Course guide
820092 - NSAE - Numerical Simulation for Engineering

Last modified: 04/06/2026

Unit in charge: Barcelona East School of Engineering
Teaching unit: 748 - FIS - Department of Physics.

Degree: BACHELOR'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2009). (Optional subject).
BACHELOR'S DEGREE IN ELECTRICAL 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: 2026 **ECTS Credits:** 6.0 **Languages:** English

LECTURER

Coordinating lecturer: JORDI JOSE PONT

Others: Primer quadrimestre:
ILEYK AHMED RENE EL MELLAH - Grup: M1
JORDI JOSE PONT - Grup: M1

PRIOR SKILLS

Ability to work with the computer and a basic knowledge of a programming language.

REQUIREMENTS

Basic knowledge of algebra, calculus and physics. The main teaching language of the course will be English.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Transversal:
1. SELF-DIRECTED LEARNING - Level 3. Applying the knowledge gained in completing a task according to its relevance and importance. Deciding how to carry out a task, the amount of time to be devoted to it and the most suitable information sources.

TEACHING METHODOLOGY

40 % Expositive methodology plus 35% individual work plus 25% working in group.

LEARNING OBJECTIVES OF THE SUBJECT

To introduce the student to the basic numerical techniques used in numerical simulation and to apply them to solve basic engineering problems.

STUDY LOAD

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

Total learning time: 150 h

CONTENTS

1. Chapter: A primer on numerical calculus.

Description:
Interpolation, fitting. Applied matrix algebra (inversion matrix algorithms. the homogeneous matrix of transformation, sparse matrix). Notions of fractal geometry. Numerical differentiation. Numerical resolution of differential equations. Stability. Explicit and Implicit methods. The fast Fourier transform FFT.

Specific objectives:
To introduce the student to the basic numerical techniques addressed to program and simulate physical and engineering systems

Related activities:
A fraction of the laboratori sessions will be devoted to write easy programs of
numerical calculus using MatLab.

Full-or-part-time: 60h
Theory classes: 24h
Self study : 36h

2. Chapter:Applications to several engineering disciplines.

Description:
Description of articulate systems by means of the homogeneous matrix. Numerical solution of the Laplace equation and its application to electrostatic problems. Applications of the Laplace equation to the heat transfer problem. Simulation of a set of coupled chemical reactions network. Planets and satellites orbital elements. An introduction to the computational fluid dynamics (CFD).

Specific objectives:
Apply the main concepts already learnt in the previous chapter. Applications to interesting engineering problems will be carefully described.

Related activities:
During the laboratory sessions and using MatLab the student will implement several of the algoritms developed at the teory sessions. A simulation program dealing to a physical system linked to engineering has to be written by the interested students as a part of the evaluation of the course. There will be a public exposition of the work done.

Full-or-part-time: 60h
Theory classes: 24h
Self study : 36h

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**.

Two classroom exams P1 and P2 and a practical work, T, consiting in planify and devise a computer algorithm aimed at solving a particular engineering problem.
Final qualification: 0.25 P1+0.25 P2+0.5 T.
NSAE does not have a final re-avaluation exam. It is not obliged to carry out laboratory experiences or practical works in this subject.

The generic competence will be evaluated taking into account: 1) The ability of the student to apply the concepts explained in the classroom to practical engineering problems, 2) the self-study abilities of the students, improvement and collective work, 3) abilities to make a public presentation and defend the work done. The weight of the generic competence within the evaluation of the course will be of 10%.

BIBLIOGRAPHY

Basic:
- DeVries, Paul L.; Hasbun, Javier Ernesto. A First course in computational physics. 2nd ed. Sudbury, Massachusetts: Jones and Bartlett Publishers, cop. 2011. ISBN 9780763773144.
- Howison, Sam. Practical applied mathematics : modelling, analysis, approximation. New York: Cambridge University Press, 2005. ISBN 0521842743.