9.9 CE0931 – Theory of Disks and Plates – Finite Element Applications

(1) GENERAL

SCHOOL	ENGINEERING SCHOOL		
ACADEMIC UNIT	CIVIL ENGINEERING DEPARTMENT		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	**CE0931**	**SEMESTER**	**9**
COURSE TITLE	**Theory of Disks and Plates – Finite Element Applications**		

INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*	**WEEKLY TEACHING HOURS**	**CREDITS**
	3	4
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).		

COURSE TYPE *general background, special background, specialised general knowledge, skills development*	Specialization Course
PREREQUISITE COURSES:	Mechanics of Deformable Bodies (CE0220), Differential Equations (CE0310), Introduction to the Finite Element Method (CE0811)
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek
IS THE COURSE OFFERED TO ERASMUS STUDENTS	Yes in the English language
COURSE WEBSITE (URL)	https://eclass.uniwa.gr/courses/CIV173/

(2) LEARNING OUTCOMES

Learning outcomes

The course learning outcomes, specific knowledge, skills and competences of an appropriate level, which the students will acquire with the successful completion of the course are described.

Consult Appendix A

- *Description of the level of learning outcomes for each qualifications cycle, according to the Qualifications Framework of the European Higher Education Area*
- *Descriptors for Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning and Appendix B*
- *Guidelines for writing Learning Outcomes*

The aim of this course is to give students the fundamental concepts of the theory of elasticity and the theory of plates. Students get acquainted to the differential equations of the two different types of structures, the discs (walls), which are plane elastic bodies loaded within their plane and the plates, which are plane elastic bodies loaded in the transverse to the plate direction. All these structures are studied for various geometries and for different types of support conditions. Several analytical and numerical methods are explored and special emphasis is given to the finite element method.

Upon completion of the course, students will be able to:

- analyze walls under various plane stress conditions and for different supports.

- study the response of plates under static loading.
- apply numerical methods for the solution of two dimensional elasticity problems and plate problems.
- improve their skills in using the finite element method for the case of two dimensional elastic bodies and plates.

General Competences

Taking into consideration the general competences that the degree-holder must acquire (as these appear in the Diploma Supplement and appear below), at which of the following does the course aim?;.

Search for, analysis and synthesis of data and information, with the use of the necessary technology	*Project planning and management*
Adapting to new situations	*Respect for difference and multiculturalism*
Decision-making	*Respect for the natural environment*
Working independently	*Showing social, professional and ethical responsibility and sensitivity to gender issues*
Team work	*Criticism and self-criticism*
Working in an international environment	*Production of free, creative and inductive thinking*
Working in an interdisciplinary environment	*……*
Production of new research ideas	*Others…*

Specifically, students will have learnt:

- the basic principles of theory of elasticity and the behavior of discs and walls,
- the basic principles of theory of plates and the behavior of plates under common loading and support conditions,
- the implementation of numerical methods for the solution of the two types of structural systems,
- the application of the finite element method for walls and plates.

(3) SYLLABUS

Theory of Elasticity (Discs)

Introduction to mathematical theory of elasticity. Stress, displacements and strains. Constitutive equations, equations of equilibrium, compatibility equations of strains. Application to real structures. Support and boundary conditions. Inclusions, holes and openings. Compatibility of displacements between different regions and materials. Stress conditions at the interfaces and equilibrium. Applications.

Evaluation of displacements. Plane stress and plane strain problems. Numerical solutions, approximate solutions (finite differences, Fourier series and integrals, energy methods, finite elements). Polar coordinate systems and plane elasticity equations. Orthotropic discs. Rectangular and triangular finite elements. Applications. Analysis of plane elastic structures by implement ting and using computer codes. Applications to common structures of the civil engineering profession and evolution of the results.

Theory of Plates

Thin plates. Thin plates with small deflections. Basic Kirchhoff theory assumptions. Bending surface and its geometrical properties. Stress resultants. Differential equation of the plate and boundary support conditions for straight and curvilinear boundaries. Rectangular plates. Analytical and approximate methods for solving thin plates with small deflections. Circular plates. Plate equation and stress resultants in polar coordinates. Circular and annular plates under axisymmetric and arbitrary loading. Approximate and numerical solutions (Galerkin, Ritz, finite difference method, finite element method). Variable thickness plates. Plates on elastic foundation. Thick plates. Shear effect on plate behavior.

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face-to-face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Communication via e-mail and an exclusive team on the MS-Teams platform with a specific course group. Additional material on the course is provided in a dedicated website. The learning process is

	supported by providing notes with selected additional exercises and illustrated examples on the website or the Ms-Teams team of the course. Teaching using information and communications technology (ICT), communication and electronic submission. In-class demonstration and impementation of the Finite Element Method for the solution of various plane elasticity and plate bending problems by using either MatLab or Excel. Assignment of homework problems and projects.
TEACHING METHODS *The manner and methods of teaching are described in detail.* *Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc.* *The student's study hours for each learning activity are given as well as the hours of non- directed study according to the principles of the ECTS*	<table><tr><th>*Activity*</th><th>*Semester workload*</th></tr><tr><td>Lectures</td><td>30</td></tr><tr><td>Classwork</td><td>20</td></tr><tr><td>Personal Study (theory)</td><td>30</td></tr><tr><td>Personal Study (applications)</td><td>20</td></tr><tr><td>Assigned problems and projects</td><td>20</td></tr><tr><td>Course total</td><td>**120**</td></tr></table>
STUDENT PERFORMANCE EVALUATION *Description of the evaluation procedure* *Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open- ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other* *Specifically-defined evaluation criteria are given, and if and where they are accessible to students.*	Language of evaluation: Greek Final written examination: 100% The final exam includes problem solving and other crisis questions. The evaluation criteria have been presented to the students before the examination, the individual grade for each excercise is given next to it and the final grade is accessible through the online platform of the University. In addition, students can see their exam paper, the analysis of grade for each problem and they are given clarifications about the exam questions. Finally, their mistakes are pointed out any they are explained. The language of assessment is Greek unless the students come from the Erasmus program, in which case the examination is in English.

(5) ATTACHED BIBLIOGRAPHY

Greek Bibliography:

1. Makarios Triant. and Manolis G., *Plane Structures: Discs, Plates and Shells*, Tziola Publications, 2018. (in Greek)
2. Valiassis Th.N., Plane Structures, Ziti Pelagia Publications, 2000. (in Greek)
3. Nitsiotas G.M., *Elastostatics, Second Volume*, Ziti Pelagia Publications, 2001. (in Greek)
4. Papadrakakis M., *Analysis of Structures by the Finite Element Method*, Papasotiriou A. Publications, 2001. (in Greek)
5. Abramidis I., Athanatopoulou A. and Morfidis K., *The Finite Element Method – Modelling and Analysis of Structures*, "Sofia" Publications, 2016. (in Greek)