

# Structural Engineering (250725)

## General Information

<b>School</b>	ETSECCPB
<b>Departments</b>	Departament d'Enginyeria Civil i Ambiental (DECA)
<b>Credits</b>	6.0 ECTS
<b>Programs</b>	MÀSTER UNIVERSITARI EN ENGINYERIA ESTRUCTURAL I DE LA CONSTRUCCIÓ (pla 2015)
<b>Course</b>	2024/25

## Main teaching language at each group

- Group 10ES2 Spanish (Q2)
- Group 20EN2 English (Q2)

## Faculty

Responsible Faculty: Gabriel Bugada Castellort  
Faculty: Gabriel Bugada Castellort, Miguel Enrique Cerrolaza Rivas

## Competencies

### Especific

Mathematically modelling structural engineering problems.  
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.

### Generic

To conceive, design, analyze and manage structures or structural elements of civil engineering or building, encouraging innovation and the advance of knowledge.  
To develop, improve and use conventional materials and new construction techniques to ensure the safety requirements, functionality, durability and sustainability.

## Total hours of student work

		Hours	Percentage
Supervised Learning	Large group	27.96 h	51.78 %
	Medium group	13.02 h	24.11 %
	Laboratory classes	13.02 h	24.11 %
	Guided Activities	0.0 h	0.00 %
Self Study		96.0 h	

## Contents

### Introduction

Introudccion and discrete systems

### **Specific Objectives**

Describe the course and present the analogy with discrete and bar systems.

### **2D Solids**

Structural analysis in plane stress and strain assumptions as well in axisymmetric 3D structures.  
Introduction to Programming the FEM in MAT LAB  
Learning a finite element program  
Solution of two-dimensional structures using FEM

### **Specific Objectives**

Present the finite element method in two-dimensional elasticity problems  
Learn to programming and solve with the program the finite element method  
Consolidate the use of computers for solving problems using FEM

### **3D Solid**

Define the finite element method in three-dimensional elasticity problems.  
solution of 3D structures using the FEM

### **Specific Objectives**

consolidate the MEF study by its matrix formulation.  
Consolidate the use of computers to solve problems by the FEM

### **Beams**

Study the theories of Timoshenko and Euler\_Bernulli for solving bending beams.

### **Specific Objectives**

Studying higher-order elements and know the complications that can present the numerical solution of a problem by the FEM

### **Evaluation**

### **Plates**

Further application of FEM for thin and thick plates analysis using the Kirchhoff and Reissner-Mindlin theories. Analyse the application to composite materials.  
Solving plate structures using the FEM

### **Specific Objectives**

Extending theories of beams to two-dimensional case  
Consolidate the use of computers to solve problems by the FEM

### **Shells**

Develop the FEM to the analysis of thin and thick shells extending Kirchhoff theories and Reissner-Mindlin as well as the 2D plane stress to the 3D flat shells analysis.  
Shells structures solution using the FEM

### **Specific Objectives**

Expanding and combining elasticity theories applied to the FEM  
Consolidate the use of computers to solve problems using the FEM

### **real examples**

Presentation of real studies conducted by engineering firms.

### **Specific Objectives**

Knowing the actual use of the method and its scope.

### **Introduction to dynamic analysis**

Introduction to dynamic analysis of structures using the FEM

### **Specific Objectives**

show the scope of the FEM in the structures design.

### **Introduction to nonlinear problems**

Introduction to nonlinear analysis and coupled problems, using the FEM

### **Specific Objectives**

show the scope of the FEM in structural design.

## **Teaching Methodology**

The course consists of 2.7 hours a week of classes in the classroom where the teacher presents the concepts and basics of the course.

Also 0.9 hours per week is spending in a middle group format, to problem solving with more interaction with the student. Practical exercises are solved to consolidate the general and specific learning objectives. Support material is used in the form of detailed teaching plan stored at the Virtual Center <http://www.cimne.com/cdl1/ctrhome/2>: content, programming and evaluation activities directed learning 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.

## **Grading Rules**

*(\*) The evaluation calendar and grading rules will be approved before the start of the course.*

The mark will be obtained from continuous assessment (40%) and the average of two exams (60%). Continuous assessment involves solving individual exercises. These exercises will be graded with a maximum score of four (4) points: One (1) point for the practical exercises solved at class time and three (3) points for the finite element method applied to a practical case.

The exams consist of a questionnaire to be answer individually, without the help of any literature. Each questionnaire adheres to the concepts taught in the course. This exams have a maximum mark of six (6) points.

## **Test Rules**

If there is any exam or continuous assessment within the scheduled period, a zero score will be considered.

## **Office Hours**

The student consultancy service is two hours per week, intensifying to four hours per week at the exam period. The schedule will be announced at the beginning of each course.

## **Bibliography**

### **Basic**

- Oñate. E. [Cálculo de estructuras por el método de los elementos finitos: análisis estático lineal](#). 2a ed. Barcelona: Centro Internacional de Métodos Numéricos en Ingeniería, 1995. ISBN 8487867006.

- Oñate. E. [Structural analysis with the finite element method: linear statics: volume 1: basis and solids.](#) Barcelona: CIMNE; Springer, 2009. ISBN 9781402087325.
- Oñate. E. [Structural analysis with the finite element method: linear statics: volume 2: Beams, Plates and Shells.](#) Barcelona: CIMNE; Springer, 2010. ISBN 9781402087424.

