Course title:	Structural Dynamics II	Course code:	CE09_S05
Credits:	5	Work load (hours):	157

Course level:	Undergraduate ☑	Graduate ☐
Τύπος μαθήματος:	Mandatory ☑	Selective ☐
Course category:	Basic ☐	Orientation ☑

Semester:	9^{o}	**Hours per week:**	4

Course objectives (capabilities pursued and learning results):

The main objective of this course is to help students understand the behaviour of structures under dynamic loading with particular emphasis in structural dynamics under seismic excitations. Several analysis methods for evaluating the structural response (forces and displacements) are being discussed.

The module is designed to strengthen the technical skills of the students in the field of structural dynamics, offering a useful background knowledge both for future practicing engineers and postgraduates. This is accomplished mainly through familiarizing the students with the state-of-the-art computational methods as well as with seismic design and assessment methodologies.

Upon completion of this course the students should be able to:

- Identify the basic features of a dynamic problem.
- Compute the equation of motion for single (SDOF) and multi-degree (MDOF) of freedom systems.
- Calculate the natural frequencies and mode shapes for MDOF systems.
- Estimate the dynamic response of MDOF systems using the mode superposition method.
- Compute the response due a time dependent external load using numerical methods.
- Understand the response spectrum and design spectrum concept.
- Understand and apply the basic seismic design provisions with particular emphasis to those of Eurocode 8.
- Apply the equivalent static and the modal response spectrum analysis.
- Understand the physical meaning of ductility and the behaviour factor.
- Identify common pitfalls in seismic design and develop the ability to choose efficient structural layouts.
- Identify common seismic damage features.
- Understand the state-of-the-art earthquake design philosophy.
- Understand the inelastic structural response as well as the main methods of nonlinear analyses.
- Understand the main principles of soil-structure interaction and seismic isolation.

Prerequisites:

Structural Dynamics I

Instructor's data:

Name:	Athanasia Kazantzi
Level:	Dr. Structural Engineer, Adjunct lecturer
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Other tutors:	-

Specific course information:

Week No.	Course contents	Hours	
		Course attendance	Preparation
1	➢ Introduction to Structural Dynamics ➢ Revision of basic principles ➢ Dynamic response of SDOF systems ➢ Newmark's method ➢ Response spectra ➢ Tutorial exercises	4	8
2	➢ Dynamic response of MDOF systems ➢ Frequency equation and evaluation of modal properties ➢ Mode superposition method ➢ Rayleigh's method for estimating the vibration frequencies ➢ Rayleigh damping ➢ Tutorial exercises	4	8
3	➢ Modal analysis for seismic excitation ➢ Normalised spectra ➢ Modal response spectrum analysis ➢ Modal combination rules ➢ Tutorial exercises	4	8
4	➢ Combination of seismic actions ➢ EC8 elastic response spectra ➢ EC8 design spectra for inelastic behaviour ➢ Ductility classes and behaviour factor q ➢ Tutorial exercises	4	8
5	➢ Methods of analysis in EC8 ➢ Lateral force method of analysis ➢ Modal response spectrum analysis ➢ Tutorial exercises	4	8
6	➢ Static condensation ➢ Tutorial exercises	4	8
7	➢ Structural regularity ➢ Diaphragmatic action ➢ Spatial combination rules ➢ Eccentricities ➢ 2nd order effects ➢ Tutorial exercises	4	4
8	➢ Earthquake design philosophy ➢ Performance based seismic design	4	8
9	➢ Inelastic response of MDOF systems: model with lumped plasticity elements	4	4
10	➢ Introduction to nonlinear analysis methods	4	8

	➢ **Pushover** ➢ **Time-history analysis**		
11	➢ **Nonlinear analysis in SAP2000 - worked examples**	**4**	**4**
12	➢ **Introduction in modal testing**	**4**	**4**
13	➢ **Soil-structure interaction**	**4**	**4**
14	➢ **Introduction to seismic isolation**	**4**	**4**

Additional hours for:			
Class project	**Examinations**	**Preparation for examinations**	**Educational visit**
	3	10	

Suggested literature:

1st Book: Anil Chopra, Δυναμική των Κατασκευών Θεωρία και Εφαρμογές στη Σεισμική Μηχανική, 3η Έκδοση, Μ. Γκιούρδας, Αθήνα 2008, (ISBN 960-512-541-2)

2nd Book: Ι.Θ. Κατσικαδέλης, Δυναμική Ανάλυση των Κατασκευών Θεωρία και Εφαρμογές, Συμμετρία, 2012 (ISBN 978-960-266-352-3)

Additional suggested literature

Eurocode 8 (CEN-Brussels)

R.W. Clough, J. Penzien, Dynamics of structures, McGraw-Hill, 1993.

M.N. Fardis, E. Carvalho, A. Elnashai, E. Faccioli, P. Pinto and A. Plumier, Designers' Guide to EN1998-1 and EN1998-5, Thomas Telford, 2005.

Teaching method *(select and describe if necessary* - **weight***):*		
Teaching	☑	60%
Seminars	☐	…….%
Demonstrations	☐	…….%
Laboratory	☐	…….%
Exercises	☑	40%
Visits at facilities	☐	…….%
Other *(describe):* …….	☐	…….%
Total		100%

Evaluation method *(select)*- **weight:**				
	Γραπτά	*%*	*Προφορικά*	*%*
Homework	☐		☐	
Class project	☐		☐	
Interim examination	☐		☐	
Final examinations	☑	100	☐	
Other *(describe):* ……	☐		☐	