

<b>Course unit title</b>	<b><i>Design for seismic and climate changes</i></b>
<b>Course unit code</b>	2C09
<b>Type of course unit</b>	Compulsory
<b>Semester</b>	Second
<b>Number of ECTS credits allocated</b>	6
<b>Name of lecturer(s)</b>	Máca (CTU); Lecturer (UC); R. Landolfo (UNINA); Lecturer (UPT); Lecturer (ULg); Lecturer (LTU); Lecturer(Associate 1); Lecturer (Associate2).
<b>Learning outcomes of the course unit</b>	<p>After completing the course, the student is expected to:</p> <ul style="list-style-type: none"> <li>• Be able to understand the dynamic behaviour of constructions and the effect of dynamic loads.</li> <li>• Have skills in structural dynamics that give the basis for construction subjects</li> <li>• Have skill to design steel structural systems and components able to attenuate or withstand seismic actions.</li> <li>• Carry out calculations with the aid of finite element methods</li> <li>• Understanding the principles and methods of dynamic analysis</li> <li>• Have skills to apply the rules and verifications given by European codes</li> <li>• Be able to design, draw seismic resistant steel structures.</li> </ul>
<b>Mode of delivery</b>	Frontal lesson Tutorials
<b>Prerequisites and co-requisites</b>	General admission requirements to the second semester.
<b>Course contents</b>	The aim of the course is to provide students with both the theoretical and constructional bases for the design of steel structures in seismic areas. Scope of the course is to provide the required background knowledge of structural dynamics and basic methodologies for the design of engineered structures in seismic zones, as well to conceive the conceptual and preliminary design of a steel seismic resistant structure. During the course students will learn the fundamental aspects of earthquake engineering, and in particular: fundamentals of engineering seismology,

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fundamentals of structural dynamics, definition of the seismic actions, behaviour of structures under earthquake actions -with reference to both the elastic and the inelastic behaviour-, structural design approaches according to the most important codes and regulations. The design methods will be described using steel structures as case studies.

The purpose of this course is to introduce students step by step with the design of seismic resistant structures.

The thirteen topics covered in the course are listed as follows:

**1. Fundamentals of seismology**

- 1.1. Brief history of earthquake engineering
- 1.2. causes of earthquakes,
- 1.3. theory of plate tectonics,
- 1.4. definition of seismic waves,
- 1.5. location of the epicentre, intensity scales, magnitude scales.

**2. Fundamentals of seismic hazard**

- 2.1. Strong ground motion
- 2.2. seismic hazard analysis
- 2.3. local site effects
- 2.4. definition of a design earthquake.

**3. Dynamic analysis of single-degree-of-freedom systems I**

- 3.1. Introduction to dynamics of structures
- 3.2. free vibration analysis of SDOF systems
- 3.3. undamped and damped vibrations of SDOF systems
- 3.4. response of SDOF systems to harmonic excitations

**4. Dynamic analysis of single-degree-of-freedom systems II**

- 4.1. Forced vibration
- 4.2. response of SDOF systems to arbitrary excitations
- 4.3. numerical evaluation of the dynamic response.

**5. Dynamic analysis of single-degree-of-freedom systems III**

- 5.1. Response of SDOF systems to earthquakes
- 5.2. elastic earthquake response spectrum
- 5.3. design spectrum.

**6. Dynamic analysis of multi-degree-of-freedom systems**

- 6.1. Free vibration
  - 6.2. natural vibration frequencies and modes
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6.3. forced motion of MDOF systems

6.4. modal analysis.

**7. Finite element methods in structural dynamics I**

7.1. Free vibration analysis

7.2. Rayleigh – Ritz method

7.3. vector iteration techniques

7.4. inverse vector iteration method

7.5. subspace iteration method.

**8. Finite element methods in structural dynamics II**

8.1. Dynamic response analysis

8.2. time-stepping procedure

8.3. central difference method

8.4. Newmark's method

8.5. stability and computational error of time integration schemes

8.6. analysis of nonlinear response

8.7. average acceleration method

8.8. HHT method.

**9. Seismic analysis I**

9.1. Earthquake analysis of linear and non-linear systems

9.2. multi-modal response history analysis

9.3. multi-modal response spectrum analysis.

**10. Seismic analysis II**

10.1. Equivalent static analysis of linear MDOF systems

10.2. ductility-modified response spectra

10.3. non-linear static analysis – pushover analysis

10.4. displacement-based seismic design.

**11. Earthquake-resistant design of structures I**

11.1. Principles and objectives of earthquake-resistant design

11.2. practical aspects of earthquake-resistant design

11.3. principles to ensure good seismic behaviour.

**12. Earthquake-resistant design of structures II**

12.1. Eurocode 8

12.2. general rules

12.3. seismic actions

12.4. general and specific rules for steel buildings and towers

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	<p><b>13. Seismic design of steel structures</b></p> <p>13.1. Conceptual design of buildings and towers,          13.2. design criteria,          13.3. dissipative design,          13.4. seismic design of connections</p>
<b>Recommended or required reading</b>	<p>Seismic Design of Buildings to Eurocode 8, Ahmed Elghazouli (Editor) , Taylor &amp; Francis</p> <p>Chopra, A.K.: Dynamics of structures. Pearson Prentice Hall, 2007.</p> <p>Booth, E. and Key, D.: Earthquake design practice for buildings. Thomas Telford, 2006.</p> <p>Fardis, M. et al : Designers´ guide to Eurocode 8, Thomas Telford, 2005.</p> <p>Bruneau, M., Uang, C.M., Whittaker, A., Ductile Design of Steel Structures. McGraw-Hill Professional 1997.</p> <p>Mazzolani F.,M., Piluso V., Theory and design of seismic resistant steel frames. Spon Press 1996.</p> <p>Leet, K. and Uang, C.M., Fundamentals of Structural Analysis, McGraw-Hill, Inc., 2004.</p>
<b>Planned learning activities and teaching methods</b>	<p>The course will be held in 13 week. Each topic will be undertaken in one week. The course is organized in theoretical lectures and tutorials. Teaching is given in classes including numerical examples and exercises. Compulsory assignments are given during the course. A final assignment on the conceptual design of a steel building in seismic area. Drawing as well as structural report showing calculations on preliminary design is also required. This work should be done in group of two students.</p>
<b>Assessment methods and criteria</b>	<p>The final oral exam only after having completed all the homework and the final project, which have to be brought at the exam. The homework has to be delivered within two weeks after the assignment. The final assignment has to be delivered within to week after the end of the course. All the assignment must be approved by the tutor. Grading system. Passed or not passed. A certificate awarding ECCS credits after the course accomplishment may be provided upon the request.</p>
<b>Language of instruction</b>	English