(B) Course information in English

General course information:

Course title:	**FINITE ELEMENTS**	**Course code:**	ΔΟ0100
Credits:	6	**Work load (hours):**	170
Course level:	Undergraduate ☒	Graduate ☐	
Course type:	Mandatory ☐	Selective ☒	
Course category:	Basic ☐	Orientation ☒	
Semester:	9th	**Hours per week:**	4

Course objectives (capabilities pursued and learning results):

The main objective is the study of the basic concepts of the Finite Element Method. The course is divided in two basic parts. The first one deals with the formulation of the method in order to solve BVP and the study of different finite elements such as truss, beam and plane stress element. Furthermore, the concept of isoparametric formulation and numerical integration is studied thoroughly. The second part deals with the simulation of real structures in an advanced commercial finite element software and modelling methodologies. For this aim different types of classical structures (e.g. reinforced concrete beam, steal beams in bending, steal beams in axial compression, etc.) are simulated employing shell, plate and plane stress elements and solved under different loading conditions.

Prerequisites:

- **Mechanics II**
- **Structural Analysis III**
- **Linear Algebra and Analytic Geometry**
- **Ordinary differential equations**

Instructor's data:

Name:	Konstantinos Tzaros
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Other tutors:	-

Specific course information:

Week No.	Course contents	Hours	
		Course attendance	**Preparation**
1	Strong and weak form of BVP. Dirichlet and Neumann Boundary conditions. Continuity of test functions.	**4**	**2**
2	Numerical discretization of second order BVP into finite elements and nodes. Shape functions. Transformation of a continuous differential problem into a discrete linear algebra system.	**4**	**2**
3	Modelling of an aluminum bar in axial tension. Analytical and finite element solution. Comparison of the obtained solutions and assessment of the reliability of the FEM.	**4**	**2**
4	Superior order shape functions. Mesh sensitivity.	**4**	**2**
5	Formulation of the finite element 3D elasticity structural problem. The principle of Virtual Work.	**4**	**2**
6	2D truss elements-Formulation of the stiffness matrix and numerical examples.	**4**	**2**
7	2D Euler Bernoulli beam elements-Formulation of the stiffness matrix and numerical examples.	**4**	**2**
8	Plane stress and plane strain elements. Formulation of the stiffness matrix and numerical examples.	**4**	**2**
9	Isoparametric formulation. The natural system and the 1-1 linear mapping. The Jacobean matrix. Plane stress isoparametric elements	**4**	**2**
10	Numerical Integration. The Gauss-Legendre numerical integration method. The hourglass phenomenon.	**4**	**2**

11	Numerical simulation of concrete structures - Part 1: Bending of a reinforced concrete beam. Simulation of the geometry, boundary conditions, load conditions and material behaviour.	**4**	**2**
12	Numerical simulation of concrete structures - Part 2: Nonlinear static analysis in order to calculate the bearing capacity of the beam. Calculation of the stress and strain field. Simulation techniques for modelling the cracking of concrete.	**4**	**2**
13	Numerical simulation of steel structures -Part 1: Simulation of steel plated structures using shell elements. Modelling the mechanical behaviour of a steel plate with hole in axial tension. Usage of isoparametric elements.		
14	Numerical simulation of steel structures -Part 2: Simulation of a steel column with a RHS section in axial compression. Buckling failure and buckling failure mode. Elastoplastic bending of an IPE beam.	**4**	**2**

Additional hours for:			
Class project	**Examinations**	**Preparation for examinations**	**Educational visit**
30 (6 projects)	Examination of the projects and oral exams	35	-

Suggested literature:
• Χ.Γ. Προβατίδης «Πεπερασμένα Στοιχεία στην Ανάλυση Κατασκευών», Εκδόσεις Τζιόλα, 2017 (ISBN 978-960-418-676-1). • Μ. Παπαδρακάκης «Ανάλυση Φορέων με Πεπερασμένα Στοιχεία», Εκδόσεις Παπασωτηρίου, 2001, (ISBN 960-7510-94-1). • J. Fish, T. Belytschko «A first course in finite elements», John Wiley and Sons, 2007. • K. J. Bathe «Finite element procedures», Prentice Hall, 1996.

Teaching method *(select and describe if necessary* - **weight***):*		
Teaching	☒	50%
Seminars	☐	
Demonstrations	☐	
Laboratory	☐	
Exercises	☒	50%
Visits at facilities	☐	
Other *(describe):* …….	☐	
Total		100%

Evaluation method *(select)*- **weight:**				
	written	*%*	*Oral*	*%*
Homework	☐		☐	
Class project	☒	70%	☐	
Interim examination	☐		☐	
Final examinations	☒		☐	30
Other *(describe):* ……	☐		☐	