270008 - M2 - Mathematics II

Coordinating unit: 270 - FIB - Barcelona School of Informatics
Teaching unit: 749 - MAT - Department of Mathematics
Academic year: 2019
Degree: BACHELOR'S DEGREE IN INFORMATICS ENGINEERING (Syllabus 2010). (Teaching unit Compulsory)
ECTS credits: 7.5  
Teaching languages: Catalan, Spanish, English

Teaching staff

Coordinator: - Natalia Sadovskaia Nurimanova (natalia.sadovskaia@upc.edu)
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         - Fernando Martínez Sáez (fernando.martinez@upc.edu)
         - Guillermo González Casado (guillermo.gonzalez@upc.edu)
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         - Vera Sacristan Adinolfi (vera.sacristan@upc.edu)

Prior skills

Students are expected be competent in mathematics to upper secondary level.

Degree competences to which the subject contributes

Specific:
CT1.2A. To interpret, select and value concepts, theories, uses and technological developments related to computer science and its application derived from the needed fundamentals of mathematics, statistics and physics. Capacity to solve the mathematical problems presented in engineering. Talent to apply the knowledge about: algebra, differential and integral calculus and numeric methods; statistics and optimization.
CT1.2C. To use properly theories, procedures and tools in the professional development of the informatics engineering in all its fields (specification, design, implementation, deployment and products evaluation) demonstrating the comprehension of the adopted compromises in the design decisions.

General:
G7. AUTONOMOUS LEARNING: to detect deficiencies in the own knowledge and overcome them through critical reflection and choosing the best actuation to extend this knowledge. Capacity for learning new methods and technologies, and versatility to adapt oneself to new situations.
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Teaching methodology

- Lectures developing the theoretical aspects of the subject.
- Lectures and participatory classes aimed at applying theory to problems.

Workshop/laboratory classes:
- Participatory workshop sessions in which students solve problems in groups or individually.
- Participatory laboratory sessions in which students complete problems individually or in groups using mathematical software.

Learning objectives of the subject

1. Understand real numbers and their properties. Solve linear equations and inequalities, with quadratic and/or absolute values.
2. Understand the basic concept of sequences, calculate the limits of sequences and identify between convergent, divergent and oscillating sequences.
3. Understand the basic theorems for continuous functions of one variable and know how to apply them to problems such as finding zeros for functions.
4. Understand the basic theorems of differentiable functions of one variable and understand and know how to use Taylor polynomial approximations.
5. Understand the basic concepts of the integration of functions of one variable: geometric interpretation, calculation of areas, approximate calculation of definite integrals, etc.
6. Understand the basic concepts of topologies in $\mathbb{R}^n$.
7. Work with functions of several variables.
8. Understand and know how to interpret the concepts of directional derivative, partial derivative and gradient vector.
9. Locate and classify outliers in a function with several variables in a domain.

Study load

<table>
<thead>
<tr>
<th>Total learning time: 187h 30m</th>
<th>Hours large group: 45h</th>
<th>24.00%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hours medium group: 0h</td>
<td>0.00%</td>
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<tr>
<td></td>
<td>Hours small group: 30h</td>
<td>16.00%</td>
</tr>
<tr>
<td></td>
<td>Guided activities: 7h 30m</td>
<td>4.00%</td>
</tr>
<tr>
<td></td>
<td>Self study: 105h</td>
<td>56.00%</td>
</tr>
</tbody>
</table>
### Real numbers

**Degree competences to which the content contributes:**

**Description:**
Axiomatic introduction to real numbers. Absolute value of a number. Real number intervals.

### Numerical sequences

**Degree competences to which the content contributes:**

**Description:**

### Theorems for continuous functions of one variable

**Degree competences to which the content contributes:**

**Description:**

### Theorems for derivatives of functions of one variable

**Degree competences to which the content contributes:**

**Description:**

### Taylor formula for functions of one variable

**Degree competences to which the content contributes:**

**Description:**

### Fundamental theorem of integral calculus

**Degree competences to which the content contributes:**
### Functions of several variables

**Degree competences to which the content contributes:**

**Description:**
Basic definitions of topology. Functions of several variables: domain, graphics, level sets, geometric interpretation. Continuous functions.

### Partial and directional derivatives. Gradient vectors

**Degree competences to which the content contributes:**

**Description:**

### Taylor polynomials in several variables.

**Degree competences to which the content contributes:**

**Description:**

### Optimization of functions of several variables

**Degree competences to which the content contributes:**

**Description:**
## Planning of activities

<table>
<thead>
<tr>
<th>Topic</th>
<th>Hours</th>
<th>Theory classes:</th>
<th>Practical classes:</th>
<th>Laboratory classes:</th>
<th>Guided activities:</th>
<th>Self study:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Real numbers</strong></td>
<td>13h</td>
<td>3h</td>
<td>0h</td>
<td>2h</td>
<td>0h</td>
<td>8h</td>
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<tr>
<td><strong>Specific objectives:</strong></td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>Numerical successions</strong></td>
<td>19h</td>
<td>3h</td>
<td>0h</td>
<td>4h</td>
<td>0h</td>
<td>12h</td>
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<tr>
<td><strong>Specific objectives:</strong></td>
<td>2</td>
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<td></td>
<td></td>
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<tr>
<td><strong>Basic theorems of functions of a real variable</strong></td>
<td>33h</td>
<td>9h</td>
<td>0h</td>
<td>6h</td>
<td>0h</td>
<td>18h</td>
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<tr>
<td><strong>Specific objectives:</strong></td>
<td>3, 4</td>
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<td></td>
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</tr>
<tr>
<td><strong>Fundamental theorem of integral calculus</strong></td>
<td>22h</td>
<td>6h</td>
<td>0h</td>
<td>4h</td>
<td>0h</td>
<td>12h</td>
</tr>
<tr>
<td><strong>Specific objectives:</strong></td>
<td>5</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Functions of several variables</td>
<td>Hours: 28h</td>
<td></td>
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<tr>
<td></td>
<td>Theory classes: 8h</td>
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<tr>
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<td>Practical classes: 0h</td>
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<tr>
<td></td>
<td>Laboratory classes: 4h</td>
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<tr>
<td></td>
<td>Guided activities: 0h</td>
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<td></td>
<td>Self study: 16h</td>
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</table>

**Specific objectives:**
6, 7, 8

<table>
<thead>
<tr>
<th>Optimization variables</th>
<th>Hours: 32h</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 10h</td>
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<tr>
<td></td>
<td>Practical classes: 0h</td>
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<td></td>
<td>Laboratory classes: 6h</td>
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<tr>
<td></td>
<td>Guided activities: 0h</td>
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<tr>
<td></td>
<td>Self study: 16h</td>
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</table>

**Specific objectives:**
6, 7, 8, 9

<table>
<thead>
<tr>
<th>Course summary</th>
<th>Hours: 11h</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 6h</td>
</tr>
<tr>
<td></td>
<td>Practical classes: 0h</td>
</tr>
<tr>
<td></td>
<td>Laboratory classes: 2h</td>
</tr>
<tr>
<td></td>
<td>Guided activities: 3h</td>
</tr>
<tr>
<td></td>
<td>Self study: 0h</td>
</tr>
</tbody>
</table>

**Specific objectives:**
1, 2, 3, 4, 5, 6, 7, 8, 9

<table>
<thead>
<tr>
<th>Mid-semester exam (P1)</th>
<th>Hours: 7h 30m</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Guided activities: 1h 30m</td>
</tr>
<tr>
<td></td>
<td>Self study: 6h</td>
</tr>
</tbody>
</table>

**Description:**
Exercise-based open-answer exam on learning objectives 1 to 5, referring to content for topics 1 to 6.

**Specific objectives:**
1, 2, 3, 4, 5

<table>
<thead>
<tr>
<th>Workshop</th>
<th>Hours: 7h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Guided activities: 2h</td>
</tr>
<tr>
<td></td>
<td>Self study: 5h</td>
</tr>
</tbody>
</table>

**Hours:**
- Functions of several variables: 28h
- Optimization variables: 32h
- Course summary: 11h
- Mid-semester exam (P1): 7h 30m
- Workshop: 7h
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**Description:**
Exercise-based open-answer exam on all the learning objectives of the course referring to the problem-solving workshop session content (blackboard and computer classrooms).

**Specific objectives:**
1, 2, 3, 4, 5, 6, 7, 8, 9

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**Final examination**

<table>
<thead>
<tr>
<th>Hours: 15h</th>
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</thead>
<tbody>
<tr>
<td>Guided activities: 3h</td>
</tr>
<tr>
<td>Self study: 12h</td>
</tr>
</tbody>
</table>

**Description:**
Exercise-based open-answer exam on all learning objectives referring to content for topics 1 to 10.

**Specific objectives:**
1, 2, 3, 4, 5, 6, 7, 8, 9

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**End-semester exam (P2)**

<table>
<thead>
<tr>
<th>Hours: 7h 30m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guided activities: 1h 30m</td>
</tr>
<tr>
<td>Self study: 6h</td>
</tr>
</tbody>
</table>

**Description:**
Exercise-based open-answer exam on learning objectives 6 to 9, referring to content for topics 7 to 10.

**Specific objectives:**
6, 7, 8, 9

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**Qualification system**

Technical and transferable competencies account for 80% and 20% of the subject, respectively. The transferable competency mark will be calculated on the basis of workshop/laboratory class and Atenea activities.

- Workshop mark (T): it represents 20% of the note and evaluates the student's performance and achievement of objectives in workshop / laboratory sessions and Atenea.
- Mark of the mid-semester exam (P1): it represents 40% of the note and corresponds to Calculus in 1 variable.
- Mark of the end-semester exam (P2): it represents 40% of the note and corresponds to the Calculus in several variables.
- Final exam (F): This exam is used to pass the subject to students who have not passed by course.

The final mark is calculated as:

Note = 0.2 * T + max (0.8 * F, 0.4 * P1 + 0.4 * P2)
Bibliography

Basic:


Complementary:


Grau Sánchez, M.; Noguera Batlle, M. Cálculo numérico [on line]. Edicions UPC, 2001Available on:


Others resources:

Hyperlink

http://archives.math.utk.edu/visual.calculus/

http://ocw.mit.edu/OcwWeb/Mathematics/index.htm

http://ocw.mit.edu/ans7870/18/18.013a/textbook/MathML/index.xhtml

http://ramanujan.math.trinity.edu/wtrench/misc/index.shtml