Course unit title	***ADVANCED DESIGN OF CONCRETE STRUCTURES***
Course unit code	2E13
Type of course unit	Elective
Semester	Second
Number of ECTS credits allocated	5
Name of lecturer(s)	Kohoutková (CTU); Lecturer (UC); Manfredi (UNINA); Lecturer (UPT); Lecturer (ULg); Lecturer (LTU); Lecturer(Associate 1); Lecturer (Associate2).
Learning outcomes of the course unit	After completing the course, the student is expected to have understanding for calculation and design of the main elements in reinforced concrete structures according to current building codes. • Be able to understand the behaviour of reinforced concrete structures •carry out calculations on safety verification of reinforced concrete members. • Have skill to design r.c. structural members and components • be able to understand the behaviour of joints diagrams, normal force, shear force and bending moments • have skills in mechanics that give the basis for construction subjects • be able to describe theories and solution methods in mechanics • understand the subject's importance to other courses in the civil engineering programme
Mode of delivery	Frontal lesson , laboratory
Prerequisites and co-requisites	General admission requirements to the second semester.
Course contents	The purpose of this course is to introduce students step by step with the design of seismic resistant structures. Thirteen topics, listed below are covered in the course. Description of topics

Design of RC frame structures

1.1 Verification and design rules for RC sections under axial-bending loads according to the ultimate limit state method.
1.2 Verification and design rules against shear and torsion.
1.3 Provisions by European and American Guide Lines (Eurocodes and ACI).

2. Ductility of RC structures

2.1 Moment-curvature diagrams, tri-linear and bi-linear models.
2.2 Ductility of RC sections under bending.
2.3 Plastic hinge and allowable plastic rotation for RC elements under bending, Eurocode criteria.
2.4 Influence of axial force.
2.5 Examples.
2.6 Ductility at sectional and structural scales.

3. Failure analysis of structures

3.1 Plastic hinge and maximum rotation in plastic range for steel and RC elements.
3.2 Limit analysis of frame structures,
3.3 Greenberg-Prager delimitation method,
3.4 Incremental analysis with control of required rotation for RC structures.
3.5 Calculation methods based on moment redistribution for RC structures.
3.6 Effect of axial forces.
3.7 Examples.

4. Serviceability limit states of RC beams

4.1 Evolution of cracking phenomenon for RC elements under tensile axial force.
4.2 Moment-curvature diagrams in cracked range.
4.3 Crack width and deformability of beams in cracking range.
4.4 Approximate formulas and normative requirements. Delayed deformation for concrete (shrinkage and creep). T
4.5 theory of linear viscoelasticity.
4.6 Creep and relaxation functions.
4.7 The ageing phenomenon, CEB, ACI methods, Italian codes.

4.8 Algebraic methods (EM, MS, AAEM methods).
4.9 Problems concerning structures subject to delayed deformation.
4.10 Principles of linear viscoelasticity.
4.11 Numerical examples.

5. Prestressed concrete beams:
5.1 Basic concepts.
5.2 Techniques for prestressed concrete elements.
5.3 Stress resultants in statically determined structures.
5.4 Statically-redundant structures (basics).
5.5 Pre-tensioned and bonded post-tensioned elements.
5.6 The design states and the limit conditions for bonded post-tensioned beams. Verification according to Eurocode and ACI Guidelines.
5.7 Loss of prestressing force.
5.8 Detailing and local verifications.

6. RC plates subject to in-plane loadings
6.1 Theory of elasticity (fundamentals),
6.2 plane stress and plane strain states. Simplified methods.
6.3 RC High beams: cracking range and failure modes, high beams with multiple supports. Design criteria and details.
6.4 Suspended loads.

7. RC plates under transverse loads
7.1 Kirchhoff plate theory: Lagrange equations and boundary conditions.
7.2 Simply-supported and clamped plates.
7.3 RC plate structures: design criteria and details. RC slabs over columns: approximate methods for calculation of internal actions, design rules and details.
7.4 Verification against punching.

8. Instability of RC structures
8.1 The model column method.
8.2 The equilibrium state method.
8.3 M-N interaction diagrams with II order effects.
8.4 The effect of delayed deformations.
8.5 The case of precast structures.
8.6 CNR 10025 Design Guidelines and International Guidelines.
8.7 Foundations for precast structures: Design criteria and construction details.

Recommended or required reading	Background material of research projects developed by the teachers Choosen chapters related to selected topics of theory of stability and connections Eurocodes ECCS recommendations Guidelines, Standards
Planned learning activities and teaching methods	The course will be held in two weeks. 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 is given concerning the preliminary design of a r.c. building. This work should be done in group of two students.
Assessment methods and criteria	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.
Language of instruction	English