Course guide
250707 - 250707 - Non-Linear Analysis and Behaviour of Concrete Structures

Last modified: 28/03/2024

Unit in charge: Barcelona School of Civil Engineering
Teaching unit: 751 - DECA - Department of Civil and Environmental Engineering.

Degree: MASTER'S DEGREE IN STRUCTURAL AND CONSTRUCTION ENGINEERING (Syllabus 2015). (Optional subject).

Academic year: 2023 **ECTS Credits:** 5.0 **Languages:** English

LECTURER

Coordinating lecturer: JESÚS MIGUEL BAIRÁN GARCÍA

Others: JESÚS MIGUEL BAIRÁN GARCÍA, NOEMÍ DUARTE GÓMEZ, ANTONIO RICARDO MARI BERNAT, JUAN MURCIA DELSO, EVA MARIA OLLER IBARS

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
13364. To conceive and design civil and building structures that are safe, durable, functional and integrated into its surroundings.
13365. Designing and building using traditional materials (reinforced concrete, prestressed concrete, structural steel, masonry, wood) and new materials (composites, stainless steel, aluminum, shape memory alloys?).
13366. To evaluate, maintain, repair and strengthen existing structures, including the historic and artistic heritage.
13369. To apply methods and advanced design software and structural calculations, based on knowledge and understanding of forces and their application to the structural types of civil engineering.

Generical:
13360. To conceive, design, analyze and manage structures or structural elements of civil engineering or building, encouraging innovation and the advance of knowledge.
13361. To develop, improve and use conventional materials and new construction techniques to ensure the safety requirements, functionality, durability and sustainability.
13362. To define construction processes and methods of organization and management of projects and works.

TEACHING METHODOLOGY

The course consists of 2,3 hours per week of classroom activity (large size group) and 0,3 hours weekly with half the students (medium size group).

The 2,3 hours in the large size groups are devoted to theoretical lectures, in which the teacher presents the basic concepts and topics of the subject, shows examples and solves exercises.

The 0,3 hours in the medium size groups is devoted to solving practical problems with greater interaction with the students. The objective of these practical exercises is to consolidate the general and specific learning objectives.

The rest of weekly hours devoted to laboratory practice.

Support material in the form of a detailed teaching plan is provided using the virtual campus ATENEA: content, program of learning and assessment activities conducted and literature.

Although most of the sessions will be given in the language indicated, sessions supported by other occasional guest experts may be held in other languages.

LEARNING OBJECTIVES OF THE SUBJECT

Subject to deepen the nonlinear phenomena and their effects in reinforced and prestressed concrete structures

Deepening in the nonlinear phenomena of concrete structures . Capability to evaluate the influence of these mechanisms in their design and calculation .

Causes of nonlinearity in concrete structures. Instantaneous and long-term behaviour of materials. Rheological models. Sectional analysis. Moment-curvature diagram. Nonlinear analysis strategies: incremental and iterative calculations. Newton-Raphson and Modified Newton-Raphson methods. Nonlinear analysis of 1D structures. Finite element method. Introduction to prestressing. Generalized matrix method. Analysis of evolutive construction processes. Two-dimensional elements. Concrete biaxial constitutive equations. Simulation of cracking and tension-stiffening .

STUDY LOAD

Type	Hours	Percentage
Hours large group	25,5	20.38
Self study	80,0	63.95
Hours small group	9,8	7.83
Hours medium group	9,8	7.83

Total learning time: 125.1 h

CONTENTS

Introduction

Description:
Introduction
Introduction

Full-or-part-time: 14h 23m
Theory classes: 4h
Practical classes: 2h
Self study : 8h 23m

Solution methods

Description:
Solution methods
Solution methods

Full-or-part-time: 14h 23m
Theory classes: 4h
Practical classes: 2h
Self study : 8h 23m

Uniaxial behaivour

Description:
Uniaxial material behaviour
Uniaxial material behaviour

Full-or-part-time: 14h 23m
Theory classes: 4h
Practical classes: 2h
Self study : 8h 23m

Frame element models

Description:
Frame elements models
Frame elements models

Full-or-part-time: 14h 23m
Theory classes: 4h
Laboratory classes: 2h
Self study : 8h 23m

Multiaxial behaviour

Description:
Multiaxial material behaviour
Multiaxial material behaviour

Full-or-part-time: 21h 36m
Theory classes: 7h
Laboratory classes: 2h
Self study : 12h 36m

Multiaxial models and applications

Description:
2D and 3D models and applications
2D and 3D models and applications

Full-or-part-time: 14h 23m
Theory classes: 4h
Laboratory classes: 2h
Self study : 8h 23m

Safety assessment

Description:
Safety assessment

Full-or-part-time: 4h 48m
Theory classes: 2h
Self study : 2h 48m

Seminars and workshops

Description:
Workshops and seminars

Full-or-part-time: 4h 48m
Theory classes: 2h
Self study : 2h 48m

Assessment

Full-or-part-time: 4h 48m
Laboratory classes: 2h
Self study : 2h 48m

GRADING SYSTEM

The assessment of the course is continuous consisting of homework, a workshop and a final exam. The grade of the course (G) is computed as follows:
G= 0.6 A + 0.4 E
where A is the average grade of activities carried out during the course (homework and workshop) and E is the grade in the final exam.

EXAMINATION RULES.

Failure to perform a laboratory or continuous assessment activity in the scheduled period will result in a mark of zero in that activity.

BIBLIOGRAPHY

Basic:
- Bairan, J.M.. Class notes of Non-linear analysis and behaviour of concrete structures.

Complementary:
- Marí, A.R. Nonlinear geometric, material and time dependent analysis of three dimensional reinforced and prestressed concrete frames. Berkeley, CA: Division of Structural Engineering and Structural Mechanics, Department of Civil Engineering, University of California, Berkeley, 1984.
- Bairán, J.M. A Non-linear coupled model for the analysis of reinforced concrete sections under bending, shear torsion and axial forces [on line]. Barcelona: UPC, 2011 [Consultation: 14/03/2023]. Available on: https://upcommons.upc.edu/handle/2117/93489.
- Van Mier, J.G.M. Fracture processes of concrete : assessment of material parameters for fracture models. Boca Raton: CRC Press, 1997. ISBN 0849391237.
- Ferreira, D., Bairán, J., Marí, A.. Numerical simulation of shear-strengthened RC beams. ELSEVIER, 2013.
- Haussler-Combe, U.. Computational methods for reinforced concrete structures. Wiley, 2015.
- Bazant, Z.P.. Mathematical modeling of creep and shrinkage of concrete. Wiley, 1988.
- Chen, W.F.. Plasticity in reinforced concrete. McGraw-Hill, 1982.
- Nilsen, M.P., Hoang, L. Limit analysis and concrete plasticity. Taylor and Francis. 2016.
- Lemaitre, J.. A course on damage mechanics. Springer,
- Crisfield, M.A.. Non-linear finite element analysis of solids and structures. Wiley,
- Bairán, J.M, Marí, A.. Multiaxial-coupled analysis of RC sections subjected to combined forces. ELSEVIER, 2007.