



Course guide

250COD010 - 250COD010 - Computational Mechanics Project Laboratory

Last modified: 17/06/2026

Unit in charge: Barcelona School of Civil Engineering

Teaching unit: 751 - DECA - Department of Civil and Environmental Engineering.

Degree: MASTER'S DEGREE IN COMPUTATIONAL AND DATA-ASSISTED ENGINEERING (Syllabus 2026).
(Compulsory subject).

Academic year: 2026

ECTS Credits: 5.0

Languages: English

LECTURER

Coordinating lecturer: JOSE MANUEL GONZALEZ LOPEZ

Others: Saez Viñas, Pablo
Giacomini, Matteo

PRIOR SKILLS

This course is based on the theoretical knowledge acquired in previous or concurrent courses, Partial Derivative Equations and Finite Element Methods (Q1), Computational Solid and Structural Mechanics (Q2) and Computational Fluid Mechanics (Q2).

REQUIREMENTS

To have completed or currently taking the courses related to the previous skills required: Partial Derivative Equations and Finite Element Methods (Q1), Computational Solid and Structural Mechanics (Q2) and Computational Fluid Mechanics (Q2).

TEACHING METHODOLOGY

This is a projected-based course that combines:

- Brief revision of previous theoretical concepts.
- Hands-on sessions using computational tools.
- Applied projects.
- Independent student work.

LEARNING OBJECTIVES OF THE SUBJECT

The main objective of the course is to enable students to:

- To strengthen the programming capabilities of the students with application projects.
- To strengthen the basic knowledge acquired during Q1 through hands-on lab projects.
- To expose the student to a large computational project related to Computational Mechanics of solids and Structures and Computational Fluid Mechanics courses
- Improve writing and presentation skills.

STUDY LOAD

Type	Hours	Percentage
Hours large group	45,0	36.00
Self study	80,0	64.00

Total learning time: 125 h

CONTENTS

Basic Concepts on Computational Mechanics

Description:

1. Basic concepts on FEM: discretization, convergence analysis, etc.
2. Constitutive models: definition and aplicación to the Computational Mechanics.
3. Dynamic analysis: basic concepts, implementation and applications.
4. Non-linearity: types of non-linearity, applications and computational issues.
5. Fluid dynamics: basic concepts, especific parameters, implementation and applications.

Specific objectives:

Remind and update the concepts of Computational Mechanics to be applied in the tasks

Related activities:

Basic concepts of the FEM
Implementation and analysis of the advanced discretization approaches
Numerical modelling of a Solid Mechanics problem
Numerical modelling of a Fluid Dynamics problem

Full-or-part-time: 4h

Theory classes: 4h

ACTIVITIES

Basic concepts of the FEM

Description:

Study and application of basic concepts of the Finite Element Metod like discretization, time integration schemes, convergence analysis, etc.

Specific objectives:

Remind and uptdate the basic concepts of the FEM and the use of computational tools.

Material:

Notes about the basic theory on FEM

Delivery:

Numerical models with the resolution of the project.
Brief technical report with the structural analysis.

Full-or-part-time: 22h

Theory classes: 7h

Self study: 15h

Implementation and analysis of the advanced discretization approaches

Description:

The students will implement and analyze basic and advanced discretization approaches described during the previous course of the master's program. The project will also involve aspects of solids and fluids described in courses of the same quatrimester.

Delivery:

The student will deliver a report on the project carried out during the computer classes

Full-or-part-time: 22h

Theory classes: 8h

Self study: 14h

Numerical modelling of a Solid Mechanics problem

Description:

The students will face a physical solids mechanical problem and propose a numerical model applying the knowledge acquired in previous or concurrent courses of the Mastter. The numerical model will have to answer the posed questions and offer optimal solutions in terms of modelling.

Specific objectives:

Deep into the capacities and limitations in terms of modelling of Solid Mechanics physical problems offered by the Finite Element Method.

Delivery:

Numerical models with the resolution of the project.

Technical report with the corresponding numerical-structural analysis.

Full-or-part-time: 31h

Theory classes: 11h

Self study: 20h

Numerical modelling of a Fluid Dynamics problem

Description:

The students will face a physical fluid dynamics problem and propose a numerical model applying the knowledge acquired in previous or concurrent courses of the Mastter. The numerical model will have to answer the posed questions and offer optimal solutions in terms of modelling.

Specific objectives:

Deep into the capacities and limitations in terms of modelling of Fluid Dynamics problems offered by the Finite Element Method.

Delivery:

Numerical models with the resolution of the project.

Technical report with the corresponding numerical analysis.

Full-or-part-time: 45h

Theory classes: 15h

Self study: 30h

GRADING SYSTEM

Any academic fraud, plagiarism or use or possession of unauthorised means in an assessment activity leads to a mark of zero (0) for the affected test or assignment. Furthermore, in accordance with the University's regulations, if disciplinary proceedings are initiated the subject is recorded as "Pending Assessment" until a decision is reached. These incidents are managed in accordance with the [Action Framework for Academic Integrity in Assessment at the UPC](#).

The final grade is calculated from the projects delivered during the course and the final exam.

The delivery of the laboratory projects is mandatory to pass the course.

The final mark is calculated as $0.75 \cdot \text{Projects (P)} + 0.25 \cdot \text{Final exam}$

The qualification of the projects (P) is the average of the qualifications on the projects delivered.

EXAMINATION RULES.

The delivery of the laboratory projects is mandatory to pass the course.

The course is passed when the final final grade is equal or above 5.

BIBLIOGRAPHY

Basic:

- Oñate, E. Cálculo de estructuras por el método de los elementos finitos : análisis elástico lineal. Barcelona: Centro Internacional de Métodos Numéricos en Ingeniería, 1992. ISBN 8487867006.

- Felippa, C.A. Introduction to finite element methods [on line]. Colorado: University of Colorado, 2004 [Consultation: 26/06/2026]. Available on :

chrome-extension://efaidnbmnnnibpcajpcgclefindmkaj/<https://vulcanhammer.net/wp-content/uploads/2017/01/ifem.pdf>.

- Reddy, J. N. Introduction to the finite element method [on line]. Fourth edition. New York: McGraw-Hill, [2019] [Consultation: 26/06/2026]. Available on :

<https://www-accessengineeringlibrary-com.recursos.biblioteca.upc.edu/content/book/9781259861901?implicit-login=true>. ISBN 9781259861901.

- Donea, J.; Huerta, A. Finite Element Methods for Flow Problems [on line]. Chichester: John Wiley & sons, 2003 [Consultation: 26/06/2026]. Available on: <https://onlinelibrary-wiley-com.recursos.biblioteca.upc.edu/doi/book/10.1002/0470013826>. ISBN 0471496669.

Complementary:

- Felippa, C.A.. Advanced finite element methods [on line]. Praha, Czech Republic: Institute of Theoretical Physics, Faculty of Mathematics and Physics, Charles University, [2000] [Consultation: 26/06/2026]. Available on: <https://es.scribd.com/document/244025561/Felippa-C-Advanced-finite-element-methods-draft-2000-O-659s-MNf-pdf>.

RESOURCES

Other resources:

The course includes the audiovisual material like presentations and complementary material, and a part of the bibliography available in ATENEA

The computational tools required to develop the projects of the course will be fully available for the students.