9.2 CE0911 – Earthquake Engineering II

(1) GENERAL

SCHOOL	ENGINEERING SCHOOL		
ACADEMIC UNIT	CIVIL ENGINEERING DEPARTMENT		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	**CE0911**	**SEMESTER**	**9**
COURSE TITLE	**Earthquake Engineering II**		

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/CIV224/

(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 the course is to give the students fundamental concepts of engineering seismology, basic concepts of current seismic codes and skills for the evaluation of the seismic response of structures.

Upon completion of the course, students will have:

1. Basic knowledge of engineering seismology for the cause of earthquakes, recording of earthquakes, seismometry, seismic waves, accelerographs.
2. In-depth knowledge and critical understanding of the theory and principles of the dynamic response of the structures and the seismic design.
3. Knowledge and understanding of the response spectrum.
4. Knowledge and skills in the processing of accelerographs and the creation of response spectra using appropriate software.

5. Knowledge and skills in the calculation and evaluation of the dynamic response of single and multi-degree of freedom systems in seismic excitation.
6. Ability to design a building based on modern earthquake resistant design codes.
7. Knowledge of performance based design and assessment philosophy.
8. Familiarity with new technologies for seismic design, such as base isolation and energy-dissipation systems.

Specifically, students will be able to:

1. Evaluate the seismic response of single and multi-degree-of-freedom systems with elastic or inelastic behaviour.
2. Evaluate the seismic response of systems with torsional response.
3. Deeply understand the seismic behaviour of a structure through the evaluation of important parameters of the inelastic response, as the ductility, behaviour factor and overstrength.
4. Apply elastic and inelastic analysis methods for the design and assessment of structures.
5. Understand seismic design using new technologies.
6. To study and evaluate the capacity of a structure and suggest solutions for its improvement.
7. Develop personal responsibility and offer scientific opinion.
8. Manage time in an appropriate manner.

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.
- Project planning and management.

(3) SYLLABUS

1. Introduction. Fundamental concepts of engineering seismology. Cause of earthquakes, Recording of earthquakes, Seismometry, Seismic waves, Accelerographs.
2. Elastic seismic response of single-degree-of-freedom systems. Response spectrum. Alternative ways of displaying spectra, Effects of foundation conditions on the seismic response.
3. Inelastic response spectrum. Design spectrum. Inelastic response of single-degree-of-freedom systems. Ductility, Behaviour factor, Overstrength.
4. Effect of torsion on the seismic response. Torsional response of elastic SDOF systems.
5. Seismic response of multi degree–of–freedom systems. Modal spectrum analysis.
6. Earthquake resistant design of structures. Linear-elastic methods of analysis. Lateral force method of analysis . Modal response spectrum analysis.
7. Basic concepts of current Seismic Codes. Seismic loads. Capacity design. Primary and secondary seismic members. Detailing of primary seismic columns for local ductility. Confinement of concrete core.Influence of masonry infill walls.
8. Non-linear methods of analysis. Nonlinear static (pushover) analysis. Nonlinear time-history (dynamic). analysis. Hysteretic energy dissipation, ductility. Basic concepts of performance based design and assessment.
9. Basic concepts of the design of base isolated structures
10. Methods to increase the strength, stiffness, ductility of members and structure.

(4) TEACHING and LEARNING METHODS - EVALUATION

<table>
<tr><td>DELIVERY
Face-to-face, Distance learning, etc.</td><td>Face-to-face</td></tr>
<tr><td>USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY
Use of ICT in teaching, laboratory education, communication with students</td><td>Teaching using ICT, Communication and Electronic Submission. Communication via email or MS-Teams. Announcements and educational material through the e-learning platform e-Class. Excel and specialised software for static and dynamic analysis.</td></tr>
<tr><td>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</td><td>
<table>
<tr><th>Activity</th><th>Semester workload</th></tr>
<tr><td>Lectures</td><td>52</td></tr>
<tr><td>Preparation for Project</td><td>30</td></tr>
<tr><td>Personal Study</td><td>53</td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td>Course total</td><td>135</td></tr>
</table>
</td></tr>
<tr><td>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.</td><td>Language of evaluation: Greek

Final written examination: 80%
Preparation for the project: 20%</td></tr>
</table>

(5) ATTACHED BIBLIOGRAPHY

Greek Bibliography:

1. Karayiannis, Ch., (2019), Design of Reinforced Concrete Structures for Seismic Actions, Thessaloniki: Sofia Publications (in Greek).
2. Pnevmatikos N. (2017), Introduction to the design of seismic structures, ISBN 978-960-6607-58-5, Lychnos Publications.
3. Avramidis, I., Athanatopoulou, A. Morfidis, K., Sextos, A. (2017), Seismic design of R/C and numerical examples of analysis and design to the Eurocodes (2nd edition), Thessaloniki: Sofia Publications (in Greek).
4. Fardis M.N., E. Carvalho, A. Elnashai, E. Faccioli, P. Pinto, A. Plumier (2011), Designers' Guide to EN 1998-1 and EN 1998-5: Eurocode 8: Design Provisions for Earthquake Resistant Structures, Athens: Klidarithmos Publications (in Greek).
5. Paulay, T. και Priestley, M. J. N. (1996), Seismic Design of Reinforced Concrete and Masonry Buildings. Athens: Klidarithmos (in Greek).
6. Bachmann Hugo (1998), Earthquake protection of buildings, Athens: Giurdas Publications (in Greek).
7. Penelis, G.G. and Kappos, A.J. (1990), Earthquake Resistant Concrete Structures. Thessaloniki: Ziti Publications (in Greek).
8. Anastasiadis, K.K. (2007), Earthquake Resistant Structures I., hessaloniki: Ziti Publications (in Greek).
9. Chopra, A.K. (2020), Dynamics of Structures: Theory and application to earthquake engineering (5th edition), Athens: Giurdas Publications (in Greek).
10. Dowrick, D. J. (1983), Earthquake resistant design, Athens: Giurdas Publications (in Greek).
11. Katsikadelis, I. (2020), Dynamic Analysis of Structures (3rd edition), Athens: Tsotras Publications (in Greek).
12. Manolis, G., Koliopoulos, P., Panagiotopoulos, C. (2015), Dynamics of Structures, [ebook] Athens:Hellenic Academic Libraries Link. Available Online at: http://hdl.handle.net/11419/2465. (www.kallipos.gr)
13. Konstantinidis, Ap. (2008), Earthquake Resistant Buildings Made of Reinforced Concrete, Vol. A – Construction and Detailing, Athens: π-Systems Publications (in Greek).
14. Konstantinidis, Ap. (2013), Earthquake Resistant Buildings Made of Reinforced Concrete, Vol. B – Static and Dynamic Analysis, Athens: π-Systems Publications (in Greek).

Foreign Bibliography:

1. Elnashai, A., L. Di Sarno, (2008), Fundamentals of earthquake engineering, Wiley.
2. Bozorgnia, Y., & Bertero, V. V. (Eds.). (2004). Earthquake engineering: from engineering seismology to performance-based engineering. CRC press.
3. Clough R.W. και Penzien J. (1993), Dynamics of Structures, McGraw-Hill, New York. 2nd Edition.
4. Chopra, A.K. (2017), Dynamics of Structures: Theory and application to earthquake engineering (5^{th} edition), Pearson.
5. Fardis MN, Carvalho E, Elnashai A, Faccioli E, Pinto P, Plumier A. 2005. Designers' Guide to EN 1998-1 and EN 1998-5: Eurocode 8: Design Provisions for Earthquake Resistant Structures, Thomas Telford, London.
6. Paulay, T. and Priestley, M. J. N. (1992), Seismic Design of Reinforced Concrete and Masonry Buildings, John Wiley & Sons, Inc.
7. Dowrick, D. J. (2009). Earthquake resistant design and risk reduction. John Wiley & Sons.
8. Kappos, A. and Penelis, G.G. (1996). Earthquake-resistant Concrete Structures, Taylor & Francis.

Related academic journals:

1. Earthquake Engineering and Structural Dynamics
2. Journal of Earthquake Engineering
3. Earthquake Spectra
4. Earthquakes and Structures
5. Engineering Structures
6. Journal of Structural Engineering