Course guide
250COD002 - 250COD002 - Computational Solid and Structural Mechanics

Last modified: 05/06/2026

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: Dialamishabankareh Soltani, Narges

Others: Dialamishabankareh Soltani, Narges

TEACHING METHODOLOGY

The course combines lectures covering theoretical background and derivations, hands-on sessions using FEM software, applied projects focused on modeling real-world structures, and independent student work involving problem solving and assignments.

LEARNING OBJECTIVES OF THE SUBJECT

The course aims to provide students with a solid foundation in computational solid and structural mechanics using the Finite Element Method (FEM). Upon successful completion of the course, students will be able to formulate FEM discretizations for 2D and 3D structural problems, model and analyze beams, plates, shells, and solid structures, apply dynamic analysis techniques, understand structural stability and buckling phenomena, and critically interpret numerical results for engineering decision-making.

STUDY LOAD

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

Total learning time: 125 h

CONTENTS

Intro and Structural FEM Foundations

Description:

â Course overview and objectives
â Relation to structural matrix methods:
â Direct Stiffness Method (DSM)
â Principle of Virtual Work (PVW) for bars
â Derivation of FEM equations:
â Weighted residuals vs PVW (equivalence)
â Transition from PDE-based FEM to structural mechanics
â Introduction to FEM software

Full-or-part-time: 9h 36m
Theory classes: 3h
Practical classes: 1h
Self study : 5h 36m

2D Solids

Description:
â Plane stress
â Plane strain
â Constitutive behavior and weak form

Full-or-part-time: 9h 36m
Theory classes: 3h
Practical classes: 1h
Self study : 5h 36m

3D & Axisymmetric Solids

Description:
â 3D elasticity
â Axisymmetric formulation (solids of revolution)

Full-or-part-time: 9h 36m
Theory classes: 3h
Practical classes: 1h
Self study : 5h 36m

Beams

Description:
â Euler–Bernoulli beam theory
â Timoshenko beam theory
â Shear locking (intro concept)

Full-or-part-time: 9h 36m
Theory classes: 4h
Self study : 5h 36m

Plates

Description:
â□□ Kirchhoff plate theory
â□□ Plate Kinematics
â□□ Why second derivatives appear □ C^1 continuity
â□□ FEM implications
â□□ Difficulty of constructing conforming elements
â□□ Practical limitations
â□□ Reissner–Mindlin plate theory
â□□ Shear deformation
â□□ Shear locking + remedies (reduced integration, etc.)

Full-or-part-time: 19h 12m
Theory classes: 6h
Practical classes: 2h
Self study : 11h 12m

Shells

Description:
â□□ Shell kinematics (membrane + bending coupling)
â□□ Relation to plates
â□□ Axisymmetric shells
â□□ Shell modeling (plate + membrane concept)
â□□ Practical aspects and limitations

Full-or-part-time: 19h 12m
Theory classes: 6h
Practical classes: 2h
Self study : 11h 12m

Dynamics

Description:
â□□ Governing equations of motion
â□□ Time integration methods
â□□ Stability and accuracy
â□□ Eigenvalue problems
â□□ Modal superposition

Full-or-part-time: 19h 12m
Theory classes: 6h
Practical classes: 2h
Self study : 11h 12m

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Nonlinear FEM & Structural Stability

Description:

â Why Nonlinear FEM?
â Types of nonlinearity
â Conceptual Solution Approach
â Structural Stability

Full-or-part-time: 12h
Theory classes: 5h
Self study : 7h

GRADING SYSTEM

The assessment is based on four components: assignments (10%), applied projects (20%), midterm examination (30%), and final examination (40%). The final grade is calculated as a weighted average of these assessment activities.

EXAMINATION RULES.

All assessment activities are mandatory. Failure to submit or attend any assessment component (assignments, projects, midterm examination, or final examination) will result in a grade of Not Presented (NP) for the course.

BIBLIOGRAPHY

Basic:
- Zienkiewicz, O. C. The Finite Element Method: Its Basis and Fundamentals [on line]. 8th ed. Cham: Elsevier Science & Technology, 2024 [Consultation: 29/07/2026]. Available on: https://www-sciencedirect-com.recursos.biblioteca.upc.edu/book/monograph/9780443160448/the-finite-element-method. ISBN 0443160457.
- Oñate, E.. Structural Analysis with the Finite Element Method. Linear Statics [on line]. Barcelona: Springer, 2009 [Consultation: 09/06/2026]. Available on: https://link-springer-com.recursos.biblioteca.upc.edu/book/10.1007/978-1-4020-8733-2. ISBN 9781402087325.

Complementary:
- Reddy, J. N. An Introduction to the Finite Element Method [on line]. 4th ed. New York: McGraw-Hill, 2019 [Consultation: 09/06/2026]. Available on: https://www-accessengineeringlibrary-com.recursos.biblioteca.upc.edu/content/book/9781259861901. ISBN 9781259861901.
- Reddy, J. N. An Introduction to nonlinear finite element analysys : with applications to heat transfer, fluid mechanis, and solid mechanics. 2nd ed. Oxford: Oxford, 2013. ISBN 9780199641758.