# Course guide
# 2500222 - GEA0222 - Structures

**Last modified:** 22/05/2024

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

**Degree:** BACHELOR'S DEGREE IN ENVIRONMENTAL ENGINEERING (Syllabus 2020). (Compulsory subject).
BACHELOR'S DEGREE IN ENVIRONMENTAL ENGINEERING / BACHELOR'S DEGREE IN MINERAL RESOURCE ENGINEERING AND MINERAL RECYCLING (Syllabus 2024). (Compulsory subject).

**Academic year:** 2024 **ECTS Credits:** 6.0 **Languages:** Catalan

## LECTURER

**Coordinating lecturer:** JOAN BAIGES AZNAR

**Others:** JOAN BAIGES AZNAR

## DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

**Specific:**
14446. Solve mathematical problems that may arise in engineering by applying knowledge about: linear algebra, geometry, differential geometry, differential and integral calculus, optimization, ordinary differential equations.
14447. Obtain basic knowledge about the use and programming of computers, operating systems, databases and basic numerical calculation and applied to engineering.
14448. Manage the basic concepts about the general laws of mechanics and thermodynamics, concept of field and heat transfer, and apply them to solve engineering problems.
14450. Describe the global functioning of the planet: atmosphere, hydrosphere, lithosphere, biosphere, anthroposphere, biogeochemical cycles (C, N, P, S), soil morphology and apply it to problems related to geology, geotechnics, edaphology and climatology.
14453. Describe and apply the techniques of analysis of physical, chemical and biological parameters; Integrate the experimental evidence found in field and / or laboratory data with the theoretical knowledge and interpret its results.
14457. Identify the fundamentals of structure theory, sustainable procedures for construction and dismantling of buildings and civil works; and describe the technology bases of the materials used in construction.
14458. Apply the methodologies of studies and evaluations of environmental impact and, in general, of environmental technologies, sustainability and waste treatment and of the management of international standards of environmental quality. Life cycle analysis, carbon footprint and water footprint and assess natural hazards (river, coastal floods, droughts, fires, soil erosion and landslides).
14459. Describe the components and modes of transport and the impact of their externalities on the environment; identify the principles of environmental management of transport systems and sustainable planning of the territory; and introduce the tools for the management and operation of transport systems.
14461. Analyze, design, simulate and optimize processes and systems with environmental relevance, both natural and artificial, and their resolution techniques, as well as recognize techniques for analysis and evaluation of climate change.
14465. Identify renewable energy generation techniques and energy transition concept.

**Generical:**
14440. Identify, formulate and solve problems related to environmental engineering.
14441. Apply the functions of consulting, analysis, design, calculation, project, construction, maintenance, conservation and exploitation of any action in the territory in the field of environmental engineering.
14442. To use in any action in the territory proven methods and accredited technologies, in order to achieve the greatest efficiency respect for the environment and the protection of the safety and health of workers and users.

## TEACHING METHODOLOGY

The subject is developed through a set of face-to-face classes taught in the classroom and in other practical classes that are taught sequentially during the 15 weeks of a semester.

25 hours are dedicated to theoretical classes during which teachers present the basic concepts and teaching materials of the subject, present examples and perform exercises. 15 hours are devoted to practical classes during which problems are solved in a more interactive process with students. These practical exercises are carried out in order to consolidate general and specific knowledge and learning objectives.

The remaining hours of the week are divided into 15-hour laboratory practical classes and 5-hour assessment processes. The practical laboratory classes aim for the student to be able to check with their own activity in the classroom, or computer room, their progress in a specific knowledge.

Support material is used in the format of a detailed teaching plan through the ATENEA virtual campus: contents, programming of assessment and guided learning activities and bibliography.

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

Basic concepts of: balance, axial behavior, bending and shear of isostatic structures, hyperstaticism (beams and gantry).
Resisting characteristics of the main building materials (wood, steel, concrete, stone, brick) and how they are used in structural elements.The most common structural types, both in residential and industrial buildings and civil works (beams, trusses, slabs, floor slabs, supports, arches, walls ...). Amounts of common materials in these structures and CO2 emissions and average energy consumption by typologies.

1. Understand the concepts of efforts and balance in structures to be able to apply simple computer calculation techniques.
2. Know the structural typologies with which professionals in environmental engineering (tanks, reactors, etc.) often interact and their impact and interaction with the environment.

Structures. Subject that introduces the student to the calculation of structures giving the fundamental concepts so that any student of environmental engineering can understand the typologies, behavior in interaction with the environment of basic structures that can be found in the development of their professional life.

The aim of the course is to understand the operation of structures in environmental engineering. We will first work on concepts of strength of materials and theory of structures, and then move on to structural typologies, materials, limit states and calculation methodologies.

## STUDY LOAD

| Type | Hours | Percentage |
|---|---|---|
| Self study | 90,0 | 60.00 |
| Hours medium group | 15,0 | 10.00 |
| Hours large group | 30,0 | 20.00 |
| Hours small group | 15,0 | 10.00 |

**Total learning time:** 150 h

## CONTENTS

### Introduction to Structural Analysis

**Description:**
Concentrated force Distributed load Resulting moment and resulting moment of a system of forces
Equilibrium equations: vector formulation Equilibrium equations: scalar formulation Free body diagram
Problems solved in class
Idealization of the geometry of the structure Identification of the applied loads Identification of the type of supports and links
Definition and hypothesis Knot method
Problems solved in class
Definition and hypothesis Calculation of external reactions Internal actions
Problems solved in class
Tension. Tension tensioner. Movement and deformation. Deformation tensor. Linear elasticity. Hooke's law. Stress-strain relationship. Experimental study. Limit voltage, allowable voltage
Axial force in straight pieces
Pure straight flexion. Bending into flat pieces
Basic cutting theories
Differential equation of the deformed one of a straight beam. Navier formulas for medium plane structures. Elastic equations.
Problems solved in class

**Full-or-part-time:** 69h 36m
Theory classes: 23h
Practical classes: 6h
Self study : 40h 36m

### Structural Design

**Description:**
Introduction. Probabilistic Representation and Semi-Probabilistic Representation. Reliability required. Actions, effects of actions (envelopes) and combination of actions. Boundary States.
Problems solved in class
Matrix formulation for bar structures.
Computer calculation practice
Cables. Arcs.

**Full-or-part-time:** 28h 47m
Theory classes: 8h
Practical classes: 2h
Laboratory classes: 2h
Self study : 16h 47m

### Structural Materials

**Description:**
Presentation of the main materials in environmental engineering and their characteristics
Introduction to reinforced concrete Project of concrete structures Materials in concrete structures Durability of concrete structures
Introduces steel structures Properties of steel Project of steel structures Bonding Mixed structures
Problems solved in class

**Full-or-part-time:** 26h 24m
Theory classes: 9h
Practical classes: 2h
Self study : 15h 24m

**Structural Typologies**

**Description:**
Dams
Foundations
Deposits
Wind turbines

**Full-or-part-time:** 19h 12m
Theory classes: 8h
Self study : 11h 12m

## GRADING SYSTEM

The final grade of the subject will be composed from the grades of the exams (2 throughout the course), the grades of the exercises done in class / practices, and the grades of the course assignments.

The final grade will be calculated as a weighted average of the internship grade (PR), exams (EX) and coursework (TC) as follows:

NOTE = 0.7 EX + 0.15 PR + 0.15 TC

All assessment tests are mandatory and can be retaken only in case of justification (medical certificate, etc.). In the case of not having one or more Assessment marks, the final mark will be an NP (not presented).

Criteria of qualification and of admission to the re-evaluation: The students suspended in the ordinary evaluation that have presented regularly in the proofs of evaluation of the asignatura suspended will have the option to realize a proof of re-evaluation in the period set in the academic calendar. Students who have already passed it or students qualified as not presented will not be able to take the re-assessment test for a subject. The maximum grade in the case of taking the re-assessment exam will be five (5.0). The non-attendance of a student summoned to the re-evaluation test, held in the set period may not lead to the performance of another test with a later date. Extraordinary assessments will be carried out for those students who, due to accredited force majeure, have not been able to take any of the continuous assessment tests.

These tests must be authorized by the corresponding head of studies, at the request of the teacher responsible for the subject, and will be carried out within the corresponding teaching period.

The final grade obtained as well as the marks of the Continuous Assessments will not be saved for the academic year of the following year.

## EXAMINATION RULES.

Continuous assessment tests are MANDATORY. If not all continuous assessment tests are performed in the scheduled period, the final grade will be NP (Not Presented).

## BIBLIOGRAPHY

**Basic:**
- Cervera, M.; Blanco, E. Mecánica de estructuras [on line]. 2a ed. Barcelona: Edicions UPC, 2002 [Consultation: 04/05/2021]. Available on: http://hdl.handle.net/2099.3/36196. ISBN 8483016354.
- Cervera, M.; Blanco, E. Mecánica y resistencia de materiales. Barcelona: CIMNE, 2012. ISBN 9788494024399.