

Computational Structural Mechanics and Dynamics (250958)

General Information

School	ETSECCPB
Departments	Centre Internacional de Mètodes Numèrics en Enginyeria (CIMNE) Departament d'Enginyeria Civil i Ambiental (DECA)
Credits	5.0 ECTS
Programs	MÀSTER UNIVERSITARI EN ENGINYERIA ESTRUCTURAL I DE LA CONSTRUCCIÓ (pla 2015) MÀSTER UNIVERSITARI EN MÈTODES NUMÈRICS EN ENGINYERIA (pla 2012) MÀSTER UNIVERSITARI EN MÈTODES NUMÈRICS EN ENGINYERIA (pla 2012)
Course	2024/25

Main teaching language at each group

- Group 10EN2 English (Q2)

Faculty

Responsible Faculty: Luis Miguel Cervera Ruiz

Faculty: Luis Miguel Cervera Ruiz, Narges Dialamishabankareh Soltani, Jose Manuel Gonzalez Lopez, Jose Francisco Zarate Araiza

Objectives of Education

This course introduces the concepts, formulations, and applications of the finite elements method (FEM) for the analysis of structures composed of classical and innovative construction materials (composite materials) under static and dynamic loading. The course focuses on linear problems, however it provides a small introduction to the non linear analysis of structures. The different methods presented will cover the majority of the structural tipologies in engineering such as dams, tunnels, tanks, shells, buildings, bridges, structural and mechanical components, etc. The details for the formulation with finite elements are provided together with the most important computational aspects, allowing the students to get involved in FEM programming for structural analysis problems.

* To know the theoretical and practical basis of the finite elements method for the analysis of structures subjected to dynamic and static loading; * to identify the fundamental theoretical aspects for each structural tipology and their inherent computational aspects. * To identify properly the theories associated to each structural tipology for the correct analysis with the finite elements method (FEM); * to be able to analyse the structures commonly found in practice by means of the FEM, using commercial codes and simultaneously developing a personal code with the basic aspects. * The students will develop practical skills to work with tensors and formulate and develop the analysis of several problems of solids and fluids in engineering.

* Basic concept of matrix in the analysis of bar elements structures.

* Solids in 2D.

* Axisimètric solids.

* Solids in 3D.

* Beams.

* Thick and thin plates.

* Folded and curved shells

* Axisimètricas shells

Escola de Camins

- * Dynamic Analysis of structures
- * Introduction to the non-linear analysis of structures.
- * Additional subjects.

Learning Resources:

o O.C. Zienkiewicz and R.L. Taylor. The finite element method. Vols. 1 and 2, 5th Edition, Butterworth-Heinemann, 2003

Competencies

Especific

Practical numerical modeling skills. Ability to acquire knowledge on advanced numerical modeling applied to different areas of engineering such as: civil or environmental engineering or mechanical and aerospace engineering or bioengineering or Nanoengineering and naval and marine engineering, etc..

Knowledge of the state of the art in numerical algorithms. Ability to catch up on the latest technologies for solving numerical problems in engineering and applied sciences.

Materials modeling skills. Ability to acquire knowledge on modern physical models of the science of materials (advanced constitutive models) in solid and fluid mechanics.

Experience in numerical simulations. Acquisition of fluency in modern numerical simulation tools and their application to multidisciplinary problems engineering and applied sciences.

Interpretation of numerical models. Understanding the applicability and limitations of the various computational techniques.

Experience in programming calculation methods. Ability to acquire training in the development and use of existing computational programs as well as pre and post-processors, knowledge of programming languages and of standard calculation libraries.

Total hours of student work

		Hours	Percentage
Supervised Learning	Large group	25.5 h	56.67 %
	Medium group	9.75 h	21.67 %
	Laboratory classes	9.75 h	21.67 %
	Guided Activities	0.0 h	0.00 %
Self Study		80.0 h	

Contents

The Direct Stiffness Method

The Direct Stiffness Method

Introduction to FEM

Introduction to FEM

ElastoStatics

ElastoStatics. Theory

ElastoStatics. Practice

ElastoStatics. Laboratory

Beam, Plates and Shells

Beams, Plates and Shells. Theory

beam, Plates and Shells. Practice

Beams, Plates and Shells. Laboratory

Introduction to Non-Linear Analysis. Practice

ElastoDynamics

ElastoDynamics. Theory
ElastoDynamics. Practice
ElastoDynamics. Laboratory

Introduction to Nonlinear Analysis

Introduction to Non-Linear Analysis. Theory

Teaching Methodology

The course consists of 0.6 hours per week of classroom activity (large size group) and 1.2 hours weekly with half the students (medium size group).

The 0.6 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 1.2 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.

The rest of weekly hours devoted to laboratory practice.

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.

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 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.

Test Rules

Failure to perform a laboratory or continuous assessment activity in the scheduled period will result in a mark of zero in that activity.

Bibliography

Basic

- Felippa, C.A. Introduction to finite element methods. Boulder, Colorado: University of Colorado, 2004.
- Zienkiewicz, O.C.; Taylor, R.L.; Zhu, J.Z. [The finite element method: its basis & fundamentals](#). 7th ed. Amsterdam: Elsevier Butterworth-Heinemann, 2013. ISBN 9781856176330.
- Felippa, C. [Advanced finite element methods](#). Praha, Czech Republic: Institute of Theoretical Physics, Faculty of Mathematics and Physics, Charles University, 2000.

