Structural Engineering (250405)

General Information

School	ETSECCPB
Departments	Departament d'Enginyeria Civil i Ambiental (DECA)
Credits	6.0 ECTS
Programs	MÀSTER UNIVERSITARI EN ENGINYERIA DE CAMINS, CANALS I PORTS (pla 2012) MÀSTER UNIVERSITARI EN ENGINYERIA DE CAMINS, CANALS I PORTS (pla 2012) PARS: ENGINYER/A DE CAMINS, CANALS I PORTS (pla 2022)
Course	2024/25

Main teaching language at each group

- Group 10EN1 English (Q1)
- Group 10EN2 English (Q2)

Faculty

Responsible Faculty: Ramon Codina Rovira
Faculty: Ramon Codina Rovira, Alejandro Cornejo Velázquez, Jose Francisco Zarate Araiza

Objectives of Education

Students will learn to apply their knowledge of structural engineering and to use advanced calculation methods to analyse, dimension and interpret the resistance behaviour of structures.

Upon completion of the course, students will be able to:

Apply their knowledge of structural engineering and use advanced calculation methods to analyse, dimension and interpret the resistance behaviour of structures;
Use dynamic analysis to examine the seismic behaviour of structures and apply advanced design techniques to improve seismic response;
Use advanced coupled nonlinear models to analyse and diagnose the possible limit states and ultimate limit states encountered during the life cycle of a structure;
Evaluate and mitigate structural seismic hazards;
Conduct durability and vulnerability studies.

Concepts and formulations of the finite element method: Application to the structural analysis of classic and advanced (composite) materials under static and dynamic conditions; Linear problems and introduction to nonlinear problems; Methods applicable to common engineering structures and materials, including dams, tunnels, tanks, sheets, buildings, bridges, mechanical components and plates: Fundamental theoretical aspects and main computational aspects; Hands-on sessions on engineering applications and structures

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 assumtions as well in axisimetric 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 theKirchhoff 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 Kirchoff 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.

Activities

Programming practices

Solve linear elasticity problems using the finite element method

Dedication

2h

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 final grade of the subject will be obtained from the exam grade (80%), the finite element practices (15%) and the exercises solved by the students (5%).

There will be two partial exams during the course. The first will weight 40% of the exam grade and the second 60%. Students will be able to present themselves for the reassessment following the general regulations of the center.

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. Barcelona: SPRINGER - CIMNE, 2009-2012. ISBN 9781402087325.