

Computational Engineering for Design and Operation (250440)

General Information

School	ETSECCPB
Departments	Centre Específic de Recerca de Mètodes Numèrics en Ciències Aplicades i Enginyeria (CER-LACÀN-UPC) 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) PARS: ENGINYER/A DE CAMINS, CANALS I PORTS (pla 2022)
Course	2025/26

Main teaching language at each group

- Group 11Q1 English (Q1)
- Group 12Q1 English (Q1)

Faculty

Responsible Faculty: Natividad Pastor Torrente
Faculty: Natividad Pastor Torrente, Denise Carina Santos Ferreira

Objectives of Education

Specialization subject in which knowledge on specific competences is intensified.

Knowledge and skills at specialization level that permit the development and application of techniques and methodologies at advanced level.

Contents of specialization at master level related to research or innovation in the field of engineering.

Tutored weekly class where case studies and practical examples are reproduced by the students. Topics in computational engineering are reviewed and worked in depth using commercial software

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

Basic steps in computer modeling
Modeling exercise FE with pdetools.

Governing physics

Balance equations: solids, fluids. Thermal balance. Transport equation

Exercise on heat transfer.

Discretization methods

Finite elements
Abaqus. SAP. Other commercial software.

Linear Elasticity

Bulk and structural elements for linear elasticity
Introduction to SAP and exercise with SAP.
Introduction to Abaqus.

Dynamics

Dynamic analysis: Modal and direct time-integration algorithms- explicit vs implicit, stability.
Resolution of a dynamic example with Abaqus.

Evaluation

Evaluation will be carried out on the basis of tutorised assignments, evaluation test at class and a final project to be carried out in groups.

Non-linearities

Non-linear elasticity. Plasticity. Viscoelasticity. Damage.
Exercise with Abaqus

Buckling

Linear and non-linear buckling
Practical exercise with Abaqus de linear vs. non-linear buckling.

Activities

Assignment with PDEtools

Practical FEM exercise with PDEtools

Dedication

1h 30m

Assignment with SAP

Practical exercise of linear elasticity with SAP

Dedication

1h 30m

Assignment on plasticity

Practical exercise of plasticity with Abaqus

Dedication

1h 30m

Course project

A course project will be given during the semester. It should be completed by teams of students. The submission of this course assignment on the announced due date is mandatory.

Dedication

1h 30m

Teaching Methodology

Taught module delivery: thirteen weeks of teaching, coursework and self-study. Apart from the 3 hours per week in the classroom, self-study must last an average of 4.5 hours per week.

At least a half of the hours devoted to the course will be carried out in small work groups (computer laboratory, evaluations, etc.)

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 as follows:

$$\text{Mark} = Q \cdot 0.2 + A \cdot 0.3 + P \cdot 0.5$$

where

Q is the mark of the in-class written exam

A is the average of the marks of the three assignments

P is the mark of the final project

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

- Zienkiewicz, O.C.; Morgan, K. Finite elements and approximation. New York: John Wiley and Sons, 1983. ISBN 0471982407.

Complementary

- Oliver Olivella, X.; Agelet de Saracibar, C. [Mecànica de medis continus per a enginyers](#). Barcelona: Edicions UPC, 2003. ISBN 8483017199.
- Bathe, K.-J. [Finite element procedures](#). [S. l.]: l'autor, 2006. ISBN 9780979004902.
- Belytschko, T.; Liu, W.K.; Moran, B.; Elkhodary, K. [Nonlinear finite elements for continua and structures](#). 2nd ed. Chichester: Wiley, 2014. ISBN 9781118632703.

