Numerical Models in Civil and Structural Engineering (250439)

General Information

School	ETSECCPB
Departments	Departament d'Enginyeria Civil i Ambiental (DECA)
Credits	5.0 ECTS
Programs	MÀSTER UNIVERSITARI EN ENGINYERIA DE CAMINS, CANALS I PORTS (pla 2012) MÀSTER UNIVERSITARI EN ENGINYERIA DE CAMINS, CANALS I PORTS (pla 2012) 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) PARS: ENGINYER/A DE CAMINS, CANALS I PORTS (pla 2022)
Course	2024/25

Main teaching language at each group

- Group 10EN2 English (Q2)

Faculty

Responsible Faculty: Michele Chiumenti
Faculty: Luis Miguel Cervera Ruiz, Michele Chiumenti, Narges Dialamishabankareh Soltani, Jose Francisco Zarate Araiza

Objectives of Education

Specialty subject in which knowledge in specific skills is intensified. Knowledge at a specialization level that must allow the development and application of advanced level techniques and methodologies. Master's level specialization content related to search or innovation in the field of engineering.

This subject aims to give a vision of the possibilities offered by numerical simulation in civil and structural engineering.
The student will have the possibility of touching different aspects related to structural calculation and in particular touching nonlinear analysis (plasticity and damage) and transient analysis (thermal and thermo-mechanical).
All the necessary knowledge will be reviewed and the appropriate calculation instruments (software, interfaces, etc.) will be provided.
To carry out the different tasks, the student will have maximum freedom to solve the proposed problems looking for the best solution in each case.

Competencies

Especific

Knowledge of and competence in the application of advanced structural design and calculations for structural analysis, based on knowledge and understanding of forces and their application to civil engineering structures. The ability to assess structural integrity.

Transversal

ENTREPRENEURSHIP AND INNOVATION: Being aware of and understanding the mechanisms on which scientific research is based, as well as the mechanisms and instruments for transferring results among socio-economic agents involved in research, development and innovation processes.
SUSTAINABILITY AND SOCIAL COMMITMENT: Being aware of and understanding the complexity of the economic and social phenomena typical of a welfare society, and being able to relate social welfare to globalisation and sustainability and to use technique, technology, economics and sustainability in a balanced and compatible manner.
TEAMWORK: Being able to work in an interdisciplinary team, whether as a member or as a leader, with the aim of contributing to projects pragmatically and responsibly and making commitments in view of the resources that are available.

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

Introduction

Introduction: The aim of the course, format of lessons, tasks

Brief review of Continuum Mechanics

Review of concepts and definitions in Continuum Mechanics
Review of the theory of elasticity and elastic problem definition

Geometric modeling and meshing

Downloading and installing GiD for pre-processing (CAD data) and post processing (results).
Guided tutorial for geometric modeling (GID).
Guided tutorial for finite element meshing

Structural Analysis

Tutorial guide on using the software interface for structural analysis with FEM (COMET).
Tutorial on Post-Processing (GID).
Description of the different failure criteria for ductile and brittle materials.

Transient Analysis

Thermal and thermo-mechanical problems.
Case studies: the numerical simulation of casting and welding processes.
Tutorial guide to the software interface for thermo-mechanical FEM analysis (COMET).
Guided exercises to solve thermal and thermo-mechanical problems.

Nonlinear analysis

Computational methods for nonlinear analysis.
Numerical techniques for nonlinear analysis: Newton-Raphson, Picard, arc length, prediction techniques, etc ...
Elasto-plasticity and elasto-damage constitutive equations for the most common materials in civil

engineering (steel, concrete, soil). Yield strength, hardening and softening variables inelastic deformations and damage.
Tutorial on solving nonlinear problems.

Activities

Geometric modeling and meshing

Guided tutorial on geometric modeling and finite element meshing (GID).

Dedication

3h

PostProcessing (GiD).

Guided tutorial on PostProcessing (GiD).

Dedication

3h

Teaching Methodology

The subject consists of 3 hours a week of face-to-face classes in a classroom: 2 hours are of theoretical classes and 1 hour to practice the concepts learned in class in order to consolidate the general and specific learning objectives.

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

Grading Rules

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

The evaluation consists of a final exam (25% of the final grade) and 5 assignments (15% of the final grade each) that correspond to the main topics covered in the course. These works are developed in class and finished at home with the delivery of a final report. It is possible to perform the work individually or with another student of the course. The final mark is calculated as the sum of the grade of the exam and the evaluation of the notes relative to all the works. It is mandatory to carry out all the proposed works. Otherwise, the final grade will be Not Presented (NP).

Test Rules

The assignments proposed during the course as part of the evaluation are mandatory.
If one or more assignments are not presented the final mark will be: Not Presented (NP).

Office Hours

Every day from 14:30 to 15:30 in the office 121 of module C1.

Bibliography

Basic

- Fung, Y.C. A first course in continuum mechanics: for physical and biological engineers and scientists. 3rd ed. Englewood Cliffs: Prentice Hall, 1994. ISBN 0130615242.
- Malvern, L.E. Introduction to the mechanics of a continuous medium. Englewood Cliffs, NJ: Prentice-Hall, 1969. ISBN 0134876032.

- Mase, G.T.; Smelser, R.E.; Mase, G.E. Continuum mechanics for engineers. 4th ed. Boca Raton, FL: CRC Press, 2020. ISBN 9781482238686.
- Fung Y.C.; Tong, P.; Chen, X. Classical and computational solid mechanics. 2nd ed. Singapore: World Scientific Publishing Co. Pte. Ltd, 2017. ISBN 9789814713641.
- Bathe, K.-J. Finite element procedures. [S. l.]: l'autor, 2006. ISBN 9780979004902.
- 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.
- Zienkiewicz, O.C.; Taylor, R.L.; Fox, D.D. The Finite element method: for solid & structural mechanics. 7th ed. Amsterdam: Elsevier Butterworth-Heinemann, 2014. ISBN 9781856176347.
- Borst, R. de; Crisfield, M.A. Nonlinear finite element analysis of solids and structures. 2nd ed. Hoboken: Wiley, 2012. ISBN 9781118375938.

Complementary

- West, H.H. Fundamentals of structural analysis. 2nd ed. New York: Wiley, 2002. ISBN 0471355569.
- Ghali, A.; Neville, A.M. Structural analysis: a unified classical and matrix approach. 7th ed. Boca Raton: CRC Press, Taylor and Francis Group, 2017. ISBN 9781498725064.
- Utku, S.; Norris, C.H.; Wilbur, J.B. Elementary structural analysis. 4th ed. New York: McGraw-Hill, 1991. ISBN 0071008365.