

## 820092 - NSAE - Numerical Simulation Applied to Engineering

Coordinating unit:	295 - EEBE - Barcelona East School of Engineering
Teaching unit:	748 - FIS - Department of Physics
Academic year:	2017
Degree:	BACHELOR'S DEGREE IN ELECTRICAL ENGINEERING (Syllabus 2009). (Teaching unit Optional) BACHELOR'S DEGREE IN MECHANICAL ENGINEERING (Syllabus 2009). (Teaching unit Optional) BACHELOR'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2009). (Teaching unit Optional) BACHELOR'S DEGREE IN BIOMEDICAL ENGINEERING (Syllabus 2009). (Teaching unit Optional) BACHELOR'S DEGREE IN INDUSTRIAL ELECTRONICS AND AUTOMATIC CONTROL ENGINEERING (Syllabus 2009). (Teaching unit Optional) BACHELOR'S DEGREE IN ELECTRICAL ENGINEERING (Syllabus 2009). (Teaching unit Optional) BACHELOR'S DEGREE IN ENERGY ENGINEERING (Syllabus 2009). (Teaching unit Optional) BACHELOR'S DEGREE IN MECHANICAL ENGINEERING (Syllabus 2009). (Teaching unit Optional) BACHELOR'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2009). (Teaching unit Optional) BACHELOR'S DEGREE IN INDUSTRIAL ELECTRONICS AND AUTOMATIC CONTROL ENGINEERING (Syllabus 2009). (Teaching unit Optional) BACHELOR'S DEGREE IN MATERIALS ENGINEERING (Syllabus 2010). (Teaching unit Optional)
ECTS credits:	6
Teaching languages:	English

### Teaching staff

Coordinator:	Domingo García Senz
Others:	Domingo García Senz

### Opening hours

Timetable:	consensuated with the professor.
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### 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



## 820092 - NSAE - Numerical Simulation Applied to Engineering

To introduce the student into basic techniques of numerical simulation and their application to solve basic engineering problems.

### Study load

Total learning time: 150h	Hours large group:	45h	30.00%
	Hours small group:	15h	10.00%
	Self study:	90h	60.00%

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### Content

<p>1. Chapter: A primer on numerical calculus.</p>	<p>Learning time: 60h Theory classes: 24h Self study : 36h</p>
<p>Description: Interpolation, fitting. Applied matrix algebra (inversion matrix algorithms. the homogeneous matrix of transformation, sparse matrix). Numerical differentiation. Numerical resolution of differential equations. Stability. Explicit and Implicit methods. The fast Fourier transform FFT.</p> <p>Related activities: A fraction of the laborator sessions will be devoted to write easy programs of numerical calculus.</p> <p>Specific objectives: To introduce the student to the basic numerical techniques addressed to simulate physical and engineering systems</p>	
<p>2. Chapter: Applications to several engineering disciplines.</p>	<p>Learning time: 60h Theory classes: 24h Self study : 36h</p>
<p>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. Numerical fluid dynamics. Signal analysis.</p> <p>Related activities: 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.</p> <p>Specific objectives: Apply the main concepts already learnt in the previous chapter. Applications to interesting engineering problems will be carefully described.</p>	

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3. Chapter: Simulation of discrete systems, bioengineering.

Learning time: 30h

Theory classes: 12h

Self study : 18h

### Description:

Discrete simulation. The game of life. Application to the study of virus replication. Fractal geometry and applications.

### Related activities:

The interested students have to write a simple program based on the discrete simulation methods as a main work of the course. There will be a specific session devoted to the exposition of the works done by the students at the end of the course.

### Specific objectives:

To introduce the student to this especial class of simulation techniques, where a set of empirical rules drive the evolution of a complex system settled in a 2D grid. This approach is often useful in biology and natural sciences.

## Qualification system

Two classroom exams P1 and P2 and a practical work, T, consisting 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 reevaluation exam.

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, 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.