7.2 CE0711 – Structural Dynamics

(1) GENERAL

SCHOOL	ENGINEERING SCHOOL		
ACADEMIC UNIT	CIVIL ENGINEERING DEPARTMENT		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	**CE0711**	**SEMESTER**	**7**
COURSE TITLE	**Structural Dynamics**		

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**
	4	5
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*	Specialisation Course
PREREQUISITE COURSES:	
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek
IS THE COURSE OFFERED TO ERASMUS STUDENTS	
COURSE WEBSITE (URL)	https://eclass.uniwa.gr/courses/CIV295/

(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 course aims to give the students fundamental concepts of the behavior of structures under dynamic loading.

Upon completion of the course, students will have :

1. Basic knowledge of how structures respond to dynamic loads
2. In-depth knowledge of how to construct and solve the equation of motion for one and multi-degree-of-freedom systems.
3. Critical understanding of the dynamic response of structures under periodic and pulse loadings.
4. Knowledge, understanding, and use of earthquake spectra.

Specifically, students will be able to:

1. Have adequate comprehension skills of the solution of real-world engineering problems

2. Evaluate the critical parameters that affect the structural dynamic response.

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 be able to perform:

- Search, analysis, and synthesis of data and information, using the necessary technologies.
- Decision Making.
- Autonomous work
- Respect for the natural environment

(3) SYLLABUS

1. Introduction. Differences in static, dynamic behavior of structures. Dynamic loads. Dynamic equilibrium. Degrees of freedom of a structure. Dynamic model and equation of motion. Formulation of equation of motion of one-degree of freedom.
2. Systems with one degree of freedom of motion. Free undamped and damped vibrations of single-degree-of-freedom systems. Forced vibrations of single-degree-of-freedom systems. Study of forced undamped and damped vibrations of single-degree-of-freedom systems subjected to harmonic and periodic forces. Resonance.
3. Forced undamped and damped vibrations for any external load. Duhamel integral. Calculation of the Duhamel integral. Applications of the Duhamel integral. Response to step and harmonic loads. Study of forced vibrations of single-degree-of-freedom systems subject to ground motion. Response spectra. Influence of gravity on forced vibrations of single-degree-of-freedom system.
4. Numerical calculation of dynamic response. Central Difference Method. Acceleration Method (Newmark). Demonstration of the dynamic behavior of a single-degree-of-freedom system on PC.
5. Systems with many degrees of freedom of motion. Elastic, inertial and damping forces of a structure. Formulation of stiffness matrix element with constant cross section. Formulation of stiffness matrix of a structure. Formulation of mass matrix of multi-degree-of-freedom systems with lumped and distributed mass.
6. Free vibration of multi-degree-of-freedom systems. Frequency equation of multi-degree-of-freedom systems. Eigenvalues, mode shapes, natural mode shapes of vibration of multi-degree-of-freedom systems. Orthogonality conditions of modes shapes. Properties of the eigenfrequencies and modes shapes of free undamped of multi-degree-of-freedom systems.
7. Forced vibrations of undamped of multi-degree-of-freedom systems. Generalized mass, stiffness, external force of multi-degree-of-freedom systems. Damped of multi-degree-of-freedom systems. Uncoupled damped equations of motion. Evaluation of damping matrix of multi-degree-of-freedom systems. Dynamic response of damped multi-degree-of-freedom systems.

(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*	Teaching using ICT. Specifically, the use of multimedia (computer, LCD projectors, speakers) in the classroom Communication and Electronic Submission.

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

Activity	*Semester workload*
Lectures	52
Personal Study	52
Homework	21
Course total	**125**

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%

(5) ATTACHED BIBLIOGRAPHY

Greek Bibliography:

1. Chopra, Anil K. (2008). Δυναμική των Κατασκευών, Θεωρία και Εφαρμογές στη Σεισμική Μηχανική (3η Έκδοση)", Εκδόσεις Χ. ΓΚΙΟΥΡΔΑ & ΣΙΑ ΕΕ. ISBN: 978-960-512-541-7.
2. Κατσικαδέλης, Ι. (2012). Δυναμική Ανάλυση των Κατασκευών, Εκδόσεις Σ. ΑΘΑΝΑΣΟΠΟΥΛΟΣ & ΣΙΑ Ι.Κ.Ε. ISBN: 978-960-266-352-3.
3. Clough, R.W., Penzien, J. (2006). Δυναμική των Κατασκευών, Εκδόσεις Foundas. ISBN: 960-330-496-4.
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5. Παναγιωτόπουλος, Χ.Γ. και Κολιόπουλος Π.Κ. (2007). Εγχειρίδιο Δυναμικής των Κατασκευών, Εκδόσεις ΣΟΦΙΑ. ISBN: 978-960-6706-04-2.
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8. Μπέσκος, Δ. (2003). Δυναμική Ανάλυση Κατασκευών (τόμος Β') – Ειδικά Θέματα Δυναμικής και Σεισμικής Μηχανικής, Εκδόσεις Ελληνικού Ανοικτού Πανεπιστημίου ΕΑΠ ΣΜΑ50/1. ISBN: 960-538-312-8.
9. Νατσιάβας, Σ. (2001). Ταλαντώσεις Μηχανικών Συστημάτων, Θεσσαλονίκη: Εκδόσεις ΖΗΤΗ. ISBN: 960-431-712-1.
10. Bachmann, H. (1995). Αντισεισμική Προστασία Κατασκευών, Εκδόσεις Μ. Γκιούρδας. ISBN: 960-512-110-7.
11. Αναστασιάδης, Κ. (1983). Δυναμική των Κατασκευών – Διακριτά Συστήματα, Εκδόσεις ΖΗΤΗ. ISBN: 978-960-431-266-5.
12. Δυναμική των Κατασκευών – Συνεχή Συστήματα", Εκδόσεις ΖΗΤΗ, ISBN: 978-960-431-267-2.
13. Αβραμίδης. Ι., Αθανατοπούλου, Α., Μορφίδης, Κ. (2016). Η Μέθοδος των Πεπερασμένων Στοιχείων – Προσομοίωση και Ανάλυση Κατασκευών – Μια Πρακτική Εισαγωγή, Εκδόσεις ΣΟΦΙΑ. ISBN: 978-960-6706-92-9.

Foreign Bibliography:

1. Chopra, Anil K. (2017). Dynamics of Structures (5th Edition), Upper Saddle River, NJ: Pearson Education. ISBN: 9780134555126.
2. Humar J. (2012). Dynamics of Structures, Taylor & Francis Ltd. ISBN: 978-041-562-086-4.
3. Paultre P. (2010). Dynamics of Structures, Wiley-ISTE. ISBN: 978-1-848-21063-9.
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6. Rajasekaran S. (2009). Structural Dynamics of Earthquake Engineering: Theory and Application Using Mathematica and Matlab", Woodhead Publishing. ISBN-13: 978-1845695187.
7. Thomson W.T. (1997). Theory of Vibration with Applications, Pearson. ISBN-13: 978-0136510680.
8. Craig R.R. (2010). Fundamentals of Structural Dynamics, Wiley. ISBN-10: 0471430447.
9. Tedesko J.W. (1998). Structural Dynamics: Theory and Applications, Pearson. ISBN-13: 978-0673980526.
10. Paz M. (2006). Structural Dynamics: Theory and Computation, Springer. ISBN-13: 978-1402076671.
11. Kausel E. (2017). Advanced Structural Dynamics, Cambridge University Press. ISBN-13: 978-1107171510.
12. "Dynamic Structural Analysis", Jan J. Tuma and Franklin Y. Cheng, Schaum's Outline Series in Engineering (1983). ISBN: 0-07-065437-9 McGRAW-HILL.
13. Elghazouli A.Y. (2009). Seismic Design of Buildings to Eurocode 8, Spon Press. ISBN: 0-203-88894-4.
14. Fardis, M.N., Carvalho, E. C., Fajfar, P., Pecker, A. (2015). Seismic Design of Concrete Buildings to Eurocode 8, CRC Press. ISBN : 978-1-4822-8253-5.
15. Avramidis, I., Athanatopoulou, A., Morfidis, K., Sextos, A., Giaralis, A. (2016). Eurocode-Compliant Seismic Analysis and Design of R/C Buildings, Springer. ISBN : 978-3-319-25269-8.
16. Williams M. (2016). Structural Dynamics, Routledge. ISBN-13: 978-0415427326.
17. Craig R.R. (1981). Structural Dynamics: An Introduction to Computer Methods, Wiley. ISBN-10: 0471044997.
18. Busby, H.R., Staab, G.H. (2017). Structural Dynamics: Concepts and Applications, CRC Press. ISBN-13: 978-1498765947.
19. Gioncu, V., Mazzolani,F. (2010). Earthquake Engineering for Structural Design, CRC Press. ISBN-13: 978-0415465335.
20. Li, G., Wong, K. (2014). Theory of Nonlinear Structural Analysis: The Force Analogy Method for Earthquake Engineering, Wiley. ISBN-13: 978-1118718063.
21. Liang, Z., Lee, G.C., Dargush, G.F., Song, J. (2011). Structural Damping: Applications in Seismic Response Modification, CRC Press. ISBN-13: 978-1439815823.
22. Cheng, F.Y. (2000). Matrix Analysis of Structural Dynamics: Applications and Earthquake Engineering, CRC Press. ISBN-13: 978-0824703875.

Related academic journals:

1. Earthquake Engineering and Structural Dynamics