820009 - CNED - Numerical Calculus. Differential Equations

Coordinating unit: 295 - EEBE - Barcelona East School of Engineering
Teaching unit: 749 - MAT - Department of Mathematics
Academic year: 2018

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

ECTS credits: 6
Teaching languages: Catalan, Spanish

Teaching staff
Coordinator: NURIA PARES MARINE - YOLANDA VIDAL SEGUI
Others: Dept. de Matemàtiques - Secció EEBE

Opening hours
Timetable: To be determined by the faculty at the beginning of the semester. The students will be attended in the Mathematics Department at EEBE.

Degree competences to which the subject contributes

Specific:
2. Solve mathematical problems that may arise in engineering. Apply knowledge of linear algebra; geometry; differential geometry; differential and integral calculus; differential equations and partial differential equations; numerical methods; numerical algorithms; statistics and optimisation.

Transversal:
1. SELF-DIRECTED LEARNING - Level 2: Completing set tasks based on the guidelines set by lecturers. Devoting the time needed to complete each task, including personal contributions and expanding on the recommended information sources.

Teaching methodology

Apart from the 6 hours per week in the classroom, self-study must last an average of 9 hours per week (40% of the total work at class and 60% of individual work).

Learning objectives of the subject

Unit 1: Introduce the students to computer simulation explaining its capabilities, potential and limitations. Programming of
basic numerical algorithms. Correct and judgeful use of basic numerical methods. Ability to chose the appropriate method for different engineering applications.

Unit 2: State, analyze and numerically and analytically solve ordinary differential equations. Physical interpretation of ode's.

Unit 3: Use of integral transforms in engineering applications.

Unit 4: State, analyze and numerically and analytically solve partial differential equations. Physical interpretation of pde's.

### 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>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total learning time:</strong> 150h</td>
<td>45h</td>
<td>0h</td>
<td>15h</td>
<td>0h</td>
<td>90h</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unit 1: Basics of numerical calculus</td>
<td>Learning time: 67h 15m</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------------------------------</td>
<td>------------------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Theory classes: 18h</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Laboratory classes: 9h 30m</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Self study : 39h 45m</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Description:**
1.1. Numbers and errors. Finite arithmetic storage. Absolute error, relative error, truncation error. Correct significant digits.

<table>
<thead>
<tr>
<th>Unit 2: Ordinary differential equations</th>
<th>Learning time: 36h 15m</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 12h</td>
</tr>
<tr>
<td></td>
<td>Laboratory classes: 2h 30m</td>
</tr>
<tr>
<td></td>
<td>Self study : 21h 45m</td>
</tr>
</tbody>
</table>

**Description:**
2.3. Linear differential equations of order 2 with constant coefficients. Undetermined coefficients method. Variation of constants method.

<table>
<thead>
<tr>
<th>Unit 3: Integral transforms and solution of ordinary differential equations</th>
<th>Learning time: 27h 45m</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 9h</td>
</tr>
<tr>
<td></td>
<td>Laboratory classes: 1h 30m</td>
</tr>
<tr>
<td></td>
<td>Self study : 17h 15m</td>
</tr>
</tbody>
</table>

**Description:**
3.2. Fourier series. Fourier transform.
Unit 4: Partial differential equations

Learning time: 18h 45m
- Theory classes: 6h
- Laboratory classes: 1h 30m
- Self study: 11h 15m

Description:
4.1. Introduction to partial differential equations. Motivation.
4.2. Equations of mathematical physics. Boundary conditions.

Qualification system

First exam: 35%
Second exam: 40%
Matlab Laboratory: 20% (composed of two exams and several tests)
Generic competence: 5%

Students can pass the course through the continuous assessment based on two exams (a first mid course exam and a second exam during the period fixed in the academic calendar of the school devoted to the final exams) and the delivery of laboratory assessments.

Finally, as detailed in the academic normative of the EEBE, a reevaluation exam will take place (excluding the Matlab Laboratory exam and the Generic Competence). To be able to do the reevaluation exam, the student has to attend to all the evaluation exams of the subject (including the lab tests) and its mark, N, for the part which can be reevaluated has to be such that $3.0 \leq N < 5.0$.

Regulations for carrying out activities

In the two exams it will be allowed to use basic scientific calculators NON PROGRAMMABLE.
In the exam will be required to write the mark/model of the calculator.

Required characteristics:
- the calculator has to do basic arithmetic operations $+, -, *, /$
- the calculator must evaluate the following functions: sinus, cosinus, tangent, logarithms, exponential

and NOT allowed characteristics:
- it CAN NOT do any kind of plot
- it CAN NOT solve equations nor system of equations
- it CAN NOT integrate nor differentiate
- it CAN NOT make conversions with base-n numbers
- it CAN NOT perform calculations with complex numbers
- it CAN NOT do neither matrix nor vector operations
- it CAN NOT have neither wifi nor bluetooth
- it CAN NOT be programmable

Example of allowed calculators: CASIO FX-82MS, CASIO FX-82SX
Bibliography

Basic:


Complementary:


