COURSE DESCRIPTION

Name of the Course:	**NONLINEAR ANALYSIS OF STRUCTURES**							
Specialization Code:	**U02.07.ICV.IZ.M26**			**Course Code:**	**2.DD.OB08**			
Year of study:	**1**	**Semester:**	**2**	**Examination form:** (**E-**Exam; **Co-** Colloquy; **P-**Project**; P/F-**Passed/Failed)	**Co**	**ECTS credits granted (CR):**	**E (Co)**	**3**
							P (P/F)	
Course Category: (**DF**- Fundamental; **DD**- General engineering; **DS**-Specialty engineering; **DC**-Complementary; **PR**-Practical stage)								**DD**
Course Type: (**OB**-Compulsory**; OP**-Elective**; FC**-Facultative)								**OB**
Number of hours per semester: Total of hours per week (TH) x Number of weeks per semester								
TOTAL :	70	**Individual study** (IS)**:**		28	**Contact hours (C + S;L;P):**			42
Academic staff member in charge: (Full name, Academic position and Department)		*Ştefan Beţea conf.dr.ing Strength of Materials Bridges and Tunnels dept.*						

Faculty	**Engineering in foreign languages Master study programme**		**Number of contact hours per semester**				
			Total	Course	Seminar	Laboratory	Project
Field	**Civil Engineering**						
Specialization	**Structural Engineering**		42	28		14	-

Course objectives - Description of the main competences: Acquisition of knowledge concerning the main theoretical and practical problems in nonlinear analysis with specialized computer programs.

Content description:

1. COURSE	1. Models of nonlinear behavior of materials under monotonic and cyclic loadings. … 2 h 2. Plasticity criteria for ductile materials. Associated flow rule and elastic-plastic material stiffness matrix. … 4 h 3. Moment-curvature diagrams for steel and RC sections. Programmable algorithms. … 2 h 4. Interaction curves M-N and M-T for steel and RC sections. Programmable algorithms. … 2 h 5. Direct determination of plastic mechanism. Theorems of minimum and maximum of loading parameter. Method of inequalities and kinematic method. … 2 h 6. The combination of mechanisms method. Typical beam mechanisms and a preliminary plastic design of multistory frames. … 2 h 7. Elastic-plastic tangent stiffness matrix of elements. Iterative procedures for solving nonlinear systems of equations. … 4 h 8. Biographical analysis of plane frames. Check of collapse mechanism by equations of virtual work. … 2 h 9. Global verification of structures at seismic action. Energy balance, inelastic spectra, capacity spectrum. … 2 h 10. Yield lines method for plane plates. … 2 h 11. Elements of geometrically nonlinear analysis. P – Δ effect, geometric stiffness matrix. … 2 h 12. Elements of nonlinear dynamic analysis. Mass and damping matrices. Methods for numerical integration of equation of motion. … 2 h
2. Seminar / Laboratory / Project / Practical stage	1. Computation of materials characteristic curves parameters. Stiffness and strength deterioration at cyclic loading. … 1h 2. Moment-curvature and M-N interaction curves of a RC section. … 1h 3. Computation of collapse load level for frames with a known position of plastic hinges. … 1 h 4. Preparation of input data for a nonlinear analysis program. … 2 h

	5. Preliminary plastic design of a plane frame and a pushover analysis. … 3 h 6. Capacity spectrum diagram after a pushover analysis. … 1 h 7. Computation of the ultimate capacity of plane plate with the yield lines method. … 1 h 8. Examples of case studies of nonlinear static and dynamic analysis – input data, interpretation of results. … 4 h
3. Bibliography	1. V. Banut, Calculul neliniar al structurilor. Ed. Tehnica 1981 2. Ch. Masssonet s.a. Calculul structurilor la calculatoare electronice. Ed Tehnica 1974 3. D.R.J. Owen, E. Hinton, Finite Elements in Plasticity. Pineridge Press 1980 4. Advanced structural analysis. IIT Madras course. http://freevideolectures.com/Course/3015/Advanced-Structural-Analysis 5. Nonlinear finite element analysis. MIT course. http://www.youtube.com/playlist?list=PL75C727EA9F6A0E8B&feature=plcp

Criteria to be considered for the final mark	**Weight of each criterion in the final mark (%)**
1. Exam defence (final examination)	40%
2. Appreciation during the entirely semester	
2.1 Seminar activity	
2.1 Laboratory activity	20%
2.2 Project activity (the project has not a distinct final mark)	
3. Periodical examinations	
3.1 Written / oral examination	10%
3.2 Home works, reports, essays etc.	30%
4. Other criteria (to be specified)	
Short description of the final evaluation procedure: a practical computer application and questions from theoretical presentations.	

Estimation of the total number of hours per semester requested for the individual study (IS)

Type of individual activity	No. of hours		Type of individual activity	No. of hours
1. Study of the course notes	10		8. Preparation of the final examination	10
2. Study of the compulsory bibliography	2		9. Advisory class participation	2
3. Study of the supplementary bibliography	2		10. Practical documentation on site	
4. Preparation of specific activities			11. Additional documentation on library	
5. Preparation of home works	2		12. Internet network documentation	
6. Preparation of periodical written examinations			13. Others (to be specified)	
7. Preparation of periodical oral examinations			**TOTAL number of hours**	28

Date:
septembre 2017

Signature of the Academic Staff member in charge:
Ştefan Beţea