

Course guide

2500025 - GECFORMARM - Reinforced Concrete

Last modified: 01/10/2023

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

Degree: BACHELOR'S DEGREE IN CIVIL ENGINEERING (Syllabus 2020). (Compulsory subject).

Academic year: 2023 **ECTS Credits:** 6.0 **Languages:** Spanish, English

LECTURER

Coordinating lecturer: EVA MARIA OLLER IBARS

Others: ALBERTO DE LA FUENTE ANTEQUERA, EVA MARIA OLLER IBARS, DAVID VERGES COLL

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:

14401. Ability to analyze and understand how the characteristics of structures influence their behavior. Ability to apply knowledge about the resistant operation of structures to size them according to existing regulations and using analytical and numerical calculation methods. (Common module to the Civil branch)

14403. Knowledge of the fundamentals of the behavior of reinforced concrete structures and metal structures and ability to conceive, design, build and maintain these types of structures. (Common module to the Civil branch)

Generical:

14380. Scientific-technical training for the exercise of the profession of Technical Engineer of Public Works and knowledge of the functions of advice, analysis, design, calculation, project, construction, maintenance, conservation and exploitation.

14383. Ability to project, inspect and direct works, in their field.

14390. Identify, formulate and solve engineering problems. Pose and solve construction engineering problems with initiative, decision-making skills and creativity. Develop a systematic and creative method of analysis and problem solving. (Additional school competition).

14391. Conceive, project, manage and maintain systems in the field of construction engineering. Cover the entire life cycle of an infrastructure or system or service in the field of construction engineering. (Additional school competition).

TEACHING METHODOLOGY

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

The 2 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 2 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.

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.

There is also a course work in group that has some submission deadlines and that takes place inside the classroom (with workshops) and outside the classroom.

In general, lectures of group 10 will be in Spanish and lectures of group 20 will be in English. Occasionally, there may be classes in another language but you will be notified in advance.

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

Introduction to reinforced concrete. Casting. Basis of project. Specific aspects related to materials and strategy of durability. Selection criteria for the suitable structural type, pre-design criteria. Resisting mechanisms of reinforced concrete structures against external loads. Verification of the ultimate limit states and of the serviceability limit states for determinate and indeterminate reinforced concrete structures, focusing on those aspects related to adequate reinforcement and constructive feasibility. Knowledge about the performance of some common structural types such as floor slabs, girders, beams, columns and foundation elements.

- 1 Ability to define actions and combinations of actions to be considered in the concrete structures project. Capacity for designing and/or verifying the strength of the sections against different types of forces and their interaction.
- 2 Ability to determine the reinforcement and the lengths of overlap and anchoring necessary in the reinforcement design. Capacity for designing and/or verifying concrete structural elements against instability phenomena.
- 3 Capacity to design the most common reinforced concrete structures.

Knowledge of the fundamentals of the behavior of concrete structures and ability to conceive, project, build and maintain this type of structures. Knowledge of the resisting mechanisms that make possible the performance of reinforced concrete structures against external forces.

Knowledge of specific aspects related to materials, design and execution of structures, and durability strategy. Knowledge of the selection criteria of the appropriate structural type, of predesign criteria and of the design and verification methods related of isostatic and hyperstatic linear pieces of structural concrete, focusing on those aspects related to the adequate reinforcement and its constructive feasibility. Knowledge of the performance of some common structural types in construction praxis such as slabs, girders, beams, columns and foundation elements.

STUDY LOAD

Type	Hours	Percentage
Hours large group	30,0	20.00
Hours medium group	24,0	16.00
Guided activities	6,0	4.00
Hours small group	6,0	4.00
Self study	84,0	56.00

Total learning time: 150 h

CONTENTS

Introduction to reinforced concrete

Description:

Introduction to reinforced concrete
Execution of reinforced concrete structures

Full-or-part-time: 7h 11m

Theory classes: 3h
Self study : 4h 11m

Basics of design

Description:

Limit states
Structural safety
Course workshop #1. Conceptual design
Loads
Exercise of load combinations and envelopes
Course workshop # 2. Loads

Full-or-part-time: 24h

Theory classes: 4h
Practical classes: 6h
Self study : 14h

Materials

Description:

Materials Steel and Concrete
Course workshop # 3. Durability and Materials

Full-or-part-time: 7h 11m

Theory classes: 1h
Practical classes: 2h
Self study : 4h 11m

Ultimate limit state under normal stresses

Description:

Behaviour of reinforced concrete elements up to failure
Assumptions of the bending ULS with or without axial forces
ULS of bending with axial force
ULS of bending with axial forces. Design and assessment. Exercise with interaction diagrams
ULS of bending. Design and assessment. Rectangular section
ULS of bending. Design and Assessment. T-section
ULS of Bending without axial forces. Exercises
Course workshop # 4. ULS of Bending

Full-or-part-time: 31h 12m

Theory classes: 7h
Practical classes: 6h
Self study : 18h 12m

Ultimate Limit State of Instability

Description:

ULS Buckling

Course workshop # 5. ULS of bending with axial forces and Buckling

Full-or-part-time: 7h 11m

Theory classes: 1h

Practical classes: 2h

Self study : 4h 11m

Ultimate Limit State under shear stresses

Description:

ULS of shear

ULS Shear. Exercices

Course workshop # 6. ULS shear

Full-or-part-time: 14h 23m

Theory classes: 2h

Practical classes: 4h

Self study : 8h 23m

Ultimate Limit State of anchorage

Description:

ULS of anchorage and overlapping

Longitudinal distribution of internal reinforcement

Longitudinal distribution of internal reinforcement

Longitudinal distribution of armor. Exercise

Course workshop # 7. ULS of anchorage

Full-or-part-time: 24h

Theory classes: 6h

Practical classes: 4h

Self study : 14h

Serviceability Limit State of Cracking

Description:

SLS Cracking

Course workshop # 8. SLS Cracking

Full-or-part-time: 9h 36m

Theory classes: 2h

Practical classes: 2h

Self study : 5h 36m



Serviceability Limit State of Deformation

Description:

SLS deformation

Course workshop # 9. SLS deformation

Full-or-part-time: 9h 36m

Theory classes: 2h

Practical classes: 2h

Self study : 5h 36m

Structural elements

Description:

Structural elements

Structural elements

Full-or-part-time: 9h 36m

Practical classes: 4h

Self study : 5h 36m

GRADING SYSTEM

The mark of the course is obtained from the ratings of continuous assessment and their corresponding laboratories and/or classroom computers.

Continuous assessment consist in several activities, both individually and in group, of additive and training characteristics, carried out during the year (both in and out of the classroom).

The teachings of the laboratory grade is the average in such activities.

The mark of the course is obtained from the marks of the exams and the coursework that should be submitted during the course.

There will be a minimum of two exams during the course. The evaluation tests consist of a part with questions about concepts associated with the learning objectives of the course with regard to knowledge or understanding, and a part with a set of application exercises.

There will be a coursework project in groups of 3 people with different submissions. After the last deadline, there will be an interview in groups, which mark will be considered for the final mark of the course.

The final mark will be obtained as:

$$NF = 0,50 E + 0,40 T + 0,10 \cdot P$$

where:

E: mark of the partial exams. $E = 0,40 P1 + 0,60 P2$

T: mean of the coursework mark

P: participation in class activities

The minimum mark to pass the course will be 5,0. If students do not assist to an exam, do not submit the work project and do not participate in at least 60% of the class activities, their mark will be not presented (NP) and they will not be able to attend the re-evaluation test.

Criteria for re-evaluation qualification and eligibility: Students that failed the ordinary evaluation and have regularly attended all evaluation tests will have the opportunity of carrying out a re-evaluation test during the period specified in the academic calendar. Students who have already passed the test or were qualified as non-attending will not be admitted to the re-evaluation test. The maximum mark for the re-evaluation exam will be five over ten (5.0). The non-attendance of a student to the re-evaluation test, in the date specified will not grant access to further re-evaluation tests. Students unable to attend any of the continuous assessment tests due to certifiable force majeure will be ensured extraordinary evaluation periods.

These tests must be authorized by the corresponding Head of Studies, at the request of the professor responsible for the course, and will be carried out within the corresponding academic period.

EXAMINATION RULES.

The rules for carrying out the tests will be indicated in Atenea



BIBLIOGRAPHY

Basic:

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- Asociación Española de Normalización y Certificación. UNE-EN 1992-1-1 : eurocódigo 2 : proyecto de estructuras de hormigón : Parte1-1. Reglas generales y reglas para edificación. Madrid: AENOR, 2016.
- Marí, A.R.; Molins, C.; Bairán, J.M.; Oller, E. Formigó armat i pretensat: exercicis curts de bases de càlcul i estats límit, adaptat a la instrucció EHE-08 [on line]. 2a ed. Barcelona: Edicions UPC, 2009 [Consultation: 25/02/2021]. Available on: <http://hdl.handle.net/2099.3/36837>. ISBN 9788498803907.
- Jiménez Montoya, P. [et al.]. Hormigón armado [on line]. 15a ed. Barcelona: Gustavo Gili, 2009 [Consultation: 08/03/2021]. Available on: <https://ebookcentral.proquest.com/lib/upcatalunya-ebooks/detail.action?docID=3209549>. ISBN 9788425223075.
- Arroyo, J.C.; Morán, F.; García Meseguer, A. Jiménez Montoya : esencial : Hormigón armado. 16a ed. rev. red. y compl.. Madrid: Cinter Divulgación Técnica, 2018. ISBN 9788493930578.