300010 - CAL-T - Calculus

Coordinating unit: 300 - EETAC - Castelldefels School of Telecommunications and Aerospace Engineering
Teaching unit: 749 - MAT - Department of Mathematics
Academic year: 2019
Degree: BACHELOR'S DEGREE IN TELECOMMUNICATIONS SYSTEMS ENGINEERING (Syllabus 2009).
BACHELOR'S DEGREE IN NETWORK ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
ECTS credits: 6
Teaching languages: Catalan, Spanish

Teaching staff
Coordinator: Definit a la infoweb de l'assignatura.
Others: Definit a la infoweb de l'assignatura.

Prior skills
Ability in arithmetic calculations and in simplifying algebraic expressions.
Knowledge of the concept of function and of the graphic representation of a function.
Ability to think in abstract terms.

Degree competences to which the subject contributes

Specific:
1. CE 1 TELECOM. Students will acquire the ability to solve mathematical problems for engineering. An aptitude for applying knowledge of linear algebra, geometry, differential geometry, differential and integral calculus, differential equations and partial differential equations, numerical methods, numerical algorithms, statistics and optimisation. (CIN/352/2009, BOE 20.2.2009)

Transversal:
2. 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.
3. TEAMWORK - Level 1. Working in a team and making positive contributions once the aims and group and individual responsibilities have been defined. Reaching joint decisions on the strategy to be followed.
4. SELF-DIRECTED LEARNING - Level 1. Completing set tasks within established deadlines. Working with recommended information sources according to the guidelines set by lecturers.

Teaching methodology
In the theory lectures we will introduce the fundamental concepts of the subject, and will present the basic exercise and problem solving techniques.

In the problems sessions, exercises and problems proposed a priori by the lecturer and autonomously prepared by the students will be discussed and solved.

Learning objectives of the subject
On completing the Calculus course, students should be able to:

- Sketch a graph of the main one variable elementary functions.
- Solve simple inequations.
- Operate with logarithms and exponentials.
- Interpret the concept of derivative of a function in physical and geometric terms.
- Calculate derivatives of functions.
- Approach and solve optimisation problems involving one variable functions.
- Compute Taylor polynomials and approximate its Lagrange remainder.
- Understand the geometrical meaning of gradient of a function of two variables.
- Identify conics and quadrics from their equations.
- Use several techniques for calculating primitives.
- Calculate the area of plane regions and the volume of some solids in space.
- Operate with binomial and exponential forms of complex numbers.
- Polynomial factoring, over the fields of real numbers and complex numbers.

### Study load

<table>
<thead>
<tr>
<th>Study load</th>
<th>Total learning time: 150h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hours large group:</td>
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<tr>
<td></td>
<td>Hours medium group:</td>
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<tr>
<td></td>
<td>Hours small group:</td>
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<tr>
<td></td>
<td>Guided activities:</td>
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<tr>
<td></td>
<td>Self study:</td>
</tr>
</tbody>
</table>
## Content

<table>
<thead>
<tr>
<th>Content 1: Equations and graphics</th>
<th>Learning time: 26h 12m</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 6h 36m</td>
</tr>
<tr>
<td></td>
<td>Practical classes: 2h 12m</td>
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<tr>
<td></td>
<td>Guided activities: 2h 24m</td>
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<tr>
<td></td>
<td>Self study: 15h</td>
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**Description:**
1.1 Straight line: basic concepts, equations, properties.
1.2 Conics: introduction, parabola, circle, ellipse, hyperbola, identification of conics according to its equation.
1.3 Elementary functions: introduction, polynomial and rational functions, exponential and logarithmic functions, absolute value function, trigonometric functions and their inverses.

**Related activities:**
Test C1, Mid term exam and Final term exam.

<table>
<thead>
<tr>
<th>Content 2: Derivation of functions of one variable</th>
<th>Learning time: 36h 12m</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 9h 36m</td>
</tr>
<tr>
<td></td>
<td>Practical classes: 3h 12m</td>
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<tr>
<td></td>
<td>Guided activities: 3h 24m</td>
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<td></td>
<td>Self study: 20h</td>
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</tbody>
</table>

**Description:**
2.1 Concept of derivative: definition, geometric interpretation, the derivative function.
2.2 Calculation of derivatives: properties of the derivative, high-order derivatives, the chain rule, derivative of the inverse function, implicit derivation, logarithmic derivation.
2.3 Tangent and normal straight lines.
2.4 The criterion of L'Hôpital.
2.5 Extrema of a function: absolute and relative extrema, increase and decrease of functions, determining relative extrema using the first derivative, concavity and convexity, determining relative extrema using the second derivative, criterion of the n-th derivative, absolute extrema on a closed interval, absolute extrema on a non closed interval.
2.6 Optimization problems.
2.7 Taylor polynomial.

**Related activities:**
Directed activity AD1, Mid term exam and Final term exam.
## Content 3: Integration of functions of one variable

### Learning time: 36h 12m
- Theory classes: 9h 36m
- Practical classes: 3h 12m
- Guided activities: 3h 24m
- Self study: 20h

**Description:**
3.1 Indefinite integral: primitive of a function, concept of indefinite integral, geometric interpretation, differential of a function, first properties of the indefinite integral.
3.2 Calculation of primitives: immediate integrals, linearity of the indefinite integral, almost immediate integrals, integration by parts, integration of rational functions, integration by change of variable, integration of trigonometric functions, integration of irrational functions.
3.3 Definite integral: definition, properties of the definite integral, the Fundamental Theorem of Calculus, Barrow's rule, change of variable in the definite integral.
3.4 Applications of the definite integral: calculation of areas of planar figures, calculation of volumes of solids of revolution.
3.5 Improper integrals.

**Related activities:**
Test C2 and Final term exam.

## Content 4: Functions of two variables

### Learning time: 25h 12m
- Theory classes: 6h 36m
- Practical classes: 2h 12m
- Guided activities: 2h 24m
- Self study: 14h

**Description:**
4.1 Functions of two variables: definition, contour lines, contour map, \( \mathbb{R}^3 \) surfaces, sections, implicit equation of a surface, quadrics.
4.2 Derivation in two variables: slope of a curve on a surface, directional derivatives, partial derivatives, slope of a surface, tangent plane, normal line, tangent plane and normal line of an implicitly given surface, gradient of a function of two variables, properties of the gradient.

**Related activities:**
Final term exam.
**Content 5: Complex numbers**

<table>
<thead>
<tr>
<th><strong>Description:</strong></th>
<th><strong>Learning time:</strong> 26h 12m</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.1 The imaginary unit.</td>
<td>Theory classes: 6h 36m</td>
</tr>
<tr>
<td>5.2 Binomic form of a complex number: definition, operations in binomic form.</td>
<td>Practical classes: 2h 12m</td>
</tr>
<tr>
<td>5.3 The complex plane.</td>
<td>Guided activities: 2h 24m</td>
</tr>
<tr>
<td>5.4 Exponential form of a complex number: definition, operations in exponential form, trigonometric formulas.</td>
<td>Self study: 15h</td>
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<tr>
<td>5.5 n-th roots of a complex number.</td>
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<tr>
<td>5.6 Fundamental theorem of Algebra. Factoring polynomials</td>
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</table>

**Related activities:**
Test C1, Mid term exam and Final term exam.
### Planning of activities

<table>
<thead>
<tr>
<th>Activity</th>
<th>Hours</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Activity 1: Test C1</strong></td>
<td>1h</td>
<td>Theory classes: 1h, Test of Contents 5 and 1.</td>
</tr>
<tr>
<td><strong>Activity 2: Test C2</strong></td>
<td>1h</td>
<td>Theory classes: 1h, Test of Content 3.</td>
</tr>
<tr>
<td><strong>Activity 3: Directed activity AD1</strong></td>
<td>1h 30m</td>
<td>Guided activities: 1h 30m, Directed activity on using Taylor's polynomial to approximate functions.</td>
</tr>
<tr>
<td><strong>Activity 4: Mid term exam</strong></td>
<td>1h 30m</td>
<td>Guided activities: 1h 30m, Exam of Contents 1 and 2.</td>
</tr>
<tr>
<td><strong>Activity 5: Final term exam</strong></td>
<td>2h</td>
<td>Guided activities: 2h, Test of Contents 1, 2, 3, 4 and 5.</td>
</tr>
</tbody>
</table>
Qualification system

Test C1: 15 %
Test C2: 15 %
Mid term exam: 25 %
Final term exam: 40 %
Directed activity AD1 : 5%

Note: The final term exam allows to remediate the mid term exam mark. In case it is effectively remediated, the mark of the mid term exam will be replaced by that of the final term exam, which will therefore weight a 65% of the final grade. However, in order to ensure a real continuous assessment only students who have attended all exams and tests (passed or failed) will be eligible to remediate the mid term exam.

Regulations for carrying out activities

Tests are made during lecture sessions and are previously announced in ATENEA. The mid and final semester exams are made according to the EETAC's schedule.

Tests and exams are made individually. The use of books, notes, calculator, software and mobile phone is not allowed.

Bibliography

Basic:

Complementary:

Others resources:
- Course schedule with syllabus.
- Initial knowledge material.
- List of exercises (and answers) of the course.
- Sample models of exams and tests of previous courses.

All of them are available in ATENEA.