340021 - FOMA-N1043 - Fundamentals of Mathematics

Coordinating unit: 340 - EPSEVG - Vilanova i la Geltrú School of Engineering
Teaching unit: 749 - MAT - Department of Mathematics
Academic year: 2019
Degree: BACHELOR'S DEGREE IN MECHANICAL 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 ELECTRICAL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN INDUSTRIAL DESIGN AND PRODUCT DEVELOPMENT ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
ECTS credits: 6
Teaching languages: Catalan, Spanish

Teaching staff
Coordinator: Prat Farran, Joana D'Arc
Others: Ybern Carballo, M. De Las Nieves
Caelles Abillar, Jordi

Prior skills
To use and simplify algebraic expressions.
To calculate and simplify function derivatives, using the basic rules of product, quotient and chain rule.
To solve linear systems with Gauss and Cramer rule.
To operate with matrix (sum, product, inverse and determinant).

Degree competences to which the subject contributes

Specific:
1. CE1. Ability to solve arithmetic problems related to engineering. Aptitude to apply knowledge concerning: linear algebra, geometry, differential geometry, differential and integral calculus, differential and partial equations, numerical methods, numerical algorithms, statistics and optimization.

Transversal:
2. 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
The theory classes consist of theoretical explanations, description of examples and solution of selected problems, using various traditional and digital media.
In several parts of the subject, open source software will be used to solve applied problems.
The student will have non-attendance activities within the continuous evaluation.

Learning objectives of the subject
Use the fundamental tools of the differential calculus to study functions of one variable, and obtain approximations of functions through the Taylor polynomial.
Understand the fundamental theorem of integration and its use in the solution of various problems.
Understand and know how to apply the basic numerical methods to calculate zeros and area calculus numerically.
Understand machine precision and relative and absolute errors and error propagation in basic operations.

Learn about the fundamental concepts and some examples of the use of vector spaces and linear applications.

Recognize a rotation matrix in space, calculate its axis of rotation and the angle.

Make use of open source to solve some problems.

**Study load**

<table>
<thead>
<tr>
<th>Total learning time: 150h</th>
<th>Hours large group:</th>
<th>60h</th>
<th>40.00%</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Hours medium group:</td>
<td>0h</td>
<td>0.00%</td>
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<tr>
<td></td>
<td>Hours small group:</td>
<td>0h</td>
<td>0.00%</td>
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<tr>
<td></td>
<td>Guided activities:</td>
<td>0h</td>
<td>0.00%</td>
</tr>
<tr>
<td></td>
<td>Self study:</td>
<td>90h</td>
<td>60.00%</td>
</tr>
</tbody>
</table>
## Content

<table>
<thead>
<tr>
<th>1. Differential and integral calculus</th>
<th>Learning time: 38h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 18h</td>
</tr>
<tr>
<td></td>
<td>Self study: 20h</td>
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</tbody>
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### Description:

Real functions of a real variable: Study of continuity, study of derivability and calculation of the tangent line, calculation of relative extremes.

1. Review of elementary functions and functions defined in pieces.
4. Application to the local study of functions: Growth and decrease. Extremes

Real functions of a real variable: Calculation of integrals defined by change of variables and by parts. Barrow Rule

5. Fundamental theorem of algebra. Integral defined as area. Barrow's rule.
6. Integration defined by parts, change of variables.

### Related activities:

Tasks 1, 2, 3 and 4

### Specific objectives:

The student will be able to:

- Study (and build on demand) the continuity and derivability of functions defined in pieces based on transferred elementary functions, etc.
- Use theorems about continuous functions.
- Calculate limits using the L'Hopital rule in simple cases.
- Explain the geometric meaning of the derivative at a point, and some examples of its use.
- Study the local behavior of a function: growth and relative extremes (by hand and from the graph of the derived function).
- Know how to integrate by parts and by changes of variables.
- State the fundamental concepts and results on integrals and interpret them in terms of areas delimited by function graphs and the x axis.
- State the fundamental theorem of integral calculus and explain its importance in calculating definite integrals.
- Know the integration by parts and the changes of variable.
- Know how to calculate areas limited by two functions.
# 2. Numerical calculus

<table>
<thead>
<tr>
<th><strong>Learning time:</strong></th>
<th>36h</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Theory classes:</strong></td>
<td>18h</td>
</tr>
<tr>
<td><strong>Self study:</strong></td>
<td>18h</td>
</tr>
</tbody>
</table>

## Description:

1. Errors and approximation.

## Related activities:
Tasks 1, 2, 3 and 4

## Specific objectives:
Know the concept of absolute and relative error and propagation of errors.
Know the floating point representation.
Know how to calculate how errors spread in basic operations.
Calculate Taylor's polynomial of any order of a function at a point, and the shape of the residue.
Knowing how to use the bisection method, Newton-Raphson method (Octave functions) to numerically calculate zeros in an Octave / Matlab environment.
Know how to use the trapeze method and the Simpson method (Octave functions) to calculate numerically integral defined in an Octave / Matlab environment.
Recognize the exact decimals of the results provided by the numerical methods studied.
Be able to calculate zeros and areas with a fixed number of exact decimals.
### 3. Linear algebra

**Learning time:** 28h  
Theory classes: 14h  
Self study: 14h

**Description:**  
1. Vector spaces: To find out linear dependency/independency of vectors and calculate dimensions and basis of subspaces.  
2. Linear maps: how to calculate the kernel and image and dimensions, its interpretation to solve linear systems. Rotations.  
3. Use of linear algebra to geometric and model problems.

**Related activities:**  
Tasks 1, 2, 3 and 4

**Specific objectives:**  
The student will be able to:  
- Determine the dependence / linear independence of vectors.  
- Determine if a certain set of vectors is a vector subspace.  
- Calculate the dimension and a base of a vector subspace.  
- Determine whether an application between vector spaces is a linear application.  
- Calculate the matrix associated with a linear application in the canonical base.  
- Calculate the dimension and a base of the image and the kern of a linear application.  
- Use the range theorem to calculate image or kernel dimensions.  
- Calculate the properties of the linear system solutions in terms of linear application dimensions associated  
- Calculate the anti-image of a vector for a given linear application.  
- Use linear algebra to model and solve complex problems.

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**Qualification system**

A1=mark Task 1, attended exam (all content done until the middle period of exams)  
A2=mark Task 2, attended exam (all content done after the middle period of exams until the last period of exams)  
A3=mark Task 3, continuous evaluation (all content)  
A4= mark Task 4, final exam (all content)

The final mark is:

\[
\text{FINAL MARK} = \max(0.4 \times A1 + 0.3 \times A2 + 0.3 \times A3, 0.4 \times A1 + 0.6 \times A4)
\]

where all qualifications are calculated over 10.

Task A4 will be reevaluated.

**Regulations for carrying out activities**

The tasks A2, A3 and A4 are on-site and individual and will be carried out in the week reserved for the first test period of the course and in the final evaluation period that appears in the academic Calendar respectively. Activity A1 is mainly non-attendance and the group's teacher designs how it will be developed. The specific rules for each activity will be indicated in sufficient time.
Bibliography

Basic:


Complementary:


Others resources: