



## Course guide

# 820077 - CENG - Computational Engineering

Last modified: 04/02/2025

**Unit in charge:** Barcelona East School of Engineering  
**Teaching unit:** 749 - MAT - Department of Mathematics.

**Degree:** BACHELOR'S DEGREE IN BIOMEDICAL ENGINEERING (Syllabus 2009). (Optional subject).  
BACHELOR'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2009). (Optional subject).  
BACHELOR'S DEGREE IN ELECTRICAL ENGINEERING (Syllabus 2009). (Optional subject).  
BACHELOR'S DEGREE IN ENERGY ENGINEERING (Syllabus 2009). (Optional subject).  
BACHELOR'S DEGREE IN INDUSTRIAL ELECTRONICS AND AUTOMATIC CONTROL ENGINEERING (Syllabus 2009). (Optional subject).  
BACHELOR'S DEGREE IN MECHANICAL ENGINEERING (Syllabus 2009). (Optional subject).  
BACHELOR'S DEGREE IN MATERIALS ENGINEERING (Syllabus 2010). (Optional subject).

**Academic year:** 2024    **ECTS Credits:** 6.0    **Languages:** English

### LECTURER

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**Coordinating lecturer:** NURIA PARES MARINE

**Others:** Segon quadrimestre:  
NURIA PARES MARINE - M11  
YOLANDA VIDAL SEGUI - M11

### PRIOR SKILLS

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It is advisable that students have passed the courses Calculus, Algebra and Multivariable Calculus, and Numerical Calculus - Differential Equations before taking this course.

### DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

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**Transversal:**

1. EFFICIENT ORAL AND WRITTEN COMMUNICATION - Level 3. Communicating clearly and efficiently in oral and written presentations. Adapting to audiences and communication aims by using suitable strategies and means.

### TEACHING METHODOLOGY

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The course is based on lectures given by the instructors (40%) and individual and group work (60%)  
All the lecture notes and tutorial of the laboratory sessions are available in the website <http://compeng.gimel.es>  
The availability of all the teaching materials that will be used in class allow students to keep track of the course in case of not being able to attend 100% of the lectures



## LEARNING OBJECTIVES OF THE SUBJECT

The goal of this elective course is to introduce students to numerical calculus, providing them with a broad knowledge of numerical techniques that will be very useful throughout the degree and later development of their profession. In particular the course will qualify students to numerically solve partial differential equations with particular interest in the Finite Element Method.

The aim of the lectures is to present the subjects without a deep theoretical formalisms in order to be able to provide a simple and practical training.

Lectures are held in computer rooms, where theoretical explanations of the different numerical methods are combined with the implementation of the methods using MATLAB. Because of this, the first lectures of the course are devoted to provide a fast and easy introduction to the software MATLAB.

## STUDY LOAD

Type	Hours	Percentage
Hours small group	15,0	10.00
Self study	90,0	60.00
Hours large group	45,0	30.00

**Total learning time:** 150 h

## CONTENTS

### Module 1: Introduction to Matlab

**Description:**

Introduction to the Matlab software. Overview of the basic features, basic operations, definition of variables, vectors and matrices; files \*.m; debugger; control statements.  
Basics on programming.

**Full-or-part-time:** 10h

Theory classes: 4h

Self study : 6h

### Module 2: Introduction to numerical methods

**Description:**

Brief introduction to the subject. Applications of numerical methods in engineering.

**Full-or-part-time:** 10h

Theory classes: 4h

Self study : 6h

### Module 3: Numerical linear algebra - basic tools

**Description:**

Solution of linear systems of equations. Systems with immediate solution: diagonal matrix, triangular matrix. Direct methods. Gauss method. Factorization methods.

**Full-or-part-time:** 30h

Theory classes: 12h

Self study : 18h



#### Module 4: Numerical calculus - review of basic tools

**Description:**

Numerical integration (rectangles, trapezoidal rule, Gauss method). Numerical interpolation (splines).

**Full-or-part-time:** 30h

Theory classes: 12h

Self study : 18h

#### Module 5: Introduction to partial differential equations (PDEs)

**Description:**

Motivation. Equations of mathematical physics. Boundary conditions. Method of separation of variables.

Heat equation. Wave equation.

**Full-or-part-time:** 30h

Theory classes: 12h

Self study : 18h

#### Module 6: Numerical solution of PDEs - Introduction to the Finite Element Method

**Description:**

Introduction to the basic concepts. Formulation of the finite element method. Structure of finite element codes. Pre and post-process. Applications to engineering.

**Full-or-part-time:** 40h

Theory classes: 16h

Self study : 24h

## GRADING SYSTEM

Exams: 40%

Assignments: 35%

Validation of the assignments: 20%

Generic Skills: 5%

## BIBLIOGRAPHY

**Basic:**

- Huerta, A.; Sarrate, J.; Rodríguez-Ferran, A. Métodos numéricos : introducción, aplicaciones y programación [on line]. Barcelona: Edicions UPC, Universitat Politècnica de Catalunya, 1998 [Consultation: 21/04/2020]. Available on: <http://hdl.handle.net/2099.3/36258>. ISBN 8483012650.

- Hoffman, Joe D. Numerical methods for engineers and scientists. 2nd ed. New York [etc. ]: Marcel Dekker, 2001. ISBN 0824704436.

- Henwood, D.; Bonet, J. Finite elements : a gentle introduction. Houndmills [etc.]: MacMillan, 1996. ISBN 0333646266.

**Complementary:**

- Zill, D. G.; Cullen, M. R. Ecuaciones diferenciales con problemas de valores en la frontera. 7ª ed. México, D.F. [etc.]: Cengage Learning, 2009. ISBN 9789708300384.

- Zienkiewicz, O. C.; Taylor, R. L.; Nithiarasu, P. The finite element method [on line]. 6th ed. Oxford; New York: Elsevier/Butterworth-Heinemann, 2005 [Consultation: 02/03/2012]. Available on: <http://www.sciencedirect.com/science/book/9780750664318>. ISBN 9780750664318.

- Chapra, S. C.; Canale, R. P. Métodos numéricos para ingenieros. 6a ed. México: McGraw-Hill, 2011. ISBN 9786071504999.



## RESOURCES

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**Hyperlink:**

- Lecture notes and course tutorials (Apunts i tutorials de l'assignatura). <http://compeng.gimel.es>

**Other resources:**

The lecture notes associated to both the theory and laboratory sessions is available in the website <http://compeng.gimel.es> />This website contains all the tutorials and lecture notes that students need to reach all the concepts introduced in the course