FINITE ELEMENTS

1. GENERAL

SCHOOL	SCHOOL OF ENGINEERING		
DEPARTMENT	CIVIL ENGINEERING		
LEVEL OF STUDIES	GRADUATE PROGRAM LEVEL 7		
COURSE CODE		**SEMESTER**	1st SEMESTER
COURSE TITLE	FINITE ELEMENTS		

TEACHING ACTIVITIES *If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.*	**TEACHING HOURS PER WEEK**	**ECTS CREDITS**
	3	7,5
Please, add lines if necessary. Teaching methods and organization of the course are described in section 4.		

COURSE TYPE *Background, General Knowledge, Scientific Area, Skill Development*	SCIENTIFIC AREA
PREREQUISITES:	NONE
TEACHING & EXAMINATION LANGUAGE:	GREEK
COURSE OFFERED TO ERASMUS STUDENTS:	NO
COURSE URL:	https://eclass.duth.gr/courses/TMB299/

2. LEARNING OUTCOMES

Learning Outcomes

Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.

Upon successful completion of the course, participants will be in a position to:

- understand the underpinning mathematical principles, the algorithmic structure, the adjoining tools from numerical analysis, and the layout of computer implementation for methods of weigthed residuals, with particular emphasis on the method of finite elements, which is the method most widely employed.
- use effectively any commercial software of finite elements, based on their knowledge of the significance of, and interactions among and, hence, the proper ways of employing and leveraging the numerous tools and settings, made available to them by such software.

- judge which models are well-defined in mathematical and numerical terms (and which are not) and to critically assess the qualitative and quantitative characteristics of computational results obtained.

General Skills

Name the desirable general skills upon successful completion of the module

Search, analysis and synthesis of data and information,

ICT Use

Adaptation to new situations

Decision making

Autonomous work

Teamwork

Working in an international environment

Working in an interdisciplinary environment

Production of new research ideas

Project design and management

Equity and Inclusion

Respect for the natural environment

Sustainability

Demonstration of social, professional and moral responsibility and sensitivity to gender issues

Critical thinking

Promoting free, creative and inductive reasoning

- Working in an interdisciplinary environment
- Search, analysis and synthesis of data and information, with ICT use
- Project design and management (with emphasis on use of mathematical models)
- Promoting free, creative and inductive reasoning
- Generating new research ideas

3. COURSE CONTENT

The course comprises a review of the principles, techniques and advantages of the Finite Element Method (*FEM*), with emphasis on its mathematical background, as well as of the computer implementation of the FEM, with emphasis on algorirhmic generality and on taking advantage of array operations.

The course also covers in detail (mathematical derivation and computer implementation):

1. the transformation from strong-form differential problems to equivalent weak-form integro-differential problems,
2. the kinds of loads and boundary conditions and how they are handled,
3. 1-D and multidimensional shape functions and their derivation,
4. analytical integration or numerical quadrature of elements to produce work-equivalent nodal “load” vector as well as stiffness matrix and (consistent) mass matrix,
5. the assembly and solution of the global system of equations,
6. the post-processing to obtain “action effects” and support design.

The course also serves as an introduction to more specialized topics, such as:

1. solution of very large and very sparse linear systems (vector methods, preconditionins, incomplete factorizations, etc.),
2. constitutive and geometric nonlinearity and incremental techniques for solving nonlinear problems,
3. dynamic problems and time-integration,

4. constrained problems and multiple incompatible fields (selective and partial integration, mixed formulations), and the like.

4. LEARNING & TEACHING METHODS - EVALUATION

TEACHING METHOD *Face to face, Distance learning, etc.*	Synchronous remote instruction
USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT) *Use of ICT in Teaching, in Laboratory Education, in Communication with students*	Use of ICT in Teaching and Communication with the students • digital slides • MsTeams/ e-class, webmail • Matlab, array programming
TEACHING ORGANIZATION *The ways and methods of teaching are described in detail.* *Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research & analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc.* *The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards.*	***Activity*** — ***Workload/semester*** Lectures — 39 Homework assignments — 75 Literature study and review — 25 Exams — 11 **Course Total** — **150**
STUDENT EVALUATION *Description of the evaluation process* *Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others* *Please indicate all relevant information about the course assessment and how students are informed*	Homework assignments (compulsory) 80% Regarding the mathematical formulation of simple finite-element models and the concise and efficient implementation of selected tools of the FEM (by leveraging array operations). Short written exam 20%

5. SUGGESTED BIBLIOGRAPHY

1. Χ. Προβατίδης, «Πεπερασμένα Στοιχεία στην Ανάλυση Κατασκευών», Τζιόλα, 2016.
2. Μ. Παπαδρακάκης, «Ανάλυση Φορέων με την Μέθοδο των Πεπερασμένων Στοιχείων», Παπασωτηρίου, 2001.
3. Γ. Τσαμασφύρος και Ε. Θεοτόκογλου, «Η Μέθοδος των Πεπερασμένων Στοιχείων – Τόμος Ι», Συμμετρία, 2005.
4. Α. Μπακόπουλος και Ι. Χρυσοβέργης, «Αριθμητικές Μέθοδοι Διαφορικών Εξισώσεων», Συμεών, 1986.
5. R. D. Cook, D. S. Malkus, M. E. Plesha, “Concepts and applications of finite element analysis”, 3rd ed., New York; Chichester: Wiley , 1989.
6. K. J. Bathe, “Finite Element Procedures in Engineering Analysis”, Prentice-Hall Inc., New Jersey, 1982.

7. T. R. J. Hughes, “The Finite Element Method – Linear Static & Dynamic Finite Element Analysis”, Prentice-Hall ed., Englewood Cliffs, NJ, 1987.
8. J. N. Reddy, “An Introduction to the Finite Element Method”, Second Edition, New York: McGraw - Hill, 1993.
9. G. H. Golub, C. F. Van Loan, “Matrix Computations”, The Johns Hopkins University Press, 1989.
10. T. R. Chandrupatla, A. D. Belegundu, επιστ. επιμ. Χ. Φραγκάκις, «Εισαγωγή στα Πεπερασμένα Στοιχεία για Μηχανικούς», Κλειδάριθμος, 2006.

ANNEX OF THE COURSE OUTLINE

Alternative ways of examining a course in emergency situations

Teacher (full name):	Balopoulos Victor
Contact details:	vbalop@civil.duth.gr
Supervisors: (1)	YES
Evaluation methods: (2)	Written assignment (100%)
Implementation Instructions: (3)	Assignment submitted through e-class on set date.

(10) Please write YES or NO

(11) Note down the evaluation methods used by the teacher, e.g.

6. *written assignment* or/and exercises
7. written or oral examination with distance learning methods, provided that the integrity and reliability of the examination are ensured.

(12) In the **Implementation Instructions** section, the teacher notes down clear instructions to the students:

a) in case of **written assignment and / or exercises:** the deadline (e.g. the last week of the semester), the means of submission, the grading system, the grade percentage of the assignment in the final grade and any other necessary information.

b) in case of **oral examination with distance learning methods:** the instructions for conducting the examination (e.g. in groups of X people), the way of administration of the questions to be answered, the distance learning platforms to be used, the technical means for the implementation of the examination (microphone, camera, word processor, internet connection, communication platform), the hyperlinks for the examination, the duration of the exam, the grading system, the percentage of the oral exam in the final grade, the ways in which the inviolability and reliability of the exam are ensured and any other necessary information.

c) in case of **written examination with distance learning methods**: the way of administration of the questions to be answered, the way of submitting the answers, the duration of the exam, the grading system, the percentage of the written exam of the exam in the final grade, the ways in which the integrity and reliability of the exam are ensured and any other necessary information.

There should be an attached list with the Student Registration Numbers only of students eligible to participate in the examination.