Course unit title:	Earthquake Engineering Design		
Course unit code:	CE 415		
Type of course unit:	Compulsory		
Level of course unit:	Bachelor (1st Cycle)		
Year of study:	4		
Semester when the unit is delivered:	1 (Fall)		
Number of ECTS credits allocated :	6		
Name of lecturer(s):	Dr. Milton Demosthenous		
Learning outcomes of the course unit:	• Identify special topics on Engineering Seismology, Soil Dynamics and Earthquake Engineering. • Describe the effects of earthquakes to the civil engineering structures. • Produce a preliminary study of Earthquake Resistance Design of R/C buildings according to the provisions of EC8. • Analyse and compare various structural systems to support earthquake loads. • Explain the seismic behaviour of structures and the philosophy of modern Seismic Codes. • Validate Earthquake Resistance Designs of R/C buildings according to the provisions of EC8.		
Mode of delivery:	Face-to-face		
Prerequisites:	CE 310, CE 400	Co-requisites:	None
Recommended optional program components:	None		
Course contents:	**Introduction to special topics of Engineering Seismology, Soil Dynamics and Earthquake Engineering:** • Understand the role of the lithospheric plates and active tectonic faults on the creation of earthquakes. • Understand the role of the geological and soil conditions to the transmission of seismic waves and to the strong ground motion. • Estimate the Magnitude of the Earthquake by a recorded signal from a seismograph. • Distinguish the duration of the strong ground motion and the Peak Ground Acceleration (PGA) by a recorded signal from an accelerograph. • Understand the “Attenuation of PGA” and the influence of soil conditions to that. • Understand the main issue of the seismic hazard study and read the information given by a seismic map. • Understand the causes of seismicity and the Seismic Hazard of Cyprus. **Seismic behaviour of structures:** • Understand the seismic response of the structures as dynamic response. • Write the differential equation of motion of SDOF and MDOF structures. • Understand the role of the mass, the damping ratio, the stiffness and the earthquake excitation to the response of the structures. • Determine the frequency and period of a SDOF system and planar MDOF frame structures. • Understand the elastic and inelastic behavior of materials and structural elements. • Distinguish the elastic and inelastic behaviour of structures. • Introduction to Duhamel’s Integral and determination of the response to earthquake excitation. • Draw the earthquake elastic response spectrum.		

	• Understand this method as an equivalent static method to determine the maximum earthquake response of SDOF structures. **Effects of Earthquakes to the soil and the existing structures – Intensity of Earthquakes:** • Know the possible effects of earthquakes to the soil and existing structures. • Distinguish the various types and the intensity of failure of structural elements and structures due to earthquake actions. • Use Modified Mercalli scale to describe the observed Intensity. • Draw the Intensity Map of an earthquake and the relation between the Intensity and the distance from the epicentre of the earthquake. **History of Seismic Codes and Philosophy of Modern Seismic Codes:** • Distinguish the different between the Codes and Guidelines. • Know the history of the Seismic Codes. • Be familiar with the main scope of Modern Seismic Codes (protection of human life, limitation of damage, operation of important structures after earthquake). • Be able to apply the basic principles of conceptual design (structural simplicity, symmetry, redundancy, bi-directional and torsional resistance and stiffness, diaphragmatic behaviour, adequate foundation). • Distinguish the regular and irregular structures in plan and in elevation. • Distinguish the structural types of R/C structures. • Understand the philosophy of the ductility class and decide about that during the design. • Estimate the important factor (γi) the behaviour factor (q) and the allowed simplification according to the EC8. **Estimation of Seismic Loading and Analysis of R/C Building structures according to the provisions of EC8:** • Evaluate the ground type, the seismic zone and design of Elastic Response Spectrum. • Estimate and draw the Design spectrum for elastic analysis. • Simulate the structure and find the fundamental periods. • Estimate the seismic actions and distribute them to the story levels. • Combination of seismic actions with other actions. • Take in the account the torsional effects. • Evaluate the numerical results from the structural analysis (2nd order effects, inter-story drift etc.) **Detailing of structural elements (according to the provisions of EC2 & Ec8):** • Evaluate the results from the numerical analysis (axial and shear forces and bending moments). • Know the materials requirements related to the Ductility Class of the structure. • Understand the role of the transverse reinforcement in critical regions and the confinement of concrete core. • Estimate and draw the detailing of earthquake resistance elements (column, shear walls, beams and joints of beams and columns).
Recommended and/or required reading:	
Textbooks:	Arnold, Christopher, “Building configuration and seismic design”, Wiley-Interscience, c1982
References:	• Thomas Pauley & M.J.N. Priestley, Seismic Design of Reinforced Concrete and Masonry Buildings, Wiley-Interscience, 1992 • Anil K. Chopra, “Dynamics of structures: Theory and Applications to Earthquake Engineering”, Prentice, 2000.

	• Naeim, Farzad. “The seismic design handbook” Springer, 2001 • Eurocode 8: Design of structures for earthquake resistance, Part 1: General rules, seismic actions and rules for buildings, 2004 and National Annex for Cyprus.
Planned learning activities and teaching methods:	The course will be presented through lectures in class. The aim of lectures is to lay down the theoretical principles of Earthquake Engineering in order to understand the importance of practical applications according to the provisions of seismic codes. Part of the material is presented using visual aids (normally in Power Point presentations) which allow the instructor to present related figures and photographs that will assist understanding of principles and methods. The learning process is enhanced through practical design examples. In the class. In addition to that, the students must complete two assignments (project). The first one is related to the basic topics of Engineering Seismology, Seismic Behaviour of Structures, Effects of Earthquakes and Seismic Hazard of Cyprus. The second one is preliminary Earthquake Resistance Deign of a R/C building according to the provisions of EC8. Also the students are strongly encouraged to read the subject textbook as well as to perform their own research on particular aspects or practical applications and problems. Interaction with students is achieved through the class website, and during office hours or by appointment in order to provide any necessary tutoring.
Assessment methods and criteria:	• Course Work 50% • Final Exam 50%
Language of instruction:	English
Work placement(s):	No