Degree competences to which the subject contributes

Specific:
4048. 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
4054. Ability to solve ordinary differential equations for application to engineering problems

Transversal:
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.
601. 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

The course is taught with 5 hours per week in a classroom. Both theoretical and practical lessons will be alternated according to the course schedule.

In the theoretical lessons, the instructor presents the concepts and essential materials on the matter and shows illustrative examples. The resolution of problems will be done with more interaction with the students. Sessions with guided solutions of exercises will be programmed, while some sessions will be devoted to solving exercises by the students to be qualified by the instructor.

Teaching materials will be available for the students at the Virtual Campus ATENEA: contents, theoretical notes, exercises, practical works and bibliography.
250324 - EQUIDIFER - Differential Equations

Learning objectives of the subject

Students will acquire an understanding of differential geometry and partial differential equations in mathematical-physics and learn how these disciplines apply to scientific and technical problems and to geological engineering in general.

Upon completion of the course, students will be able to: 1. Apply partial differential equations to engineering problems in continuous media; 2. Use basic software to formulate complex solutions and obtain numerical solutions for simple geometric conditions; 3. Solve problems in simple geometric conditions and use a range of techniques including parametric analysis to evaluate the solutions found.

Curvilinear coordinates and their application to differential operators; Parameterisation of curves and surfaces; Differentiation and integration of variants; Divergence theorem, Green’s theorem and Stokes’ theorem; Partial differential equations: Types and analytical solutions in specific engineering problems

Study load

<table>
<thead>
<tr>
<th>Total learning time: 187h 30m</th>
<th>Hours large group: 32h</th>
<th>17.07%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours medium group: 27h</td>
<td>14.40%</td>
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<tr>
<td>Hours small group: 16h</td>
<td>8.53%</td>
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<tr>
<td>Guided activities: 7h 30m</td>
<td>4.00%</td>
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<tr>
<td>Self study: 105h</td>
<td>56.00%</td>
<td></td>
</tr>
</tbody>
</table>
# Content

<table>
<thead>
<tr>
<th>Topic</th>
<th>Learning Time</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fourier Series</strong></td>
<td><strong>12h</strong></td>
<td>- Description: Sets of orthogonal functions.</td>
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<tr>
<td></td>
<td></td>
<td>- Fourier Series.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Quadratic approximation on average.</td>
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<tr>
<td></td>
<td></td>
<td>- Representation of functions.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Examples.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Examples of representations in Fourier series</td>
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<tr>
<td></td>
<td></td>
<td>- Examples and detailed discussion of practical cases with computer support.</td>
</tr>
<tr>
<td><strong>Ordinary Differential Equations</strong></td>
<td><strong>12h</strong></td>
<td>- Description: Approach and solving first order differential equations.</td>
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<td></td>
<td></td>
<td>- Planning and solving differential equations of second order</td>
</tr>
<tr>
<td><strong>Dimensional boundary problems</strong></td>
<td><strong>36h</strong></td>
<td>- Description: Approach boundary problems in a single variable.</td>
</tr>
<tr>
<td></td>
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<td>- Exercises</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Sturm-Liouville problem</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Periodic problem</td>
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<tr>
<td></td>
<td></td>
<td>- There will be one hour of guided exercises done by students in class</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Exercise assessable (E2)</td>
</tr>
</tbody>
</table>
## Physical models

**Learning time:** 4h 48m  
Theory classes: 2h  
Self study: 2h 48m

**Description:**  
Obtaining differential equations from physical laws  
Boundary conditions and its physical meaning  
Diffusion processes, wave propagation and stationary processes

## Structure of linear 2nd order PDE's

**Learning time:** 2h 24m  
Theory classes: 1h  
Self study: 1h 24m

**Description:**  
Classification in parabolic equations, hyperbolic and elliptical

## Evaluation PDE's

**Learning time:** 12h  
Laboratory classes: 5h  
Self study: 7h

## Method of separation of variables

**Learning time:** 9h 36m  
Theory classes: 4h  
Self study: 5h 36m

**Description:**  
Construction of the solution, step by step, of a simple problem based on the diffusion equation
## Parabolic problem

**Learning time:** 28h 47m  
- Theory classes: 4h  
- Practical classes: 5h  
- Laboratory classes: 3h  
- Self study: 16h 47m  

**Description:**  
Approach and solve a general problem as an extension of the solution of the previous problem.  
We propose a homogeneous parabolic problem to be solved by the students in the classroom with teacher's supervision.  
Approach and solution of problems with the equation and boundary conditions in non-homogeneous form.  
Exercises  
Study and practical solution to a problem with computer support.

## Hyperbolic Problem

**Learning time:** 14h 23m  
- Theory classes: 3h  
- Practical classes: 3h  
- Self study: 8h 23m  

**Description:**  
Presentation of a hyperbolic problem  
Exercises

## Elliptic problem

**Learning time:** 12h  
- Theory classes: 2h  
- Practical classes: 3h  
- Self study: 7h  

**Description:**  
Approach and physical sense of elliptic problems.  
Square domains.  
A session will be devoted to guided problems.
## Differential operators

**Learning time:** 16h 48m
- Theory classes: 4h
- Practical classes: 3h
- Self study: 9h 48m

**Description:**
Introduction of the gradient of a scalar field and the divergence and rotational of vector fields
Describe the most interesting curvilinear coordinates in Euclidean space and bi-dimensional

**Specific objectives:**
Learn how to make changes to common variable

## Parametrized surfaces

**Learning time:** 14h 23m
- Theory classes: 3h
- Practical classes: 2h
- Laboratory classes: 1h
- Self study: 8h 23m

**Description:**
Determine the size and appearance depending on the way to describe them
Exercises
Guided Exercise (E4)

## Differential Geometry Assessment

**Learning time:** 4h 48m
- Laboratory classes: 2h
- Self study: 2h 48m
Qualification system

The mark of the course is obtained from the ratings of continuous assessment according to:

Final mark = 0.25P1 + 0.4P2 + 0.05P3 + 0.3 E
where Pi = partial exam
E = average of Ei

Continuous assessment consist in several activities, of additive and training characteristics, carried out during the year (both in and out of the classroom).

The evaluation tests consist of a part with questions about concepts associated with the learning objectives of the course with regard to knowledge or understanding, and a part with a set of 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 laboratory or continuous assessment activity in the scheduled period will result in a mark of zero in that activity.

Bibliography

Basic:


Complementary: