

## Course guide

### 250963 - PROBACOB - Coupled Problems

**Last modified:** 28/03/2024

<b>Unit in charge:</b>	Barcelona School of Civil Engineering	
<b>Teaching unit:</b>	751 - DECA - Department of Civil and Environmental Engineering.	
<b>Degree:</b>	MASTER'S DEGREE IN NUMERICAL METHODS IN ENGINEERING (Syllabus 2012). (Optional subject). ERASMUS MUNDUS MASTER'S DEGREE IN COMPUTATIONAL MECHANICS (Syllabus 2013). (Optional subject).	
<b>Academic year:</b> 2023	<b>ECTS Credits:</b> 5.0	<b>Languages:</b> English

#### LECTURER

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<b>Coordinating lecturer:</b>	RAMON CODINA ROVIRA
<b>Others:</b>	JOAN BAIGES AZNAR, RAMON CODINA ROVIRA

#### DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

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##### 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

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The course consists of 1.2 hours per week of classroom activity (large size group) and 1.2 hours weekly with half the students (medium size group).

The 1.2 hours in the large size groups are devoted to theoretical lectures, in which the teacher presents the basic concepts and topics of the subject, shows examples and solves exercises.

The 1.2 hours in the medium size groups is devoted to solving practical problems with greater interaction with the students. The objective of these practical exercises is to consolidate the general and specific learning objectives.

The rest of weekly hours devoted to laboratory practice.

Support material in the form of a detailed teaching plan is provided using the virtual campus ATENEA: content, program of learning and assessment activities conducted and literature.

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.

## LEARNING OBJECTIVES OF THE SUBJECT

This course covers the theoretical and computational aspects for the solution of coupled problems, using the finite elements method (FEM) and the procedures related to discretisation. It emphasizes on the description of the mathematical formulation of each problem and on the details of the practical solution by the FEM.

\* To learn the fundamentals of the modeling of geomaterials, porous materials in particular, and termo-hidro-mechanical coupling \* Emphasis will be put on the need for students to acquire independence in their studies; they have to learn to use a computer for basic programming and learn to use and make the most of their study hours. \* To implement and use computer programs to solve non-linear problems on different fields of application. \* To analyse from a critical point of view the results obtained by the simulations.

\* Summary and classification of coupled problems.

\* Fluid-structure Interaction.

\* Fluid-pores interaction in grounds.

\* Termo-mechanical coupling.

\* Electro-magneto-dynamic coupling.

\* Partitions and scales diagrams.

\* Programming aspects.

\* Applications

Learning resources:

o Textos de conferencias

o O.C. Zienkiewicz et al. The finite element method. Vols 1, 2 y 3. 6ª edición, Elsevier, 2006.

## STUDY LOAD

Type	Hours	Percentage
Hours large group	25,5	20.38
Hours medium group	9,8	7.83
Hours small group	9,8	7.83
Self study	80,0	63.95

**Total learning time:** 125.1 h

## CONTENTS

### Transmission Conditions

#### Description:

Terms of transmission in continuum mechanics  
Problems transmission conditions

**Full-or-part-time:** 14h 23m

Theory classes: 3h

Practical classes: 3h

Self study : 8h 23m

### Coupled Problems

**Description:**

Link to the homogeneous space problems

Link to space problems heterogeneous

Coupling time I

Coupling time II

Problems coupled problems

Problems coupled problems II

**Full-or-part-time:** 39h 36m

Theory classes: 10h 30m

Practical classes: 6h

Self study : 23h 06m

### Applications

**Description:**

Fluid-structure interaction

Thermal and mechanical coupling

Mechanical and electromagnetic coupling

Application Problems

Practical Matlab II

**Full-or-part-time:** 32h 24m

Theory classes: 7h

Practical classes: 3h

Laboratory classes: 3h 30m

Self study : 18h 54m

### Implementation issues

**Description:**

Implementation issues

Problems of implementation issues

Practices with MatLab

**Full-or-part-time:** 21h 36m

Theory classes: 2h

Practical classes: 3h

Laboratory classes: 4h

Self study : 12h 36m

## GRADING SYSTEM

The mark of the course is obtained from the ratings of continuous assessment and their corresponding laboratories and/or classroom computers.

Continuous assessment consist in several activities, both individually and in group, of additive and training characteristics, carried out during the year (both in and out of the classroom).

The teachings of the laboratory grade is the average in such activities.

The evaluation tests consist of a part with questions about concepts associated with the learning objectives of the course with regard to knowledge or understanding, and a part with a set of application exercises.

## EXAMINATION RULES.

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

## BIBLIOGRAPHY

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### Basic:

- Codina, Ramon; Baiges, Joan. Notes de curs [on line]. [Consultation: 14/05/2020]. Available on:  
<https://atenea.upc.edu/login/index.php>.