## Course guides

### 2500025 - GECFORMARM - Reinforced Concrete

<table>
<thead>
<tr>
<th>Unit in charge:</th>
<th>Barcelona School of Civil Engineering</th>
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<tbody>
<tr>
<td>Teaching unit:</td>
<td>751 - DECA - Department of Civil and Environmental Engineering.</td>
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<tr>
<td>Degree:</td>
<td>BACHELOR’S DEGREE IN CIVIL ENGINEERING (Syllabus 2020). (Compulsory subject).</td>
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<tr>
<td>Academic year:</td>
<td>2021</td>
</tr>
<tr>
<td>ECTS Credits:</td>
<td>6.0</td>
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<tr>
<td>Languages:</td>
<td>Catalan, Spanish</td>
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### 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)

**General:**
- 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.
- 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.
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

<table>
<thead>
<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Hours medium group</td>
<td>30,0</td>
<td>20.00</td>
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<tr>
<td>Hours large group</td>
<td>30,0</td>
<td>20.00</td>
</tr>
<tr>
<td>Guided activities</td>
<td>6,0</td>
<td>4.00</td>
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<tr>
<td>Self study</td>
<td>84,0</td>
<td>56.00</td>
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**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  

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**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  

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**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  

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**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. Exercises
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
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 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.

BIBLIOGRAPHY

Basic: