

APPENDIX - C2:
DESCRIPTION OF CURRICULUM PER OBLIGATORY AND OPTIONAL
SUBJECTS WITHIN THE IZIIS' MASTER STUDIES IN EARTHQUAKE
ENGINEERING (Programme-2)

Subject: DYNAMICS OF STRUCTURES				
<i>Code</i>	<i>Status</i>	<i>Semester</i>	<i>Number of ECTS credits</i>	<i>Number of lecture hours</i>
EA-101	Obligatory	I	6	30

Curriculum of IZIIS' Postgraduate Studies						
Earthquake Engineering Major (Curriculum – 2)						
Enrollment conditions:						
Name and surname of professors (participants in preparation of contents):						
Principal lecturer: Prof. Dr. Ljubomir Taskov						
Other lecturers: Assist. Prof. Dr. Lidija Krstevska						
Visiting professors:						
Contents of the subject:						
1. Single degree of freedom systems:						
1.1. Equations of motion, problem statement and solution methods;						
1.2. Free vibrations;						
1.3. Response to harmonic, periodic, random and impulse excitations;						
1.4. Numerical evaluation of dynamic response;						
1.5. Earthquake response of linear and nonlinear systems;						
1.6. Generalized single degree of freedom systems.						
2. Multi degree of freedom systems:						
2.1. Equations of motion, problem statement and solution methods;						
2.2. Free vibration, damping in the structure;						
2.3. Dynamic analysis and response of linear systems;						
2.4. Seismic analysis of linear systems,						
2.5. Reduction of degrees of freedom;						
2.6. Numerical evaluation of dynamic response;						
2.7. Systems with distributed mass and elasticity						
3. Earthquake response and design of multistorey buildings:						
3.1. Earthquake response of linear elastic buildings;						
3.2. Seismic response of inelastic buildings;						
3.3. Seismic dynamics of base-isolated buildings;						
3.4. Dynamics of structures in seismic codes for buildings.						
Method:						
<i>Lectures</i>	<i>Exercises</i>	<i>Numerical and Graphical tasks</i>	<i>Use of software</i>	<i>Laboratory exercises</i>	<i>Seminar papers</i>	<i>Field lectures</i>
<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>
Grading:						
<i>Attendance of lectures</i>	<i>Obligatory tasks</i>	<i>Colloquia</i>	<i>Seminar papers</i>	<i>Written examination</i>	<i>Oral examination</i>	
<i>Yes</i>	<i>Yes</i>	<i>/</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	
References: Main: Dynamics of Structures and Earthquake Dynamics, Anil Chopra						
<i>Additional: Dynamics of Structures, Mario Paz; Dynamics of Structures, Pensen and Clough, Special chapters from Dynamics of Structures, Trifun Paskalov, Dynamics of Structures – Constantine Mescouris</i>						

Subject: ANALYSIS OF STRUCTURES				
<i>Code</i>	<i>Status</i>	<i>Semester</i>	<i>Number of ECTS credits</i>	<i>Number of lecture hours</i>
EA-102	Obligatory	/	6	30

Curriculum of IZIIS' Postgraduate Studies						
Earthquake Engineering Major (Curriculum – 2)						
Enrollment conditions:						
Name and surname of professors (participants in preparation of contents):						
Principal lecturer: Prof. Dr. Danilo Ristic						
Other lecturers: Assoc. Prof. Dr. Viktor Hristovski						
Visiting professors:						
Contents of the subject:						
<p>Introduction to structural analysis: classification of loads and structural problems. Theory of advanced matrix structural analysis: theory of elasticity, virtual work principles, energy theorems. Direct stiffness (displacement) method: element and structure stiffness formulation, solution methods. Flexibility (force) method: concept and applicability. Computer implementation: solution strategies, basic linear static and dynamic analysis procedures. Theory of large deflections and stability analysis. Introduction to structural analysis theory of nonlinear structures: fundamentals of plastic analysis of structures. Plastic hinge. Elastic-plastic analysis of beams and frames. Basic principles of limit analysis. Influence of axial forces and interaction with bending moments. Fundamentals of FEM application in static model formulation. Fundamentals of FEM application in formulation of models for static analysis. Fundamentals of application of FEM in formulation of models for dynamic analysis. General methods for dynamic problem solution: general equation of motion, step-by-step numerical integration methods, numerical methods for dynamic equilibrium iterations. Strategies and methods for static and dynamic analysis of large nonlinear systems: methods for computation of initial dynamic characteristics (solution of eigen value and eigen vector problems). Introduction to static and dynamic analysis of special structures: analysis of complex systems exposed to combined loads, analysis of seismically isolated structures, analysis of structures with elements for energy dissipation and vibration control. Introduction to advanced techniques for numerical analysis and computer programming, development of specialized computer software and its practical application for experimental and design purposes, application of modern computer software for scientific and design purposes.</p>						
Method:						
<i>Lectures</i>	<i>Exercises</i>	<i>Numerical and Graphical tasks</i>	<i>Use of software</i>	<i>Laboratory exercises</i>	<i>Seminar papers</i>	<i>Field lectures</i>
Yes	Yes	Yes	Yes	/	Yes	/
Grading:						
<i>Attendance of lectures</i>	<i>Obligatory tasks</i>	<i>Colloquia</i>	<i>Seminar papers</i>	<i>Written examination</i>	<i>Oral examination</i>	
Yes	Yes	Yes	Yes	Yes	Yes	
References: Main: Notes containing lectures for the international IZIIS-DAAD master studies prepared by Prof. Dr. D. Ristic						
Additional: Selected new relevant scientific papers						

		Subject: ENGINEERING SEISMOLOGY		
Code	Status	Semester	Number of ECTS credits	Number of lecture hours
EA-103	Obligatory	/	6	30

Curriculum of IZIIS' Postgraduate Studies Earthquake Engineering Major (Curriculum – 2)						
Enrollment conditions:						
Name and surname of professors (participants in preparation of contents): Principal lecturer: Assist. Prof. dr. Dragi Dojcinovski Other lecturers: Assoc. Prof. Dr. Snezana Stamatovska Visiting professors:						
Contents of the subject:						
<p>1. Earthquake phenomenon: introduction; reasons for occurrence of earthquakes; types of earthquakes; earthquake parameters: focus; epicenter, depth, epicentral distance, seismic energy; tectonics; faults, seismic waves – types; definition of earthquake size: intensity, magnitude, seismic scales, ground motion parameters.</p> <p>2. Engineering aspects of earthquakes: regional seismological characteristics: seismotectonic model; concept of bedrock; predominant periods and time duration of individual regional parameters of ground motion; amplitude; attenuation; local seismological effects: approaches using engineering-geological seismic impedance and dynamic response in analysis of soil media; geotechnical investigations; microtremors, predominant periods and equivalent soil models, earthquake records; processing and interpretation of records, response spectra: concept, spectral parameters, relationships; spectral characteristics and structure; linear and nonlinear spectra, effective response spectra and compatible time histories.</p> <p>3. Seismic hazard analysis: methodology, deterministic and probabilistic approach; seismic hazard elements, seismic models, earthquake recurrence curves, probabilistic models (Poisson's, Markov's model, etc.) for generation of earthquakes, attenuation, methods and models for computation of seismic hazard, results, application: seismic hazard map, diagram of return periods, concept of return period.</p> <p>4. Seismic design parameters: seismic risk, concept of return period, design parameters based on seismic hazard and risk analysis (acceleration, velocity, displacement, time duration), parameters at bedrock and foundation levels: effect of local soil conditions – dynamic amplification factor, response spectra, artificial accelerogrammes, time histories, seismic design criteria: design and maximum earthquake, seismic zoning, microzoning, regulations.</p> <p>5. Seismic monitoring: need for seismic monitoring, basic principles, project for seismic monitoring, monitoring of engineering structures (highrises, bridges, dams, etc.), processing and application of obtained results</p>						
Method:						
<i>Lectures</i>	<i>Exercises</i>	<i>Numerical and Graphical tasks</i>	<i>Use of software</i>	<i>Laboratory exercises</i>	<i>Seminar papers</i>	<i>Field lectures</i>
Yes	Yes	Yes	Yes	/	/	Yes
Grading:						
<i>Attendance of lectures</i>	<i>Obligatory tasks</i>	<i>Colloquia</i>	<i>Seminar papers</i>	<i>Written examination</i>	<i>Oral examination</i>	
Yes	/	/	/	Yes	Yes	
References: <i>Main: Mimeographed notes containing lectures for master studies prepared by V. Mihailov and D. Dojcinovski</i> <i>Additional: Selected papers</i>						

Subject: DYNAMICS OF SOIL AND FOUNDATION				
Code	Status	Semester	Number of ECTS credits	Number of lecture hours
EA-104	Obligatory	/	6	30

Curriculum of IZIIS' Postgraduate Studies Earthquake Engineering Major (Curriculum – 2)						
Enrollment conditions:						
Name and surname of professors (participants in preparation of contents): Principal lecturer: Assist. Prof. Dr. Vlatko Sesov Other lecturers: Assist. Prof. Dr. Violeta Mircevska Visiting professors:						
Contents of the subject:						
Dynamic properties of soils <ul style="list-style-type: none"> - Dynamic stress-strain relationships - Factor influencing dynamic parameters of soils - Laboratory methods for definition of dynamic parameters of soil - Field investigations Dynamic response of soils <ul style="list-style-type: none"> - Numerical modelling of local soil conditions - Dynamic response of soil medium Soil instabilities <ul style="list-style-type: none"> - Landslides - Liquefaction Soil-structure interaction <ul style="list-style-type: none"> - Vibration of foundation - Seismic performance of deep foundation - Dynamic soil-structure interaction Improvement of soil <ul style="list-style-type: none"> - Methods for improvement - Decreasing of liquefaction potential - Structural measures for protection 						
Method						
<i>Lectures</i>	<i>Exercises</i>	<i>Numerical and Graphical tasks</i>	<i>Use of software</i>	<i>Laboratory exercises</i>	<i>Seminar papers</i>	<i>Field lectures</i>
Yes	Yes	Yes	Yes	Yes	/	/
Grading:						
<i>Attendance of lectures</i>	<i>Obligatory tasks</i>	<i>Colloquia</i>	<i>Seminar papers</i>	<i>Written examination</i>	<i>Oral examination</i>	
yes	Yes	Yes	/	Yes	/	
References: <i>Main: Mimeographed notes prepared by Prof. Dr. Kosta Talaganov</i> <i>Additional: Numerous selected papers from professional journals; Behaviour of Soils in Seismic Geotechnics by Kenji Ishihara, Klaredon Press – Oxford, 1996</i>						

Subject: <i>EXPERIMENTAL MECHANICS</i>				
<i>Code</i>	<i>Status</i>	<i>Semester</i>	<i>Number of ECTS credits</i>	<i>Number of lecture hours</i>
EA-105	Optional	I	6	30

Curriculum of IZIIS' Postgraduate Studies

Earthquake Engineering Major (Curriculum – 2)

Enrollment conditions:

Name and surname of professors (participants in preparation of contents):

Principal lecturer: **Assist. Prof. Dr. Lidija Krstevska**

Other lecturers: **Assoc. Prof. Dr. Zoran Rakicevic**

Visiting professors:

Contents of the subject:

1. Introduction to experimental mechanics; importance and need for physical modelling in earthquake engineering.
2. Theory of physical models: dimensional analysis - Buckingham's theorem, examples; types of physical models, true-replica, adequate and distorted. Linear models; nonlinear models. Characteristics of materials for models (σ - ε , ν , ρ , ξ); strain rate effect, simulation of time-dependent effects, size effect, production. Materials for physical models; plastics, epoxy resins, metals and alloys, micro concrete, gypsum and gypsum-sand mixtures, reinforcement simulation. Modelling of reinforced-concrete, masonry and steel structures – examples.
3. Seismic shaking tables. Characteristics of shaking tables; size, material, mass, kinematic properties, overturning moment, foundation, displacement, velocity and acceleration. Fields of application. Degrees of freedom. Control of motion. Examples.
4. Pseudo-dynamic testing of models. Reaction walls.
5. Quasi-static testing of elements, ensembles and structures. Definition, field of application and identified quantities; P - Δ ; M - Φ ; σ - ε ; stiffness and deformability, ductility and energy dissipation. Procedure for quasi-static testing. Loading histories. Controlled variables. Examples of quasi-static testing: wall elements, frame structures, shear-wall systems, steel systems.
6. Full-scale testing of structures. Need and objectives of the tests; testing methods, testing by forced vibration method: theory, equipment, procedure, identified characteristics. Testing by ambient vibration method; theory, equipment, testing procedure and identified quantities. Applicative software for data processing. Examples.
7. Instrumentation of structures and models – principles and application. Gauges. Static and dynamic characteristics of gauges. Load cells, accelerometers, displacement transducers, strain gauges. Wheatstone bridge; measurement of axial force, moment. Data acquisition.
8. Analysis of experimental data. Errors during experimental testing of models of structures. Statistic analysis. Probabilistic analysis. Methods for fitting of data; least square method.

Method:

<i>Lectures</i>	<i>Exercises</i>	<i>Numerical and Graphical tasks</i>	<i>Use of software</i>	<i>Laboratory exercises</i>	<i>Seminar papers</i>	<i>Field lectures</i>
<i>Yes</i>	/	<i>Yes</i>	/	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>

Grading:

<i>Attendance of lectures</i>	<i>Obligatory tasks</i>	<i>Colloquia</i>	<i>Seminar papers</i>	<i>Written examination</i>	<i>Oral examination</i>
<i>Yes</i>	/	/	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>

References: *Main: Instructive materials prepared by lecturers*
Additional: Papers and other materials, video materials

Subject: ENGINEERING MATERIALS				
Code	Status	Semester	Number of ECTS credits	Number of lecture hours
EA-106	Optional	I	6	30

Curriculum of IZIIS' Postgraduate Studies

Earthquake Engineering Major (Curriculum – 2)

Enrollment conditions:

Name and surname of professors (participants in preparation of contents):

Principal lecturer: Assoc. Prof. Dr. Veronika Sendova

Other lecturers: Assist. Prof. Dr. Roberta Apostolska

Visiting professors:

Contents of the subject:

1. Introductory notes: role of materials science in engineering; why should materials be studied, classification of materials, modern needs.
2. Atomic structure and inter-atomic bonding“ main concepts; primary inter-atomic bonding; secondary inter-atomic bonding; molecules.
3. Structure of crystal materials: crystal structure, crystal vectors and planes, crystalline and non-crystalline materials.
4. Structure and mechanical characteristics of metals: main concepts; elastic deformations, (stress-strain relationship, characteristic of materials); plastic deformations, (characteristics under tension, compression, shear and torsion, real and engineering stress and strain, hardness of materials, design factors and safety factors). Phase diagrams in alloys: definitions and main concepts, phase diagrams in ferro-carbonate alloys. Smart materials: main principles and application.
5. Failure: fundamentals of rigid and ductile failure; principles of failure mechanics; fatigue of materials (S-N curves, initial opening and propagation of cracks, factors affecting fatigue); creeping of materials (behaviour at creeping, effects of level of stress and temperature);
6. Structure and characteristics of ceramics: crystal structure, phase diagrams, mechanical characteristics (stress-strain relationship, mechanisms of plastic deformations, advantages and setbacks, application in civil engineering);
7. Structure and characteristics of polymers: characteristics of hydrocarbon molecules, mechanical and thermo-mechanical characteristics of polymers, advantages and setbacks, application in civil engineering.
8. Composite materials: characteristics of: (1) composite materials strengthened by strips, (2) composite materials strengthened by fibers, (3) laminated composite materials; application of composite materials in civil and earthquake engineering;
9. Economic and social aspects in science and design of materials: design of components of materials, techniques of construction, possibilities for recycling.

Method:

Lectures	Exercises	Numerical and Graphical tasks	Use of software	Laboratory exercises	Seminar papers	Field lectures
Yes	/	/	/	Optional	/	/

Grading:

Attendance of lectures	Obligatory tasks	Colloquia	Seminar papers	Written examination	Oral examination
20%	/	30%	/	30%	50%

References: Main: Materials Science and Engineering – An Introduction, W.D. Callister – selected chapters
Additional: Selected scientific papers

Subject: FINITE ELEMENT ANALYSIS				
<i>Code</i>	<i>Status</i>	<i>Semester</i>	<i>Number of ECTS credits</i>	<i>Number of lecture hours</i>
EA-107	Optional	II	6	30

Curriculum of IZIIS' Postgraduate Studies						
Earthquake Engineering Major (Curriculum – 2)						
Enrollment conditions: Theory of Structures & Application						
Name and surname of professors (participants in preparation of contents):						
Principal lecturer: Assoc. Prof. Dr. Viktor Hristovski						
Other lecturers: Prof. Dr. Danilo Ristic						
Visiting professors:						
Contents of the subject:						
<ol style="list-style-type: none"> 1. Introduction to FEM; 2. Weighted-integral and weak formulations: need for weighted-integral forms, derivation of the weak form for a given differential equation, variational methods of approximation, the Rayleigh-Ritz method; 3. Finite elements of an elastic continuum: basic relations within an element, generalizations to the whole region, displacement approach as a minimization of total potential energy. 4. Plane stress and plane strain; 5. Axisymmetric stress analysis: plane strain as a special case of axisymmetry; 6. Three-dimensional stress analysis; 7. Shape functions: standard and hierarchical concept, standard shape functions, rectangular elements – serendipity family, triangular elements, area coordinates for triangles, three-dimensional rectangular prisms; 8. Mapped elements and numerical integration: parametric curvilinear coordinates, transformations, numerical integration; 9. Patch test for element validation: convergence requirements, simple patch test (forms a and b) – necessary condition for convergence, generalized patch test (test c), example with a bar element; 10. Implementation of iso-parametric elements into a computer code: introduction, preparation of input file, FORTRAN code, interpretation of results obtained by FEM analysis. 						
Method:						
<i>Lectures</i>	<i>Exercises</i>	<i>Numerical and Graphical tasks</i>	<i>Use of software</i>	<i>Laboratory exercises</i>	<i>Seminar papers</i>	<i>Field lectures</i>
Yes	Yes	Yes	Yes	/	Yes	/
Grading:						
<i>Attendance of lectures</i>	<i>Obligatory tasks</i>	<i>Colloquia</i>	<i>Seminar papers</i>	<i>Written examination</i>	<i>Oral examination</i>	
5%	5%	/	20%	35%	35%	
References: Main: Finite Element Method, O.C. Zienkiewicz and R.L. Taylor, 4 Edition, 1989. Additional: Finite Element Procedures, K. J. Bath, Prentice Hall, 1996, Introduction to FEM, J. N. Redy.						

		Subject: INTRODUCTION TO MATLAB AND ITS APPLICATION IN ENGINEERING ANALYSES		
Code	Status	Semester	Number of ECTS credits	Number of lecture hours
EA-108	Optional	I	6	30

Curriculum of IZIIS' Postgraduate Studies						
Structural Engineering & Seismic Resistant Design Major (Curriculum – 1)						
Enrollment conditions:						
Name and surname of professors (participants in preparation of contents):						
Principal lecturer: Dr. Katarina Manova, Scientific Collaborator						
Other lecturers:						
Visiting professors:						
Contents of the subject:						
Introduction to MATLAB and its application in solving problems in the domain of engineering and applied mathematics.						
MATLAB starting; some useful commands: syntax, main operators, numbers and formats.						
Use of MATLAB in linear algebra: vectors and vector operations in MATLAB; main operations with matrices in MATLAB, determinants, inverse and transposed matrices, special matrices; characteristic values and characteristic vectors of matrices (eigenvalues and eigenvectors of matrices); solving of systems of linear equations; application in linear algebra.						
Numerical analyses with MATLAB: MATLAB functions; roots of polynoms; zero functions; interpolations; numerical integrations and derivations.						
Use of graphics in MATLAB: 2-dimensional graphics, main drawings, multiplots, subplots; 3-dimensional graphics, plotting of three-dimensional structures and surfaces. Flow-control instructions in MATLAB: for loop; while loop, if statement.						
Programming in MATLAB: mimeographed notes and functional programmes.						
Method:						
<i>Lectures</i>	<i>Exercises</i>	<i>Numerical and Graphical tasks</i>	<i>Use of software</i>	<i>Laboratory exercises</i>	<i>Seminar papers</i>	<i>Field lectures</i>
Yes	Yes	Yes	Yes	Yes	/	/
Grading:						
<i>Attendance of lectures</i>	<i>Obligatory tasks</i>	<i>Colloquia</i>	<i>Seminar papers</i>	<i>Written examination</i>	<i>Oral examination</i>	
20%	30%	/	30%	/	50%	
References: Main: MATLAB Primer, Kermit Sigmon, An Introduction to MATLAB, David F. Griffiths, An Introduction to Numerical Linear Algebra, Charles G. Cullen, 1994, Selected chapters, Numerical Mathematics and Computing, Ward Cheney, David Kincaid, 1999, selected chapters						
Additional: Instructive materials prepared by the IZIIS' lecturer in the subject.						

		Subject: SEISMIC DESIGN OF RC, STEEL AND MASORNY STRUCTURES		
Code	Status	Semester	Number of ECTS credits	Number of lecture hours
EA-201	Obligatory	II	6	30

Curriculum of IZIIS' Postgraduate Studies						
Earthquake Engineering Major (Curriculum – 2)						
Enrollment conditions: Dynamics of Structures and Analysis of Structures						
Name and surname of professors (participants in preparation of contents):						
Principal lecturer: Prof. Dr. Golubka Necevska Cvetanovska						
Other lecturers: Assist. Prof. Dr. Roberta Apostolska						
Assoc. Prof. Dr. Veronika Sendova						
Visiting professors:						
Contents of the subject:						
Experience from occurred earthquakes – damages to structures caused by recent earthquakes. Behaviour of structures under the effect of earthquakes and dynamic loads. Seismic design concepts; seismic design and seismic behaviour (ultimate states of seismic design; characteristics of structures).						
Seismically resistant structural systems (structural systems to sustain seismic forces, effect of structural configuration upon seismic response, classification of structures in respect to designed ductility level).						
Definition of design quantities (design loads and forces, design load combinations, definition of strength, strength reduction factors, seismic forces).						
Basic principles of seismic design of buildings and safety criteria. Methodology and approach to seismic design of structures.						
Philosophy of design based on structural capacity (main characteristics, illustrative analogy, design based on capacity of structures (illustrative example).						
Comparison of seismic forces obtained according to different regulations. Brief review of existing seismic regulations.						
Method:						
<i>Lectures</i>	<i>Exercises</i>	<i>Numerical and Graphical tasks</i>	<i>Use of software</i>	<i>Laboratory exercises</i>	<i>Seminar papers</i>	<i>Field lectures</i>
Yes	/	/	Yes	/	/	/
Grading:						
<i>Attendance of lectures</i>	<i>Obligatory tasks</i>	<i>Colloquia</i>	<i>Seminar papers</i>	<i>Written examination</i>	<i>Oral examination</i>	
10%	/	/	/	/	90%	
References: <i>Main: Seismic Design of Reinforced Concrete and Masonry Structures, Pauley and Priestley 1992, Design of Aseismic Buildings, Wakabayashi, McGraw Hill Book Company 1986, Eurocode 8, Design of Seismically Resistant Structures, Part 1-1 General Rules. Seismic Effect and Rules for Buildings</i>						
<i>Additional: Instructive material prepared by the IZIIS' lecturers in the subject</i>						

Subject: SEISMIC RISK AND VULNERABILITY ANALYSIS				
<i>Code</i>	<i>Status</i>	<i>Semester</i>	<i>Number of ECTS credits</i>	<i>Number of lecture hours</i>
EA-202	Obligatory	II	6	30

Curriculum of IZIIS' Postgraduate Studies						
Earthquake Engineering Major (Curriculum – 2)						
Enrollment conditions: Engineering Seismology						
Name and surname of professors (participants in preparation of contents):						
Principal lecturer: Prof. Dr. Zoran Milutinovic						
Other lecturers: Assist. Prof. Dr. Goran Trendafiloski						
Visiting professors:						
Contents of the subject:						
Overview of fundamentals of seismic hazard analysis						
Seismic source parameters; effects of local site conditions; principal collateral hazards: landslides, liquefaction, tsunamis; seismic parameters for vulnerability and risk analysis.						
Earthquake damage and usability classification						
Inventory of elements at risk; damage and usability classification of buildings, transportation systems and lifelines, facilities with essential emergency functions, facilities with a potential to suffer huge losses.						
Concept of vulnerability, vulnerability/Fragility functions						
Empirical, experimental and analytical vulnerability functions for buildings and structures; vulnerability of earthquake non-resistant and earthquake resistant structures; damage potential and vulnerability of infrastructure and utility systems.						
Seismic risk analysis						
Inventory, presentation and density distribution of elements at risk, loss prediction potential, loss per element at risk, cumulative loss analysis and presentation; seismic risk analysis; optimisation of seismic risk, acceptable level of seismic risk.						
GIS technology for seismic risk assessment						
Introduction, current state-of-the-art, inventory, data attributization and matching, development and structuring of layers, analysis, thematic mapping, generation of results, decision making, traditional versus dynamic system for support to decision making, new technologies for monitoring and managing of risk pertaining to catastrophes.						
Method:						
<i>Lectures</i>	<i>Exercises</i>	<i>Numerical and Graphical tasks</i>	<i>Use of software</i>	<i>Laboratory exercises</i>	<i>Seminar papers</i>	<i>Field lectures</i>
60%	/	20%	/	/	20%	/
Grading:						
<i>Attendance of lectures</i>	<i>Obligatory tasks</i>	<i>Colloquia</i>	<i>Seminar papers</i>	<i>Written examination</i>	<i>Oral examination</i>	
Yes	Yes	Yes	Yes	Yes	Yes	
References: Main: Mimeographed notes for DAAD master studies prepared by Prof. Dr. Z. Milutinovic Additional: Selected scientific papers						

Subject: PLANNING AND MANAGEMENT OF PROJECTS				
Code	Status	Semester	Number of ECTS credits	Number of lecture hours
EA-203	Obligatory	II	6	30

Curriculum of IZIIS' Postgraduate Studies						
Structural Engineering & Seismic Resistant Design Major (Curriculum – 1)						
Enrollment conditions:						
Name and surname of professors (participants in preparation of contents):						
Principal lecturer: Prof. Dr. Mihail Garevski						
Other lecturers:						
Visiting professors:						
Contents of the subject:						
<p>Today, the necessity of planning and management of projects is imposed in all the activities of human life. The projects are becoming increasingly complex wherefore there is a need of training of staff, who will deal with this problem in future. Planning and management of projects is needed also when constructing complex structures or structures requiring big investments.</p> <p>Knowledge in planning of projects is necessary even when big scientific-research and educative projects (local and international large scale projects) are to be carried out. The contents proposed for this subject are the following:</p> <ol style="list-style-type: none"> 1. Project Management Environment 2. Project Organization 3. Planning and Management of Human and Other Resources 4. Financial Planning and Managing of Project 5. Project Control 6. Project Communications 7. Computer Applications in Project Design 						
Method:						
<i>Lectures</i>	<i>Exercises</i>	<i>Numerical and Graphical tasks</i>	<i>Use of software</i>	<i>Laboratory exercises</i>	<i>Seminar papers</i>	<i>Field lectures</i>
Yes	/	/	Yes	/	Yes	/
Grading:						
<i>Attendance of lectures</i>	<i>Obligatory tasks</i>	<i>Colloquia</i>	<i>Seminar papers</i>	<i>Written examination</i>	<i>Oral examination</i>	
5%	30%	/	/	50%	15%	
References: <i>Main: Materials recommended by the lecturer in the subject</i> <i>Additional: Selected scientific papers</i>						

Subject: EARTHQUAKE RESISTANCE OF RC BUILDINGS				
Code	Status	Semester	Number of ECTS credits	Number of lecture hours
EA-204	Optional	II	6	30

Curriculum of IZIIS' Postgraduate Studies						
Earthquake Engineering Major (Curriculum – 2)						
Enrollment conditions: Dynamics of Structures, Analysis of Structures, Seismic Design of RC, Steel and Masonry Structures						
Name and surname of professors (participants in preparation of contents):						
Principal lecturer: Prof. Dr. Golubka Necevska - Cvetanovska						
Other lecturers: Assist. Prof. Dr. Roberta Apostolska						
Visiting professors:						
Contents of the subject:						
<p>Strength and deformability characteristics of concrete and steel exposed to cyclic loads. Nonlinear behaviour of RC structural elements. Main principles of nonlinear analysis of RC cross-sections and elements; effect of bending, axial forces and shear forces; confinement; ductility.</p> <p>Design of RC buildings; philosophy of design; design according to different regulations. Strength and ductility capacity of structural elements; nonlinear behaviour of RC beams and columns under the effect of monotonous and cyclic loads; methodology for definition of strength and displacement capacity of structural elements and buildings. Analysis of inelastic response of RC buildings exposed to different earthquakes; hysteretic behaviour of RC buildings. Methodology for seismic design of new RC structures and evaluation of seismic resistance of existing RC structures (RESIST-INELA methodology). Numerical example: analysis, design and evaluation of seismic resistance of a five-storey RC building.</p>						
Method:						
<i>Lectures</i>	<i>Exercises</i>	<i>Numerical and Graphical tasks</i>	<i>Use of software</i>	<i>Laboratory exercises</i>	<i>Seminar papers</i>	<i>Field lectures</i>
Yes	Yes	Yes	Yes	/	Yes	/
Grading:						
<i>Attendance of lectures</i>	<i>Obligatory tasks</i>	<i>Colloquia</i>	<i>Seminar papers</i>	<i>Written examination</i>	<i>Oral examination</i>	
10%	/	2 x 20%	40%	40%	10%	
References: <i>Main: Design of Earthquake Resistant Buildings, Wakabayashi, McGraw-Hill Book Company, 1986, Seismic Design of Reinforced Concrete and Masonry Buildings, Paulay and Priestley, 1992, Reinforced Concrete Structures, Park and Paulay, 1975, Eurocode 8: Design of Structures for Earthquake Resistance, Part 1-1: General Rules, Seismic Action and Rules for Buildings.</i>						
<i>Additional: Instructive materials prepared by the IZIIS' lecturers in the subject</i>						

		Subject: ANALYSIS OF SEISMIC RESISTANCE OF STEEL, MASONRY AND TIMBER STRUCTURES		
Code	Status	Semester	Number of ECTS credits	Number of lecture hours
EA-205	Optional	II	6	30

Curriculum of IZIIS' Postgraduate Studies Earthquake Engineering Major (Curriculum – 2)						
Enrollment conditions:						
Name and surname of professors (participants in preparation of contents): Principal lecturer: Assist. Prof. Dr. Roberta Apostolska Other lecturers: Assoc. Prof. Dr. Veronika Sendova Visiting professors:						
Contents of the subject:						
<p>Steel structures: learning from past earthquakes - damage to steel structures during recent earthquakes. Classification of failure mechanisms. Study of nonlinear behavior of steel structural elements - beams, columns and joints under monotonic and cyclic loads. Steel structural systems in seismic areas. Evaluation of q-factor. Seismic design of steel structures. Design methodology based on ductility. Required ductility, ductility capacity of seismically resistant steel structures. Recommendations for seismic design of different steel structural systems. Numerical example – design and evaluation of seismic resistance of a steel structure.</p> <p>Masonry structures: introduction; behaviour of masonry structures during earthquakes: analysis of occurred damage, failure mechanism of individual walls, failure mechanisms in structures, reasons for failure of masonry structures; seismic resistance of existing masonry structures: analysis of bearing capacity of plain, framed and reinforced masonry; analysis of deformability capacity of plain, framed and reinforced masonry; seismic resistance of cultural historic structures and monuments; numerical examples: evaluation of seismic resistance of an existing masonry structure.</p> <p>Timber structures: introduction: behaviour of timber structures during earthquakes: analysis of occurred damage, failure mechanisms, reasons for damage and failure of timber structures; seismic resistance of existing timber structures.</p>						
Method:						
<i>Lectures</i>	<i>Exercises</i>	<i>Numerical and Graphical tasks</i>	<i>Use of software</i>	<i>Laboratory exercises</i>	<i>Seminar papers</i>	<i>Field lectures</i>
Yes	Yes	/	Yes	/	Yes	/
Grading:						
<i>Attendance of lectures</i>	<i>Obligatory tasks</i>	<i>Colloquia</i>	<i>Seminar papers</i>	<i>Written examination</i>	<i>Oral examination</i>	
10%	/	/	20%	30%	40%	
References: <i>Main: Theory and Design of Seismically Resistant Steel Frames, F. M. Mazzolani and V. Piluso, Chapman & Hall, 1996, Ductility of Seismic Resistant Steel Structures, V. Giancu and F.M. Mazzolani, Spon 2000, Seismic Design of Wood and Masonry Buildings, The Seismic Design Handbook, F. Naeim 2000, Earthquake Resistant Design of Masonry Buildings by M. Tomazevic, Eurocode 8: Design of Structures for Earthquake Resistance, Part 1-1: General Rules, Seismic Action and Rules for Buildings.</i> <i>Additional: Instructive material prepared by the IZIIS' lecturers in the subject.</i>						

Subject: <i>PLANNING AND DESIGN OF TRANSPORTATION SYSTEMS AND OTHER INFRASTRUCTURE SYSTEMS IN SEISMIC REGIONS</i>				
<i>Code</i>	<i>Status</i>	<i>Semester</i>	<i>Number of ECTS credits</i>	<i>Number of lecture hours</i>
EA-206	Optional	II	6	30

Curriculum of IZIIS' Postgraduate Studies Earthquake Engineering Major (Curriculum – 2)						
Enrollment conditions:						
Name and surname of professors (participants in preparation of contents): Principal lecturer: Prof. Dr. Danilo Ristic Other lecturers: Assoc. Prof. Dr. Vlado Micov Visiting professors:						
Contents of the subject:						
<p>Typical earthquake damage to bridges: effects of site conditions and structural configuration, damage to substructures, bearings and superstructures. Seismic analysis of bridges: concept of a single-degree-of-freedom system, concept of a multi degree-of-freedom system, application of response spectrum, linear dynamic analysis, nonlinear dynamic analysis. Nonlinear expert analysis of bridges: classification, general guidelines, nonlinear section analysis, formulation of nonlinear models, nonlinear analysis of integral bridges. Seismic design philosophy: basic seismic design philosophy, performance-based criteria, performance-based design. Seismic design of reinforced concrete bridges: Performance of columns, flexural and shear design of piers, pier-beam connections, pier-footing design. Seismic design of steel bridges: ductile moment resisting frame, ductile braced frame, combined systems. Seismic isolation of bridges: basic concept, modeling and analysis, modeling of seismic isolation and energy dissipation devices, performance and testing requirements, design guidelines. Soil-foundation-structural interaction: Typical problems, characterization of soil-foundation-structure interaction. Seismic retrofitting: information system, identification, prioritization, performance criteria, structural state diagnosis, retrofit design. Structural health monitoring, dynamic in-situ testing, seismic instrumentation of bridges, bridge maintenance. Seismic design of transportation systems and lifelines: seismic parameters, collateral hazards (fault rupture, landslides, rock falls, liquefaction, tsunamis). Damage and vulnerability assessment: vibration induced effects, ground failure along the routes and specific structural systems, earthquake damage classification and damage potential. Planning and design of regional and urban lifelines: water supply systems, gas systems, design of specific structures, pipelines, underground structures; principal code requirements.</p>						
Method:						
<i>Lectures</i>	<i>Exercises</i>	<i>Numerical and Graphical tasks</i>	<i>Use of software</i>	<i>Laboratory exercises</i>	<i>Seminar papers</i>	<i>Field lectures</i>
Yes	Yes	Yes	Yes	/	Yes	/
Grading:						
<i>Attendance of lectures</i>	<i>Obligatory tasks</i>	<i>Colloquia</i>	<i>Seminar papers</i>	<i>Written examination</i>	<i>Oral examination</i>	
Yes	Yes	/	yes	/	Yes	
References: <i>Main: Materials recommended by the lecturers in the subject</i> <i>Additional: Selected scientific papers</i>						

Subject: SEISMIC DESIGN OF DAMS				
<i>Code</i>	<i>Status</i>	<i>Semester</i>	<i>Number of ECTS credits</i>	<i>Number of lecture hours</i>
EA-207	Optional	II	6	30

Curriculum of IZIIS' Postgraduate Studies						
Earthquake Engineering Major (Curriculum – 2)						
Enrollment conditions:						
Name and surname of professors (participants in preparation of contents):						
Principal lecturer: Assoc. Prof. Dr. Violeta Mircevska						
Other lecturers: Assoc. Prof. Dr. Vlatko Sesov						
Visiting professors:						
Contents of the subject:						
<p>1. Seismic design of gravity and arch dams. Seismic behavior of dams and types of damage due to occurred earthquakes. Definition of principal and additional loads due to seismic effect, hydrodynamic pressure and inertial forces. Mathematical modeling by including dam-soil-reservoir interaction, concepts and methods of analysis. Definition of main parameters of the mathematical model, stiffness, mass, damping. Analysis of discontinuities, i.e., structural and parametric joints. Definition of parameters of contact elements. Field surveys and analysis of natural vibrations. Linear and nonlinear stress-strain state. Stability criteria. Instructions for improvement of seismic safety in design of dams.</p> <p>2. Seismic design of dams constructed of local materials. Seismic behavior of dams exposed to earthquakes. Comments on statistic data on typical damage due to occurred earthquakes. Mathematical modeling by application of linear and nonlinear mathematical models. Effect of change of pore pressure upon stability of dams. Dynamic response of dams. Characteristics of natural vibrations, effect of geomechanical characteristics of materials present upon the dynamic response. Effect of dam-reservoir-foundation interaction. Effect of the dam geometry upon the stress-strain state. Stability criteria. Instructions for improvement of the seismic stability of dams.</p> <p>3. Special attention is paid to mathematical modeling of 2D and 3D models by application of finite elements, boundary elements and contact elements. Application of computer programmes in analysis of dams.</p>						
Method:						
<i>Lectures</i>	<i>Exercises</i>	<i>Numerical and Graphical tasks</i>	<i>Use of software</i>	<i>Laboratory exercises</i>	<i>Seminar papers</i>	<i>Field lectures</i>
Yes	Yes	Yes	/	Yes	/	
Grading:						
<i>Attendance of lectures</i>	<i>Obligatory tasks</i>	<i>Colloquia</i>	<i>Seminar papers</i>	<i>Written examination</i>	<i>Oral examination</i>	
5%	5%	/	30%	30%	30%	
References: Main: Dam Engineering, Volumes 1, 2 and 3, Hinds and Geger & Jastine Additional: ICOLD reports						

		Subject: REPAIR AND STRENGTHENING OF STRUCTURES		
Code	Status	Semester	Number of ECTS credits	Number of lecture hours
<i>EA-208</i>	<i>Optional</i>	<i>II</i>	<i>6</i>	<i>30</i>

Curriculum of IZIIS' Postgraduate Studies Earthquake Engineering Major (Curriculum – 2)						
Enrollment conditions:						
Name and surname of professors (participants in preparation of contents): Principal lecturer: Prof. Dr. Zivko Bozinovski Other lecturers: Assoc. Prof. Dr. Veronika Sendova Visiting professors:						
Contents of the subject:						
REPAIR AND STRENGTHENING OF BUILDINGS Introduction: post-earthquake damage evaluation and emergency measures for temporal protection, data collection, evaluation of damage, inspection and recommendations, short and long term activities for elimination of earthquake consequences; Repair and strengthening design procedure: criteria for repair and/or strengthening, definition of characteristics of material, definition of capacity and required strength, stiffness and deformability of structural elements and integral systems, damage evaluation and selection of repair and/or strengthening solution; materials, methodology and technique of strengthening; conventional concrete, , special concrete and mortar, polymer modified concrete, gunite concrete, resins, grouting, epoxides and other. Repair and strengthening of R/C structures: columns, beams, beam-column joints, shear walls, slabs; Repair and strengthening of structural systems and introducing new elements as shear walls, infill walls, wing walls, etc.; analysis and detailing. Masonry structures: repair of walls, strengthening of walls by ties (steel sections), R/C jacketing, injection, construction techniques, method for analysis and design procedure. Special structures and industrial facilities: bridges, lifeline systems, industrial facilities and equipment experimental investigations, codes and regulations, experience and recent knowledge.						
REPAIR AND STRENGTHENING OF MONUMENTS Introduction: (significance of cultural heritage, definitions, criteria and strategy, earthquake protection of historic buildings and monuments); specific characteristics of masonry in historic structures: (materials, structural elements, experimental and analytical investigations of materials and structures); Material and methods for repair, structural strengthening and conservation; case studies: (Byzantine Monuments in Macedonia, reconstruction and rebuilding of monuments, examples of repair and strengthening of monuments in the world).						
Method:						
<i>Lectures</i>	<i>Exercises</i>	<i>Numerical and Graphical tasks</i>	<i>Use of software</i>	<i>Laboratory exercises</i>	<i>Seminar papers</i>	<i>Field lectures</i>
<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>
Grading:						
<i>Attendance of lectures</i>	<i>Obligatory tasks</i>	<i>Colloquia</i>	<i>Seminar papers</i>	<i>Written examination</i>	<i>Oral examination</i>	
<i>Yes</i>	<i>Yes</i>	<i>/</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	
References: <i>Main: Materials recommended by the lecturers in the subject</i> <i>Additional: Selected scientific papers</i>						

		Subject: SEISMIC ANALYSIS AND DESIGN OF SPECIAL STRUCTURES		
Code	Status	Semester	Number of ECTS credits	Number of lecture hours
EA-209	Optional	II	6	30

Curriculum of IZIIS' Postgraduate Studies Earthquake Engineering Major (Curriculum – 2)						
Enrollment conditions:						
Name and surname of professors (participants in preparation of contents): Principal lecturer: Assoc. Prof. Dr. Zoran Rakicevic Other lecturers: Prof. Dr. Mihail Garevski Visiting professors:						
Contents of the subject:						
Main concept of design of seismically resistant structures General concept: earthquake levels, seismic categorization of structures, systems and components, combination of seismic loads and other loads, allowable stress and strain limits, procedure and approach to definition of seismic excitation, damping values. Modeling techniques. Analytical approaches for main structures. Design aspects for primary structures. Seismic aspects related to secondary systems: seismic qualification. Uncertainties in seismic design and analysis.						
New technology for design of seismically resistant structures Base isolation: - Introduction - Principles of base isolation - Types of isolators and their characteristics - Isolation of buildings - Isolation of bridges Passive energy dissipation systems - Introduction - Principles and types of dampers - Design with damping - Practical application (examples)						
Method:						
<i>Lectures</i>	<i>Exercises</i>	<i>Numerical and Graphical tasks</i>	<i>Use of software</i>	<i>Laboratory exercises</i>	<i>Seminar papers</i>	<i>Field lectures</i>
Yes	/	Yes	Yes	/	/	/
Grading:						
<i>Attendance of lectures</i>	<i>Obligatory tasks</i>	<i>Colloquia</i>	<i>Seminar papers</i>	<i>Written examination</i>	<i>Oral examination</i>	
10%	20%	/	/	70%	/	
References: <i>Main: Materials recommended by the lecturers in the subject</i> <i>Additional: Selected scientific papers</i>						

Subject: DESIGN BY APPLICATION OF EUROCODE 8				
Code	Status	Semester	Number of ECTS credits	Number of lecture hours
EA-210	Optional	II	6	30

Curriculum of IZIIS' Postgraduate Studies Earthquake Engineering Major (Curriculum – 2)						
Enrollment conditions:						
Name and surname of professors (participants in preparation of contents): Principal lecturer: Prof. Dr. Mihail Garevski Other lecturers: Prof. Dr. Golubka Necevska Cvetanovska Prof. Dr. Danilo Ristic Prof. Dr. Zoran Milutinovic Visiting professors:						
Contents of the subject:						
Main concept of design of structures by application of Eurocode 8:						
<ol style="list-style-type: none"> 1. Principles and design guidelines; 2. Fundamental requirements and requirements for structural „performance“; 3. Soil conditions and seismic effects; 4. Design of seismically resistant buildings (basic principles, analysis of structures, verification of seismic safety); 5. Specific requirements (rules) for reinforced-concrete buildings (definitions, design concepts, design guidelines for specific elements and details); 6. Specific requirements for steel buildings (definitions, design concepts, specific design guidelines for different structural elements and details); 7. Specific requirements for composite structures constructed of steel and concrete (definitions, specific design requirements for different structural elements and structural details); 8. Specific requirements for timber structures (main requirements and design guidelines); 9. Specific requirements for masonry structures (main requirements and design guidelines); 10. Base isolation of structures (definitions and specific design requirements); 11. Practical recommendations for application of Eurocode 8 in design practice. 						
Method:						
<i>Lectures</i>	<i>Exercises</i>	<i>Numerical and Graphical tasks</i>	<i>Use of software</i>	<i>Laboratory exercises</i>	<i>Seminar papers</i>	<i>Field lectures</i>
Yes	/	/	Yes	/	Yes	/
Grading:						
<i>Attendance of lectures</i>	<i>Obligatory tasks</i>	<i>Colloquia</i>	<i>Seminar papers</i>	<i>Written examination</i>	<i>Oral examination</i>	
5%	30%	/	/	50%	15%	
References: <i>Main: Materials recommended by the lecturers in the subject</i> <i>Additional: Selected scientific papers</i>						