250221 - EQUADIF - Differential Equations

Coordinating unit: 250 - ETSECCPB - Barcelona School of Civil Engineering
Teaching unit: 751 - DECA - Department of Civil and Environmental Engineering
Academic year: 2018
Degree: BACHELOR'S DEGREE IN PUBLIC WORKS ENGINEERING (Syllabus 2010). (Teaching unit Compulsory)
ECTS credits: 4,5  Teaching languages: Catalan

Teaching staff
Coordinator: ANA MARIA SERRA TORT
Others: ANA MARIA SERRA TORT

Opening hours
Timetable: It will be fixed at the beginning of the course.

Degree competences to which the subject contributes

Specific:
3096. Ability to solve the types of mathematical problems that may arise in engineering. Ability to apply knowledge of: linear algebra; geometry; differential geometry; differential and integral calculus; differential equations and partial derivatives; numerical methods; numerical algorithms; statistics and optimisation.

Transversal:
588. SUSTAINABILITY AND SOCIAL COMMITMENT - Level 1. Analyzing the world's situation critically and systemically, while taking an interdisciplinary approach to sustainability and adhering to the principles of sustainable human development. Recognizing the social and environmental implications of a particular professional activity.
591. EFFICIENT ORAL AND WRITTEN COMMUNICATION - Level 1. Planning oral communication, answering questions properly and writing straightforward texts that are spelt correctly and are grammatically coherent.
598. EFFECTIVE USE OF INFORMATION RESOURCES - Level 2. Designing and executing a good strategy for advanced searches using specialized information resources, once the various parts of an academic document have been identified and bibliographical references provided. Choosing suitable information based on its relevance and quality.

Teaching methodology
The course is taught with 3 hours per week in a classroom. Both theoretical and practical lessons will be alternated according to the course schedule.

In the theoretical lessons, the teacher presents the concepts and essential objectives of the subject and shows illustrative examples. The resolution of problems will be done with more interaction with the students. Guided resolution of exercises will be programmed. In some sessions the students will solve individually the exercises that will be assessed.

Teaching materials will be available for the students at the Virtual Campus ATENEA: contents, theoretical notes, exercises, practical works and bibliography.
250221 - EQUADIF - Differential Equations

**Learning objectives of the subject**

Students will learn to solve basic differential equations of mathematical physics that may arise in an engineering context.

Upon completion of the course, students will have acquired the ability to: 1. Relate ordinary differential equations to engineering problems. 2. Program simple solutions using basic software and obtain numerical solutions. 3. Develop solutions to these problems under simple conditions that allow an analysis of these solutions, including a parametric study.

Ordinary differential equations; Basic concepts of partial differential equations: types, some analytical solutions in specific cases of particular interest in engineering

**Study load**

<table>
<thead>
<tr>
<th>Total learning time: 112h 30m</th>
<th>Hours large group:</th>
<th>18h</th>
<th>16.00%</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Hours medium group:</td>
<td>15h</td>
<td>13.33%</td>
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<tr>
<td></td>
<td>Hours small group:</td>
<td>12h</td>
<td>10.67%</td>
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<tr>
<td></td>
<td>Guided activities:</td>
<td>4h 30m</td>
<td>4.00%</td>
</tr>
<tr>
<td></td>
<td>Self study:</td>
<td>63h</td>
<td>56.00%</td>
</tr>
</tbody>
</table>
## Content

<table>
<thead>
<tr>
<th><strong>Fourier Series</strong></th>
<th><strong>Learning time:</strong> 12h</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>Theory classes: 2h</td>
</tr>
<tr>
<td></td>
<td>Practical classes: 1h</td>
</tr>
<tr>
<td></td>
<td>Laboratory classes: 2h</td>
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<tr>
<td></td>
<td>Self study: 7h</td>
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Sets of orthogonal functions.
Fourier series.
Mean square approximation.
Representation of functions.
Examples.

Examples of representation of functions in Fourier series.
Examples and detailed discussion of practical cases with computer support.

<table>
<thead>
<tr>
<th><strong>Ordinary differential equations</strong></th>
<th><strong>Learning time:</strong> 7h 11m</th>
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</thead>
<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>Theory classes: 3h</td>
</tr>
<tr>
<td></td>
<td>Self study: 4h 11m</td>
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Obtaining differential equations from physical laws.
Boundary conditions and physical sense.

**Specific objectives:**
Prepare the student for the correct resolution of EDPs
### Dimensional boundary problems

**Description:**
Approach to boundary value problems in a variable.

Solution of illustrative problems with different boundary conditions.
Exercise assessable (E1)
Introductory examples.

Sturm-Liouville problem.

Periodic problem.
Solution of eigenvalue problems with different boundary conditions.

<table>
<thead>
<tr>
<th>Learning time:</th>
<th>36h</th>
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</thead>
<tbody>
<tr>
<td>Theory classes:</td>
<td>6h</td>
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<tr>
<td>Practical classes:</td>
<td>8h</td>
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<tr>
<td>Laboratory classes:</td>
<td>1h</td>
</tr>
<tr>
<td>Self study:</td>
<td>21h</td>
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</tbody>
</table>

### Evaluation 1

<table>
<thead>
<tr>
<th>Learning time:</th>
<th>7h 11m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laboratory classes:</td>
<td>3h</td>
</tr>
<tr>
<td>Self study:</td>
<td>4h 11m</td>
</tr>
</tbody>
</table>

### Structure of linear 2nd order PDE's

**Description:**
Type equation.
Classification in hyperbolic, parabolic and elliptical equations.

<table>
<thead>
<tr>
<th>Learning time:</th>
<th>2h 24m</th>
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<tbody>
<tr>
<td>Theory classes:</td>
<td>1h</td>
</tr>
<tr>
<td>Self study:</td>
<td>1h 24m</td>
</tr>
</tbody>
</table>
# Method of separation of variables

**Learning time:** 26h 24m  
- Theory classes: 4h  
- Practical classes: 4h  
- Laboratory classes: 3h  
- Self study: 15h 24m

**Description:**  
Constructive step-by-step solution of a simple problem with the diffusion equation.  
Statement and solution of a general problem as an extension of the solution of the introductory problem.  
We propose a homogeneous parabolic problem to be solved by the students during the lecture.  
Problem-solving approach to the problem with non homogeneous equation and boundary conditions.  
Solution by expansion in series of eigenfunctions.  
Solution of illustrative problems with different boundary conditions.  
Solution and practical analysis of a problem by the students.  
Exercise assessable (E3)

# Elliptical and hyperbolic problems

**Learning time:** 9h 36m  
- Theory classes: 3h  
- Practical classes: 1h  
- Self study: 5h 36m

**Description:**  
Presentation of a prototype hyperbolic problem.  
Equation of the elastic string and vibration modes.  
Solution of illustrative problems with different boundary conditions.

# Evaluation 2

**Learning time:** 7h 11m  
- Laboratory classes: 3h  
- Self study: 4h 11m
**Qualification system**

The mark of the course is obtained from the ratings of continuous assessment, which is composed by 2 partial exams (P1 and P2), marked exercises with a mean mark E, each one of them normalized to 10 points.

Final mark of continuous assessment:

\[ NF1 = 0.3 \times P1 + 0.4 \times P2 + 0.3 \times E \]

or

\[ NF1 = 0.7 \times P3 + 0.3 \times E \]

depending on the choice during the second exam (P2 or P3)

If the School organizes extraordinary exams and the student's mark is 0 < NF1 < 5, then the student can attend an exam NF2 being the final mark NF= max(NF1, NF2)

The exams contain a part with questions on concepts associated to the learning objective of the course (knowledge and understanding) and another part with application exercises.

Criteria for re-evaluation qualification and eligibility: Students that failed the ordinary evaluation and have regularly attended all evaluation tests will have the opportunity of carrying out a re-evaluation test during the period specified in the academic calendar. Students who have already passed the test or were qualified as non-attending will not be admitted to the re-evaluation test. The maximum mark for the re-evaluation exam will be five over ten (5.0). The non-attendance of a student to the re-evaluation test, in the date specified will not grant access to further re-evaluation tests. Students unable to attend any of the continuous assessment tests due to certifiable force majeure will be ensured extraordinary evaluation periods.

These tests must be authorized by the corresponding Head of Studies, at the request of the professor responsible for the course, and will be carried out within the corresponding academic period.

**Regulations for carrying out activities**

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

**Bibliography**

**Basic:**


**Complementory:**
