820007 - CAL - Calculus

Coordinating unit: 295 - EEBE - Barcelona East School of Engineering
Teaching unit: 749 - MAT - Department of Mathematics
Academic year: 2019
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 BIOMEDICAL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
BACHELOR’S DEGREE IN CHEMICAL 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)
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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, English

Teaching staff
Coordinator:  FRANCESC POZO MONTERO - LUIS EDUARDO MUJICA DELGADO
Others:  Pozo Montero, Francesc
         Mujica Delgado, Luis Eduardo

Opening hours
Timetable:  Reach your teacher by e-mail for a more detailed information.

Prior skills
This course requires no previous skills.

Requirements
This course has no prerequisites.

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;
umerical methods; numerical algorithms; statistics and optimisation.

Transversal:
1. SELF-DIRECTED LEARNING - Level 1. Completing set tasks within established deadlines. Working with
recommended information sources according to the guidelines set by lecturers.
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Teaching methodology

The course uses the expositive methodology by 40% and individual work by 60%.

Learning objectives of the subject

General objectives: Students will learn the fundamental concepts of single variable calculus, developing the capacity of abstraction and applying these techniques to mathematical problems encountered in engineering.

Study load

<table>
<thead>
<tr>
<th>Total learning time: 150h</th>
<th>Hours large group: 45h</th>
<th>30.00%</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Hours medium group: 0h</td>
<td>0.00%</td>
</tr>
<tr>
<td></td>
<td>Hours small group: 15h</td>
<td>10.00%</td>
</tr>
<tr>
<td></td>
<td>Guided activities: 0h</td>
<td>0.00%</td>
</tr>
<tr>
<td></td>
<td>Self study: 90h</td>
<td>60.00%</td>
</tr>
</tbody>
</table>
## Content

### Sets of numbers

<table>
<thead>
<tr>
<th>Learning time: 35h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory classes: 9h</td>
</tr>
<tr>
<td>Practical classes: 0h</td>
</tr>
<tr>
<td>Laboratory classes: 5h</td>
</tr>
<tr>
<td>Self study: 21h</td>
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</tbody>
</table>

### Description:
- Introduction to the mathematical reasoning. Proof methods (direct, reductio ad absurdum, indirect proof by contraposition, mathematical induction).
- The set of natural, integer, rational and real numbers.

### Related activities:
- Lab session 1. Introduction to Maple (Part 1)
- Lab session 2. Introduction to Maple (Part 2)
- Lab session 3. Complex numbers and their representation
- Lab session 4. Operations with complex numbers

### Specific objectives:
- The students will learn:
  - to recognise the importance of mathematical reasoning and the different proof methods
  - to describe the different sets of numbers
  - to operate with complex numbers
  - to establish relationships between binomial, polar and exponentials forms.
### Functions of real variable. Limits and continuity.

**Learning time:** 30h

- Theory classes: 9h
- Practical classes: 0h
- Laboratory classes: 3h
- Self study: 18h

**Description:**
- Continuity. Continuity theorems (Weierstrass, Bolzano, intermediate value theorem).

**Related activities:**
- Lab Session 6. Functions. Graphical representation
- Lab Session 7. Lab session exam (5%)
- Lab Session 8. Limits and Continuity (Part 1)

**Specific objectives:**
- Students will learn:
  - to represent a real-valued function
  - to understand the importance of the concept of limit and its relationship to continuity.
Differentiation of real valued functions

<table>
<thead>
<tr>
<th>Description:</th>
<th>Learning time: 37h 30m</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Derivative of a function at a point. Differentiable functions. The derivative as a function. The chain rule. Implicit differentiation. Relationship between differentiability and continuity.</td>
<td>Theory classes: 12h</td>
</tr>
<tr>
<td>- Extrema of a function in an interval.</td>
<td>Practical classes: 0h</td>
</tr>
<tr>
<td>- Study and graphical representation of functions.</td>
<td>Laboratory classes: 3h</td>
</tr>
<tr>
<td>- The mean value theorems (Rolle, Cauchy, Lagrange).</td>
<td>Self study: 22h 30m</td>
</tr>
</tbody>
</table>

Related activities:
- Lab session 10. Differentiation
- Lab session 11. Derivative Applications

Specific objectives:
The student will learn:
- the basic concepts of derivative.
- to understand the geometric interpretation of the derivative and its applications in engineering.
- to master and to apply the elementary properties of the differentiable functions.
- to master the calculation of derivatives, both analytically and with the help of mathematical software.
- to model and solve various problems by calculating derivatives, optimization, approximating functions and study of functions.
## Integration of functions of real variable.

### Description:
- Antiderivatives.
- Integration methods. Change of variable, integration by parts, rational (decomposition into partial fractions).
- Calculation of areas of plane regions. Applications.
- Improper integrals.

### Related activities:
- Lab session 12. Integration
- Lab session 13. Applications of definite integrals
- Lab session 14. Lab session exam (5%)
- Lab session 15. Solution of problems using Maple for the preparation of the second exam

### Specific objectives:
Students will learn:
- to express in terms of integrals the problem of calculation the area of a plane region.
- to understand the relationship between derivatives and integrals, given by the fundamental theorem of calculus.
- to use the Barrow's rule.
- to calculate some improper integrals of continuous functions on an unbounded interval.

## Linear algebra

### Description:
- Systems of linear equations. Gaussian elimination.
- Inverse matrix.
- Linear geometry: equation of a straight line and a plane; orthogonality and parallelism; distances.

### Specific objectives:
Students will learn:
- to solve systems of linear equations and
- to graphically represent the solution of a system of linear equations
## Planning of activities

<table>
<thead>
<tr>
<th>(ENG) PRÀCTICA 2</th>
<th>Hours: 1h</th>
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<tbody>
<tr>
<td></td>
<td>Laboratory classes: 1h</td>
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<tr>
<td>(ENG) PRÀCTICA 3</td>
<td>Hours: 1h</td>
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<tr>
<td></td>
<td>Laboratory classes: 1h</td>
</tr>
<tr>
<td>(ENG) PRÀCTICA 4</td>
<td>Hours: 1h</td>
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<tr>
<td></td>
<td>Laboratory classes: 1h</td>
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<tr>
<td>(ENG) PRÀCTICA 5</td>
<td>Hours: 1h</td>
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<tr>
<td></td>
<td>Laboratory classes: 1h</td>
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<tr>
<td>(ENG) EXAMEN DE PRÀCTIQUES</td>
<td>Hours: 1h</td>
</tr>
<tr>
<td></td>
<td>Laboratory classes: 1h</td>
</tr>
<tr>
<td>FIRST PARTIAL EXAM</td>
<td>Hours: 2h</td>
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<tr>
<td></td>
<td>Theory classes: 2h</td>
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</tbody>
</table>
Qualification system

First partial exam: 30%
Second partial exam: 50%
Laboratory: 10%
Complex numbers: 5%
Generic competency (self-directed learning): 5%

The evaluation will be conducted through the assessment by the teacher.

The students can pass the course only by the assessment during the course from two partial exams (first partial exam within the course weeks; the second partial exam will be scheduled in the official final examination period) and laboratory.

An individual test will be performed in the assessment of the laboratory, during the last laboratory session.

Competency assessment: This course assesses the self-directed learning competency through individual tests the same day of the second partial exam. More precisely, the test will assess matrices and systems of linear equations.

Finally, as detailed in the academic normative of the EEBE, a reevaluation exam will take place (excluding the Maple Laboratory exam and the Generic Competence). To be able to do the reevaluation exam, the student has to fail and has to attend to all the evaluation exams of the subject and its mark, N, for the part which can be reevaluated has to be such that $N > 3.0$ (https://eebe.upc.edu/ca/estudis/normatives-academiques/documents/eebe-normativa-avaluacio-i-permanencia-18-19-aprovat-je-2018-06-13.pdf).

Regulations for carrying out activities

No writing paper, books, papers, manuscripts or notes of any kind are to be taken into an examination room. The use of calculators, cell phones, tablets or any electronic device is not permitted in examinations.
Bibliography

Basic:


Complementary:


Others resources:

Web page: https://es.khanacademy.org

Hyperlink

Khan Academy

Resource