# 250956 - MECSOLCOM - Computational Solid Mechanics

**Coordinating unit:** 250 - ETSECCPB - Barcelona School of Civil Engineering  
**Teaching unit:** 751 - DECA - Department of Civil and Environmental Engineering  
**Academic year:** 2019  
**Degree:** MASTER'S DEGREE IN NUMERICAL METHODS IN ENGINEERING (Syllabus 2012). (Teaching unit Compulsory)  
ERASMUS MUNDUS MASTER'S DEGREE IN COMPUTATIONAL MECHANICS (Syllabus 2013). (Teaching unit Optional)  
**ECTS credits:** 5  
**Teaching languages:** English

### Teaching staff

**Coordinator:** FRANCISCO JAVIER OLIVER OLIVELLA  
**Others:** CARLOS AGELET DE SARACIBAR BOSCH, MARINO ARROYO BALAGUER, JOAQUIN ALBERTO HERNANDEZ ORTEGA, ALFREDO EDMUNDO HUESPE, FRANCISCO JAVIER OLIVER OLIVELLA

### Opening hours

**Timetable:** Office hours to be arranged with the teachers of the subject.

### Degree competences to which the subject contributes

**Specific:**

- 8378. 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.  
- 8379. 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.  
- 8380. Materials modeling skills. Ability to acquire knowledge on modern physical models of the science of materials (advanced constitutive models) in solid and fluid mechanics.  
- 8382. Experience in numerical simulations. Acquisition of fluency in modern numerical simulation tools and their application to multidisciplinary problems engineering and applied sciences.  
- 8383. Interpretation of numerical models. Understanding the applicability and limitations of the various computational techniques.  
- 8384. 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.

### Teaching methodology

The course consists of 3 hours a week of lectures given in the classroom. Theory, problems and laboratory will be alternated following the schedule of the course.

### Learning objectives of the subject

The course is centered on the numerical methods applied to the modeling of the behaviour of nonlinear materials in solids. It makes special emphasis on the integration of the constitutive models and the generalizations towards the nonlinear versions of the finite element method. The course includes the essential theoretical aspects as well as their practical applications.
The students will be able to understand and assimilate the foundations of the mechanics of solids, identifying the most important aspects of the modeling of a material, like the mechanisms of dissipation associated with nonlinear behaviour. They have to be able to interpret the physical meaning of the properties of a material and properly identify the numerical methods for the solution of problems of mechanics of solids with its application on elasticity and learn the foundations of fluid mechanics. To know the theoretical and practical foundations of the method of the finite elements for the analysis of structures submitted to dynamic and static loads; to identify the fundamental theoretical aspects for each structural topology and their inherent computational aspects. Identify properly the theories associated to each structural topology for the correct analysis with the finite elements method (FEM), to be able to analyse the structural topologies commonly found in practice by means of the FEM, using commercial codes and simultaneously develop a personal code with their basic aspects. To learn the foundations of the behaviour of the numerical approximations to the dynamics of fluids: Their equations, the spatial and temporal discretisations, and the most relevant mathematical aspects, such as the stabilisation of convection and incompressibility, understanding the most important aspects of spatial and temporal discretisation as well as identifying the correct conditions for boundaries and methods but adapted to the solution for dynamics of fluids problems. The students will develop practical skills to work with tensors and formulate and develop the analysis of diverse problems of solids and fluids in engineering.

- Constitutive modeling of materials.
- Elasticity and visco elasticity.
- Continuum damage and visco-damage.
- Plasticity And visco plasticity.
- Material stability.
- Computational techniques for the modeling of non-linear materials in solids.
- Advanced subjects: Mechanics of contact and extension to finite deformations.

Learning resources:
- Belytschko T., Liu W.K., Moran B., Non-linear Finite Elements for Continua and Structures, Wiley, 2002

### Study load

<table>
<thead>
<tr>
<th></th>
<th>Hours large group:</th>
<th>Hours medium group:</th>
<th>Hours small group:</th>
<th>Guided activities:</th>
<th>Self study:</th>
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<tbody>
<tr>
<td><strong>Total learning time</strong></td>
<td>125h</td>
<td>7h 30m</td>
<td>15h</td>
<td>5h</td>
<td>80h</td>
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# Content

## Introduction

<table>
<thead>
<tr>
<th>Description</th>
<th>Learning time</th>
<th>Theory classes: 1h 30m</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Practical classes: 5h</td>
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<tr>
<td></td>
<td></td>
<td>Laboratory classes: 5h 30m</td>
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<tr>
<td></td>
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<td>Self study : 16h 47m</td>
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## Thermodynamic foundations of constitutive modelling

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<tbody>
<tr>
<td></td>
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<td>Self study : 4h 11m</td>
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## Continuum damage models

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<tbody>
<tr>
<td></td>
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<td>Practical classes: 5h</td>
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<tr>
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<td>Laboratory classes: 5h 30m</td>
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<tr>
<td></td>
<td></td>
<td>Self study : 16h 47m</td>
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## Plasticity models

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<tbody>
<tr>
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<tr>
<td></td>
<td></td>
<td>Laboratory classes: 5h 30m</td>
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<td>Self study : 16h 47m</td>
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</table>
Nonlinear continuum mechanics

Learning time: 28h 47m
- Theory classes: 1h 30m
- Practical classes: 5h
- Laboratory classes: 5h 30m
- Self study: 16h 47m

Description:
- Nonlinear continuum mechanics
- Nonlinear continuum mechanics
- Algorithms and Implementation

Qualification system

The course grade will be obtained from weighted average of the continuous assessment marks.
The continuous assessment consists of different additive and formative activities (individual assignment) done during the course (in the classroom and outside of it).

Regulations for carrying out activities

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

Bibliography

Basic:

Complementary: