rods [1] 8. Form finding of prestressed cable structures : 8.1 Force density method (analogy with displacement method) [2] 8.2 Newton-Raphson-Gauss-Seidel procedure [2]. • Exercises: 1. Exercises accompany lectures.
Study and examination requirements and forms of examination	• Seminar paper 60%, • Presentation 40%.
Media employed	Whiteboard, projector
Reading list	Required literature: 1. K. Fresl, Sage Worksheets PPPK_*, http://sage.grad.hr. 2. J. J. C. Remmers, C. V. Verhoosel, R. de Borst: PyFEM, 2012., code in 1. in Optional literature, http://www.wiley.com/go/deborst Optional literature: 1. R. de Borst, M. A. Crisfield, J. J. C. Remmers, C. V. Verhoosel:Non-linear Finite Element Analysis of Solids and Structures, Wiley, 2012, 2. M. L. Overton:Numerical Computing with IEEE Floating Point Arithmetic, SIAM, Philadelphia, 2001, 3. J. J. Barton, L. R. Nackman:Scientific and Engineering C++, Addison--Wesley, Reading, 1994

IV. SEMESTER

Module name:	**Stability Theory**
Module level, if applicable	Master’s Degree Programmes
Code, if applicable	126335
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	IV (Summer)
Person responsible for the module	Damir Lazarević, Mario Uroš
Lecturer	
Language	Croatian
Relation to curriculum	Master’s degree programm. Theory and Modelling of Structures. Compulsory. Semestar III.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises (auditory): 30
Workload	Lecture hours 30 Hours of computer research 30 Other contact hours 15 Self study hours 105
Credit points	6 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, • Seminar paper presentation.
Recommended prerequisites	• Knowledge about linear and nonlinear algebra, • Knowledge about differential and integral calculus (including ordinary differential equations) and linear algebra, • Knowledge about linear and nonlinear static analysis procedures for frame structures.
Module objectives/intended learning outcomes	• Applying the principles of stability theory, • Carrying out nonlinear analyses of structures, • Analysing the results of nonlinear procedures, • Understanding scientific and professional literature in the field of structural stability. • Designing engineering structures using computers and modern design directives.
Content	• Lectures: 1. The basics of stability phenomena [2] 2. Examples of the stability problem using the mechanical models [2] 3. Problem of elastic stability of columns [2] 4. Influence of imperfections on the stability of axial loaded columns [2] 5. Stability of columns and beams simultaneously loaded by axial forces and bending [2] 6. Stability of the moment resisting frames [2] 7. Stability of arches [2] 8. Application of energy methods in stability analysis [2] 9. Stability of plates [2] 10. Stability of thin elastic plates [2]

	11. Stability of shells [2] 12. Stability of thin-walled beam cross sections [2] 13. Stability in the plastic range [2] 14. Clarification of the design codes [2] 15. Problems of the stability in real structures [2]. • Exercises (auditory, design): 1. The basics of stability phenomena [2] 2. Simple models of stability loss [4] 3. Computer codes for stability [4] 4. Elastic stability of columns [2] 5. Elastic stability of imperfect columns [2] 6. Stability of eccentrically loaded beams and columns [2] 7. Stability of frames [2] 8. Stability of arches [2] 9. Energy methods in structural stability [2] 10. Stability of plates [2] 11. Stability of shells [2] 12. Stability of thin walled sections [2] 13. Inelastic stability [2]. • Seminars: 1
Study and examination requirements and forms of examination	• Seminar paper presentation, • Oral exam.
Media employed	Whiteboard, projector
Reading list	Required literature: 1. Lazarević, D., Theory of stability with the introduction in structural stability, mimeographed lecture notes, GF, Zagreb, 2014 Optional literature: 1. Timoshenko S. P., Theory of elastic stability, Građevinska knjiga, Belgrade 1959, 2. Mihanović A., Structural stability, DHGK, 1993

Module name:	**Numerical Methods in Structural Analysis**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	114883
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	IV (Summer)
Person responsible for the module	Mladen Meštrović
Lecturer	
Language	Croatian
Relation to curriculum	Master's degree programme. Theory and Modelling of Structure. Elective. Semestar IV.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises: 15 (auditory - 10, design -5)
Workload	Lecture hours 30 Exercises 15 Other contact hours 15 Self study hours 75
Credit points	4.5 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, • Solving different problems.
Recommended prerequisites	• Understanding and ability to apply equilibrium equations in 2D and 3D, • Knowledge about finite element method, • Basic mathematical knowledge about numerical methods, • Basic mathematical knowledge about partial differential equations.
Module objectives/intended learning outcomes	• Knowledge about the approach to solving structural problems with numerical methods, • Knowledge about the application of numerical methods for computational analysis in structural analysis.
Content	• Lectures: 1. Newton's method of different rate of convergence[4] 2. Euler and modified Euler method [2] 3. Runge-Kuta Methods[4] 4. Predictor-Corrector Methods[6] 5. Decomposition methods (Adomian) [2] 6. Numerical methods in Dynamics (Wilson, Newmark) [6] 7. Boundary element method [6]. • Exercises: 1. Newton's method of different rate of convergence [2] 2. Euler and modified Euler method [2] 3. Runge-Kuta Methods[2] 4. Predictor-Corrector Methods[2] 5. Decomposition methods (Adomian)[2] 6. Numerical methods in Dynamics (Wilson, Newmark) [3] 7. Boundary element method [2].
Study and examination requirements and forms of examination	• Final seminar paper, • Oral exam.

Media employed	Whiteboard, projector
Reading list	Required literature: 1. E. Stein, R. de Borst, T.J.R. Hughes,Encyclopedia of Computational Mechanics, Vol. 1 2. Z. Bittnar, J. Šejnoha, Numerical Methods in Structural Mechanics

Module name:	**Selected Topics on Strength of Materials**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	21872
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	IV (Summer)
Person responsible for the module	Diana Šimić Penava
Lecturer	Marko Bartolac
Language	Croatian
Relation to curriculum	Master's degree programme. Theory and Modelling of Structure. Elective. Semestar IV.
Type of teaching, contact hours	Number of hours (in semester): • Lectures:30 • Exercises: 15 (auditory)
Workload	Lecture hours 30 Hours of exercise 15 Other contact hours 30 Self study hours 60
Credit points	4,5 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, • Seminar paper.
Recommended prerequisites	• Understanding and determining the mechanical properties of materials. • Knowledge about basic methods of determining the stresses and strains in construction elements of elastic, homogeneous, linear materials. • Knowledge about differential and integral calculus (including ordinary differential equations) and linear algebra.
Module objectives/intended learning outcomes	• Explaining the transverse normal stress in bending rods under the transverse load. • Calculating the stress in rods of non-linear and bilinear elastic material subjected to bending load. • Calculating the stress and strain in rods at impact loading. Apply Herz 's formula for the calculation of contact stresses and strains. • Analyzing the general case of two bodies in contact under pressure. • Explaining and calculating the stress and strain in thick-walled tubes under the influence of internal and external pressure. The calculated stresses in composite thick-walled tubes and their optimal overlap.
Content	• Lectures: 1. Beam bending of gradually variable cross section. A beam of equal strength. Transversal normal stresses in beam bending under transversal loading. 2. Concentration of stresses. Axial load, torsion, bending. 3. Modeling of structures made of nonlinear elastic material. 4. Axial load of rod structure. Straight beam bending of bilinear elastic material. Torsion. 5. Contact problems. General assumptions. Herz's formulas for contact stresses and strains.

	6. A sphere on a plane, a sphere on a sphere, a cylinder on a cylinder under pressure. 7. General case of two bodies touching point under pressure. 8. Thickwalled tubes. General definitions and assumptions. 9. Differential equations and boundary conditions for axially symmetric body. 10. Stresses and strains in thick- walled tubes under the action of internal and external pressures. Stresses and strains in composed thick- walled tubes. Thermal strains in thick-walled tubes. 11. Dynamic problems. Stresses and strains in structural members at motion with acceleration. 12. Inertia forces, internal forces. 13. Bending Theory of impact. General assumptions. Stresses calculation and rod strain at impact load. Axial impact load. Impact load at bending. 14. Torsion impact load. Stresses in longitudinal rod impact against a hard base. Stresses in transversal beam impact against stiff bearings. 15. Calculation of strength in alternating stresses. Multiaxially alternating stresses. Application of theories of failure. • Exercises (auditory): 1. Beam bending gradually changing section. 2. Beam of equal strength. 3. Transverse normal stresses in beam bending under transverse load. Rod bending of linear elastic materials. 4. Rod bending of bilinear elastic material. 5. Calculation of stress and strain at impact loading. 6. Axial impact load. Stresses in the longitudinal rod impact of rigid substrates. 7. Stress and strain girders at impact loading. 8. Stresses in the transverse girder impact on rigid bearings. 9. Calculation of strength in alternating stresses. 10. Variable multiaxial stress. 11. Applying the theory of strength. 12. Contact stresses and strains two balls under pressure. 13. Contact stresses and strains two rollers under pressure. Check the contact pressure. 14. Stresses and strains in a thick-walled tubes under the influence of internal and external pressure. 15. Stresses and strains in composite thick-walled tubes.
Study and examination requirements and forms of examination	• Written exam – minimum 50% score, • Oral exam.
Media employed	Whiteboard, projector
Reading list	Required literature: 1. V. Šimić, Otpornost materijala I, Školska knjiga, Zagreb, 2002, 2. V. Šimić, Otpornost materijala II, Školska knjiga, Zagreb, 2002, 3. I. Alfirević, Nauka o čvrstoći II, Golden marketing, Zagreb, 1999, 4. D. Bazjanac,Nauka o čvrstoći, Tehnička knjiga, Zagreb, 1973, 5. J. Brnić, G. Turkalj, Nauka o čvrstoć II, ZIGO, Rijeka, 2006 Optional literature: 1. Alfirević, Nauka o čvrstoć I, Tehnička knjiga, Zagreb, 1989, 2. Timošenko, S.: Otpornost materijala I, Građevinska knjiga, Beograd, 1965, 3. Timošenko, S.: Otpornost materijala II, Građevinska knjiga, Beograd, 1966,

	4. J.Case, A. Chilver, Strength of Materials and Structures, Edward Arnold, 1985

Module name:	**Stochastic Analysis of Structures**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	114886
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	IV (Summer)
Person responsible for the module	Mladen Meštrović
Lecturer	
Language	Croatian
Relation to curriculum	Master's degree programme. Theory and Modelling of Structure. Elective. Semestar IV.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises: 15 (auditory - 10, design - 5)
Workload	Lecture hours 30 Exercises 15 Other contact hours 15 Self study hours 75
Credit points	4.5 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, • Solutions to different problems.
Recommended prerequisites	• Knowledge of basic probability • Knowledge about FEM
Module objectives/intended learning outcomes	• knowledge about approach to solving uncertain structures understanding the uncertainty of structures knowledge about the application the uncertainties for computational analysis in structural analysis
Content	• Lectures: 1. Revision of basic probability[2] 2. Random variables and random fields[4] 3. Uncertainty of input quantities (elastic modulus, cross section) [6] 4. Variability response function[4] 5. Stochastic finite element method (SFEM) [8] 6. Application in structural analysis [6]. • Exercises (auditory, design, laboratory): 1. Operations with random variables [2] 2. Variability response function[4] 3. Weighed integral method [4] 4. Applications on beams and plates [5].
Study and examination requirements and forms of examination	• Final seminar paper, • Oral exam.
Media employed	Whiteboard, projector
Reading list	Required literature: 1. I. Elishakoff,Probabilistic Theory of Structures A. Haldar, A. Guran, 2. B.M. Ayyub, Uncertainty Modelling in Finite Element, Fatigue and Stability of Systems

	3. A. Haldar, S. Mahadevan, Reliability Assessment Using Stochastic Finite Element Analysis 4. M. Meštrović: skripta, http://www.grad.hr/predmeti/sak_a(mimeographed lecture notes)

Module name:	**Numerical Mathematics**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	21805
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	IV (Summer)
Person responsible for the module	Tomislav Došlić, Alan Filipin
Lecturer	
Language	Croatian
Relation to curriculum	Master's degree programme.Elective.Semestar IV.
Type of teaching, contact hours	Number of hours (in semester): 60 • Lectures: 30 • Exercises (auditory): 30
Workload	Lecture hours 28 Exercises hours 30 Other contact hours 2 Self study hours 60
Credit points	6 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises.
Recommended prerequisites	• Familiarity with the calculus, including ordinary differential equations, and basic linear algebra.
Module objectives/intended learning outcomes	• Understanding the conditions and limits of applicability of particular numerical methods, • Ability to choose and successfully apply correct methods.
Content	• Lectures: 1. Sources and types of errors (5) 2. Methods for solving non-linear equations (5) 3. Interpolation and approximation (5) 4. Numerical integration (5) 5. Numerical methods for solutions of ordinary differential equations (5) 6. Numerical linear algebra (5) • Exercises (auditory): follow the lectures.
Study and examination requirements and forms of examination	• Correct solution of a pre-assigned problem, • Oral exam.
Media employed	Whiteboard, projector
Reading list	Required literature: 1. T. Došlić, Numerička matematika, available at the course web-page. Optional literature: 1. E. Kreyszig: Advanced Engineering Mathematics, John Wiley and Sons Ltd., 1999,. 2. F. Scheid: Numerical Analysis, Schaum's Outline Series in Mathematics, McGraw-Hill

Module name:	**Perspective**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	21806
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	IV (Summer)
Person responsible for the module	Sonja Gorjanc
Lecturer	Iva Kodrnja, Helena Koncul, Dora Pokaz
Language	Croatian
Relation to curriculum	Master’s Degree Programmes. Elective. Semester IV.
Type of teaching, contact hours	Number of hours (in semester): 60 • Lectures:30 • Exercises (auditory, design, laboratory): 30
Workload	Lecture hours 30 Hours of laboratories or skills 30 Other contact hours 30 Self study hours 90
Credit points	6 ECTS
Requirements according to the examination regulations	• 100% attendance in lectures and exercises, • 4 projects, • 1 seminar paper, • 1 pre-exam.
Recommended prerequisites	• Familiarity with the methods of parallel projection.
Module objectives/intended learning outcomes	• Mastering basic constructive procedures in perspective, • Acquiring knowledge on methods of construction of perspective image of an object, • Acquiring knowledge on geometric properties of algebraic surfaces of higher order, • Ability to construct perspective image of objects from civil engineering.
Content	• Lectures: 1. Central projection [8] 2. Quadric surfaces [4] 3. Ruled surfaces [6] 4. Computer modeling of surfaces [8] 5. Terrains in perspective [4] • Exercises (constructive, in computer classroom): 1. Central projection [8] 2. Quadric surfaces [4] 3. Ruled surfaces [6] 4. Computer modeling of surfaces [8] 5. Terrains in perspective [4]
Study and examination requirements and forms of examination	• Written exam - minimum 60% score, • Oral exam, • Students who have achieved a positive grade in projects, seminar paper and pre-exam are exempt from the written and oral exam.
Media employed	Whiteboard, projector

Reading list	Required literature: 1. P. Kurilj, N. Sudeta, M. Šimić, Perspektiva (Perspective), Arhitektonski fakultet, Zagreb, 2005 Optional literature: 1. V. Niče, Perspektiva (Perspective), Školska knjiga, Zagreb, 1978, 2. B. Kučinić et al., Oble forme u graditeljstvu, Građevinar, Zagreb, 1992, 3. H. Brauner, W. Kickinger, Geometrija u graditeljstvu, Školska knjiga, Zagreb,1980

Module name:	**Basics of Differential Geometry**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	21804
Subtitle, if applicable	
Courses, if applicable	1 class for lectures 1 class for exercises
Semester(s) in which the module is taught	IV. (summer)
Person responsible for the module	
Lecturer	Iva Kodrnja, Sonja Gorjanc
Language	Croatian
Relation to curriculum	Master's degree programme.Elective.Semestar IV.
Type of teaching, contact hours	Number of hours (in semester): 60 • Lectures:30 • Exercises (auditory, design, laboratory): 30
Workload	Lecture hours 30 Hours of exercise 30 Other contact hours 30 Self study hours 90
Credit points	6 ECTS
Requirements according to the examination regulations	• 100% attendance in lectures and exercises, • 2 projects, • 1 seminar paper, • 2 pre-exams.
Recommended prerequisites	• Familiarity with the basics of differential calculus and linear algebra.
Module objectives/intended learning outcomes	• Acquiring basic knowledge about differential geometry of curves and surfaces in Euclidean space, • Ability to solve tasks in differential geometry by using program Mathematica, • Knowledge about the properties of minimal surfaces, • The ability to apply the methods and content of differential geometry in civil engineering.
Content	• Lectures: 1. Curves in Euclidean space [8] 2. Surfaces in Euclidean space [10] 3. Curvatures of surfaces [6] 4. Mapping of surfaces [4] 5. Minimal surfaces [4]. • Exercises (constructive, in computer classroom): 1. Curves in Euclidean space [8] 2. Surfaces in Euclidean space [10] 3. Curvatures of surfaces [6] 4. Mapping of surfaces [4] 5. Minimal surfaces [4].
Study and examination requirements and forms of examination	• Written exam - minimum 60% score, • Oral exam, • Students who have achieved a positive grade in projects, seminar paper and pre-exam are exempt from written and oral exam.

Media employed	Whiteboard, projector
Reading list	Required literature: 1. I. Kamenarović, Diferencijalna geometrija, Sveučilište u Rijeci, Pedagoški fakultet, Rijeka, 1990, 2. J. Beban-Brkić: web-scrip:http://www.grad.hr/itproject_math/Links/jelena/index.html Optional literature: 1. Gray, A.: Modern Differential Geometry of Curves and Surfaces With Mathematica, CRS Press, Boston, London, 1998, 2. On-line Encyclopedia of mathematical concepts: MathWorldWolfram

Module name:	**Waves and Oscillations**
Module level, if applicable	Master's Degree Programme
Code, if applicable	21807
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	IV (Summer)
Person responsible for the module	Dario Jukić
Lecturer	Dario Jukić
Language	Croatian and/or English
Relation to curriculum	Master degree programme, Physics. Elective. IV. Semester.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 30 • Exercises: 30 (auditory - 15, laboratory - 15)
Workload	Lecture hours 30 Hours of laboratories 15 Hours of practical exercies 15
Credit points	6 ECTS
Requirements according to the examination regulations	• Attendance in lectures and exercises, • Three pre-exams – minimum 35% score in each, • One make up exam.
Recommended prerequisites	• Undergraduate course mathematics, including differential equations, • Basics of programming and use of Mathematics software.
Module objectives/intended learning outcomes	• Mastering equations on given problems: free vibrations of simple systems – wires, slabs; waves and wire extension in one, two or three dimensions, deformations, • Understanding the physical background of the equations taught in professional and mathematical courses, • Ability to find equations through physical properties of a problem – coupled oscillations and vibrations, acoustic wave spreading, acoustic insulation, • Modeling by applying a harmonic oscillator, • Computer modelling of individual physical models of the problems dealt with in professional and mathematical courses, • Understanding physical properties of forced oscillation and interference, • Understanding the physical basis for measurements in civil engineering.
Content	• Lectures: 1. Basics of deriving equations from given problems (4) 2. Waves and wave propagation in one, two or three dimensions, deformations (5) 3. Physical background for the equations mastered in professional and mathematical courses (5) 4. Finding solutions for the equations through physical properties of problems (5) 5. Modeling by harmonic oscillator (2) 6. Computer modeling of physical models for problems dealt with in professional and mathematical courses (3) 7. Physical properties of forced oscillations, interferences (5) 8. Physical basis of measurements in civil engineering (2).

	• Exercises (auditory, laboratory): 1. Free vibrations of simple systems – wires, slabs (4) 2. Coupled oscillations and vibrations, acoustic wave spreading, acoustic insulation (9) 3. Coupled oscillations and vibrations, acoustic wave spreading, acoustic insulation (7) 4. Modeling: physical models (3) 5. Forced oscillations, interferences (5) 6. Physical measurements (2). • Seminars: included in exercises.
Study and examination requirements and forms of examination	• Pre-exam – students with a minimum 60% score are exempt from a part of the final exam (only final test is mandatory) End of semester grading: • The final test is the requirement for the final exam.
Media employed	Whiteboard, projector
Reading list	Required literature: 1. F. S. Crawford, Waves: Berkeley physics course v.3, McGraw-Hill college, 1968 Optional literature: 1. A. P. French, Vibrations and Waves, W.W. Norton & Company, New York, 1971

Module name:	**Stochastic Processes**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	
Subtitle, if applicable	
Courses, if applicable	
Semester(s) in which the module is taught	IV (Summer)
Person responsible for the module	Tomislav Došlić, Alan Filipin
Lecturer	Rafael Mrđen, Kristina Ana Škreb
Language	Croatian
Relation to curriculum	Master degree programme for all engineering programmes. Compulsore elective. Semester IV.
Type of teaching, contact hours	Number of hours (in semester): • Lectures: 45 • Exercises (auditory): 30
Workload	Lecture hours 45, hours of exercise 30, other contact hours 30, self study hours 120.
Credit points	7.5 ECTS
Requirements according to the examination regulations	• Regular attendance • Minimum 25 % score in the pre-exam.
Recommended prerequisites	
Module objectives/intended learning outcomes	• Understanding conditions and limits of applicability of stochastic models, • Ability to recognize and choose correct model. • Ability to formulate and solve simple problems in terms of Markov chains and processes.
Content	• Lectures: 1. Basic characteristics and examples of stochastic processes [3], 2. Markov chains with discrete time and finite and countable set of states [27], 3. Markov processes [6], 4. Poisson processes and the theory of queues [6], • Exercises (auditory: follow the lectures.
Study and examination requirements and forms of examination	• Eliminatory written exam - minimum 50 % score, • Students who pass the pre-exam take only the second part, • Oral exam.
Media employed	Whiteboard, projector
Reading list	Required literature: 1. N. Berglund, Processus aleatoires et applications, available as Croatian translation on the course web-page and originally at ArXiv.org. Optional literature: 1. R. Durrett: Essentials of Stochastic Processes, Springer Texts in Statistics, Springer, New York, 1999, 2. D. P. Bertsekas, J. N. Tsitsiklis: Introduction to Probability, On line lecture notes, M.I.T., 2000.

Module name:	**English Language in Civil Engineering 2**
Module level, if applicable	Master's Degree Programmes
Code, if applicable	93234
Subtitle, if applicable	
Courses, if applicable	Master's's programme 7 classes
Semester(s) in which the module is taught	IV (Summer)
Person responsible for the module	Alemka Kralj Štih
Lecturer	
Language	English
Relation to curriculum	Master's Degree Programmes. Elective. Semester IV.
Type of teaching, contact hours	Number of hours (in semester): • Exercises: 45
Workload	Lecture hours 45 Other contact hours 10 Self study hours 80
Credit points	4,5 ECTS
Requirements according to the examination regulations	• 75% attendance in lectures, • Making a presentation, • 3 pre-exams.
Recommended prerequisites	• Intermediate level, B 1.
Module objectives/intended learning outcomes	• Developing language competences which include professional terminology in the field of transport facilities and geotechnical engineering, • Independent user – ability to read technical literature independently, • Revision of basic grammar categories in professional language – passive, past tenses, modal verbs, • Confident use of sentences in professional language, developing presentation skills and skills in writing professional papers.
Content	• Exercises: 1. A Career in Structural Engineering – Varieties in the field of structural engineering [3] 2. Bridge Building – Damages in Arch Building [3] 3. Europe's Longest Viaduct[3] 4. Wembley Stadium[3] 5. Weak Points of the House[3] 6. At the Heart of Dome's Design Process [3] 7. Joint students' presentations [3] 8. Single students' presentations [3] 9. The Story of the Dome[3] 10. Hyatt Hotel Collapse[3] 11. Terminology practice in TIMBER STRUCTURES I [3] 12. Career Job Hunting – avoiding potential job (interview) disasters – Tips and Advice [3] 13. Creating a CV - How to write a CV? How to write a letter of application / Job Interview Questions [3] 14. Professional Development. Preparing for the Interview Skills – Techniques, Tips and Advice. Recruitment of graduates [3] 15. Preliminary exam [3]

Study and examination requirements and forms of examination	• The credits earned through all the testing and pre-exams make up the final grade. The grades are based as follows: pre-exam results, points earned during semester - active participation in class, grammar checks, translations into a foreign language, translations from a foreign language, professional vocabulary checks. Maximum number of points that can be earned in the pre-exam is 20 – the grade is multiplied by four. Students who have not earned enough points are required to take the final exam. • Grading is as follows - 50-62% score = sufficient (2), - 63-75% score = good (3), - 76-88% score = very good (4), - 89-100% score = excellent (5).
Media employed	Whiteboard, projector
Reading list	Required literature: 1. A. Kralj Štih: English in Structural Engineering, course materials. Optional literature: 5. D. Bonamy: Technical English 4, Pearson Longman, 2011 6. The Internet pages, program Building Big, Brantacan, ASCE. 7. Z. Vulelija: Ilustrirani rječnik arhitekture i građe inar t a – hrvatsko engleski i englesko hrvatski, Masmedia, Zagreb, 2010 8. A. Prager: Trojezični građevinski rječnik, Masmedia, Zagreb, 2002

Module name:	**German Language in Civil Engineering 2**
Module level, if applicable	Master's Degree Programm
Code, if applicable	93235
Subtitle, if applicable	
Courses, if applicable	Master's Programmes 1 class
Semester(s) in which the module is taught	IV (Summer)
Person responsible for the module	Alemka Kralj Štih
Lecturer	
Language	German
Relation to curriculum	Master's Degree Programmes. Elective. Semester IV.
Type of teaching, contact hours	Number of hours (in semester): 45 • Exercises (auditory):45
Workload	Lecture hours 45 Other contact hours 10 Self study hours 80
Credit points	4,5 ECTS
Requirements according to the examination regulations	• 75% attendance in exercised, • Preparing one presentation, • 3 pre-exams.
Recommended prerequisites	• German language competence at B1, B2 level.
Module objectives/intended learning outcomes	• Understanding and interpreting technical texts, • Independent oral skills in technical field, ability to explain professional terms, • Writing a CV and job applications.
Content	• Auditory exercises: 1. Die Geschichte des Kuppelbaus [3] 2. Wie schreibt man einen Lebenslauf? [3] 3. Bewerbungsschreiben [3] 4. Wie man sich auf ein Interview vorbereitet [3] 5. Die größte Drehbrücke der Welt [3] 6. Bewerbungsschreiben [3] 7. Die Geschichte der Tunnelkonstruktion [3] 8. Kräfte und Gegenkräfte [3] 9. Einige Festigkeitsarten [3] 10. Elastizität und Verformung [3] 11. Der Straßenbau [3] 12. Gebäude im Erdbeben [3] 13. Der Flughafen [3]
Study and examination requirements and forms of examination	• The credits earned through all the testing and pre-exams make up the final grade. The grades are based as follows: pre-exam results, points earned during semester - active participation in class, grammar checks, translations into a foreign language, translations from a foreign language, professional vocabulary checks. Maximum number of points that can be earned in the pre-exam is 20 – the grade is multiplied by four. Students who have not earned enough points are required to take the final exam. • Grading is as follows - 50-62% score = sufficient (2), - 63-75% score = good (3),

	- 76-88% score = very good (4), - 89-100% score = excellent (5).
Media employed	Whiteboard, projector
Reading list	Required literature: 1. A. Kralj Štih: Deutsch für Konstruktionen, Geotechnik, Verkehr un Theorie un M ellierung der Konstruktionen, Kursunterlagen, 2011 Optional literature: 1. A. Prager: Trojezični građevinski rječnik, Masmedia, Zagreb, 2002