POLITEHNICA University of Bucharest (**UPB**)
Faculty of Industrial Engineering and Robotics (**IIR**)
Study Programme: Industrial Engineering (**IE**)
Form of study: Licence (Bachelor)

COURSE SPECIFICATION

Course title:	**Finite Element Analysis of Solids**	*Semester:*	5
Course code:	UPB.06.S.05.A.006	*Credits (ECTS):*	4

Course structure	Lecture	Seminar	Laboratory	Project	Total hours
Number of hours per week	2	-	2	-	4
Number of hours per semester	28	-	28	-	56

Lecturer	Lecture	Seminar / Laboratory / Project
Name, academic degree	Ştefan Sorohan, Prof.	Emil Nuţu, Lecturer
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Course description:

The objective of the course is introducing finite element method for approximate numerical solutions of engineering problems. The course concentrates on solution of structural problems, but also provides the basis for expanding that focus to other engineering field problems (e.g., thermal, fluid).
The course is presented in the classic way.In designing the course, our aim is to produce students capable of: a) understanding the theoretical background; b) appreciating the structure of finite element programs for potential amendment and development; c) running packages and assessing their limitations; d) taking a detached view in checking output; e) understanding failure messages and finding ways of rectifying the errors. The course syllabus is controlled to 2D linear elastic structural problems. The course is divided into two parts. Firstly, the assembly process without any approximations -illustrated by frameworks, followed by the true finite element process which involves approximations. This is achieved starting with trusses, then with beams and plane frames, and progressively dealing with membrane and plate-bending elements. 3D solid elements and shells are treated in the last part.
Our objective is to ensure that students will get: a) a familiarity in working with matrix methods and developing stiffness matrices; b) an understanding of global versus local coordinate systems; c) the ability to use the minimum potential energy theorem and virtual work equations; d) the mapping from isoparametric space to real geometrics and the need for numerical integration; e) an insight in numerical techniques for linear equation solving (Gauss elimination, frontal, sparse and iterative solvers); f) the need to use of equilibrium, compatibility, stress/strain relations and boundary conditions to solve structural problems.

Seminar / Laboratory / Project description:

The objective of the applications is to train the fundamentals of finite element method with emphasize on the underlying theory, assumption, and modelling issues as well as providing hands on experience using finite element software to model, analyze and design systems of relevance to mechanical engineers. The outline of the labs is as follows: 1. Approximate solution of boundary values problem; 2. Introduction to continuous/discrete problems 3. Linear elasticity (Structural Analysis for 2D models); 4. Specialized elements (Truss and Beam elements); 5.Mesh generation and modelling concerns; 6. Stationary and transient analysis. The applications (labs) activities pass of on half of groups in the computer laboratory rooms using in-house finite element codes at beginning and a commercial code (ANSYS) at the end of course. Usually the first problem of each chapter is presented by teacher, the next ones are proposed and each student must to solve them. The results are then discussed by the teacher.

Intended learning outcomes:

Students who successfully complete the course will demonstrate the following outcomes by test, work in the laboratory and two engineering reports.Relevant criteria: ability to apply knowledge of mathematics, science and engineering to design a system to meet desired needs; ability to identify, formulate, and solve engineering problems and to communicate effectively;ability to use the techniques, skills, and modern engineering tools necessary for engineering practice, a knowledge of modern issues.Concrete:students will be able to solve and analyze a set of linear elastic structures - plane frames, plane strain, plane stress, axial symmetric or 3-D by means of the finite element method using the in-house programs or the commercial software ANSYS; students will read and discuss finite element literature including the history of its development as well as recent and current applications. Results, including failures, can be discussed. Students will can read about applications in the current mechanical engineering literature.

References:

1. M. Radeş, *Finite Element Analysis*, Editura Printech, Bucureşti, 2006
2. I.N. Constantinescu,**Şt. Sorohan**, Şt. Pastramă, *The Practice of Finite Element Modeling and Analysis*, EdituraPrintech, Bucureşti, 2006
3. **Şt. Sorohan**, I.N. Constantinescu, *Practica modelării şi analizei cu elemente finite*, Editura Politehnica Press, Bucureşti, 2003
4. **Şt. Sorohan**, C. Petre, *Programe şi aplicaţii cu elemente finite*, Editura Printech, Bucureşti, 2004
5. R.D. Cook, D.S. Malkus and M.E. Plesha, *Concepts and Applications of Finite Element Analysis*, Wiley, 1989
6. **Şt. Sorohan**, *Modelare cu elemente finite în analiza dinamică a structurilor*, Editura Matrix Rom, ISBN 978-973-755-696-7, Bucureşti, 2011

Prerequisites:	***Co-requisites*** ***(courses to be taken in parallel as a condition for enrolment):***

Technical Mechanics; Mathematics 1& 2; Computer Programming 1& 2; Mechanics of Materials 1& 2; Computer Aided Design 1&2;	-

Assessment method:	% of the final grade	Minimal requirements for award of credits
Written exam	40	20
Report / project	-	-
Homework	30	15
Laboratory	30	15
Other	-	-

Machine elements; Modelling and simulation	
Additional relevant information:	
Requirements for 5 grade. Basics on: a) Definitions of FEA, analysis domain, discretization; b) Boundary conditions types, necessity of imposed displacements in static structural analysis; c) Terminology and signification of derivate quantities: stress, strain etc; d) Graphical interpretation of results. Requirements for 10 grade. Be able to prove understanding of: a) types of simulations with respect to output analysis; b) Basic finite element stiffness matrix formulation; c) Measures of finite element model performance; d) Model generation, input data verification and solution circumstances; e) Verification of simulation models; f) Updating and validation of models.	

Date:11.07.2016
Prof.ŞtefanSorohan: