310607 - Mathematical Methods

Coordinating unit: 310 - EPSEB - Barcelona School of Building Construction
Teaching unit: 749 - MAT - Department of Mathematics
Academic year: 2018
Degree: BACHELOR'S DEGREE IN GEINFORMATION AND GEOMATICS ENGINEERING (Syllabus 2016).
(Teaching unit Compulsory)
ECTS credits: 6
Teaching languages: Catalan, English

Teaching staff
Coordinator: Joan J. Rodríguez Jordana

Opening hours
Timetable: Tuesday from 10 to 12

Prior skills
Understand the fundamentals of calculus in one variable. Domain, continuity and differentiability of functions of one variable concepts. Plot a function of one variable. Elementary functions.
Knowing the analysis of several variables functions: directional derivatives, differential application.
Applying the concept of linearization of a function.
Understanding the integration of functions and applications.
To study and solve, if any, systems of linear equations including overdetermined, both analytically and numerically.
To analyze and interpret the eigenvalues and eigenvectors of a square matrix

Requirements
Calculus and Algebra of previous term

Degree competences to which the subject contributes

Specific:
4. Capacity of spatial vision and knowledge of the graphic representation techniques, for traditional methods of metric and geometric geometry but also for applications of assisted design by a computer.
5. Capacity for the resolution of mathematic problems that can be set out in engineering. Aptitude to apply the knowledge about: linear algebra, geometry, differential geometry, differential and integral calculus, differential equations and in partial derivates, numeric methods, numeric algorithm, statistics and optimization.
6. (ENG) Gestió i execució de projectes d'investigació, de desenvolupament i d'innovació dins l'àmbit d'aquesta enginyeria.

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.
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. THIRD LANGUAGE. Learning a third language, preferably English, to a degree of oral and written fluency that fits in with the future needs of the graduates of each course.
310607 - Mathematical Methods

Learning objectives of the subject

The main goal of the subject is provide the language and the math knowledge that will be used in different subjects of the degree, for the ones that have a more technic charater and also the more basic ones. In addition there is an instrumental goal, that consists in learning the calculus techniques that are common in the geoinformation and geomatic environment. This aspect is also showed in the practical classes, using predfined files in order to be used in the computer.

Study load

<table>
<thead>
<tr>
<th>Total learning time: 150h</th>
<th>Hours large group: 24h</th>
<th>16.00%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hours medium group: 36h</td>
<td>24.00%</td>
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<tr>
<td></td>
<td>Hours small group: 0h</td>
<td>0.00%</td>
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<tr>
<td></td>
<td>Self study: 90h</td>
<td>60.00%</td>
</tr>
</tbody>
</table>
## Content

<table>
<thead>
<tr>
<th><strong>C1 Differential geometry of curves and surfaces</strong></th>
<th><strong>Learning time:</strong> 48h</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 9h</td>
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<tr>
<td></td>
<td>Practical classes: 6h</td>
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<tr>
<td></td>
<td>Laboratory classes: 3h</td>
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<tr>
<td></td>
<td>Self study : 30h</td>
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</tbody>
</table>

### Description:

Differentiable curves. Parametrized curves.
Arc length. Curvature and torsion. Frénet formulas.

Differentiable surfaces: explicit, implicit and parameterized definition.
Regular surfaces. Tangent plane and normal line.
First fundamental quadratic form.
Application to the computation to the arc length of a curve, area and angle between curves on a surface.

### Related activities:

L1, P1

### Specific objectives:

- How to parametrize a regular curve both in the plane and in the tridimensional space.
- Recognize when a curve is parameterized by arc parameter.
- Identifying the curvature parameters with the properties of a curve.
- Know how to define and parametrize a clotoid

- Knowing the different ways of representing a differentiable surface.
- Learn simple parameterized surfaces.
- Being able to compute the tangent plane and the normal vector to a differentiable surface.

- Understand the information given by the first fundamental quadratic form.
- Being able to use it to calculate the length of a curve on a surface and the angle between two curves.
310607 - Mathematical Methods

C2 Complex variable

**Description:**
Complex numbers. Binomic, trigonometric and polar representation. Moivre's formulas.


**Related activities:**
P1, P2

**Specific objectives:**
- Operate with complex numbers.
- Interpret geometrically the concept of derivation in the complex filed.
- Get the Cauchy-Riemann equations.
- Knowing the properties of the elementary complex variable functions.
- Understand the concept of conform map.
- Interpret the complex variable functions as transformations of the plane.

Learning time: 53h
- Theory classes: 8h
- Practical classes: 3h
- Laboratory classes: 7h
- Self study: 35h

C3 Statistics

**Description:**
Descriptive statistics.

Probability. Random variables
Probability function and density function,

Discrete random variables: Binomial and Poisson distributions

**Related activities:**
L2, P2

**Specific objectives:**
- Solve problems related to probability and statistics.
- Use the right tools for modeling and solving related problems.
- Manipulate data, apply appropriate methods and discuss the conclusions of the results.
- Using a suitable software for the treatment of statistical data.

Learning time: 29h
- Theory classes: 5h
- Practical classes: 6h
- Laboratory classes: 3h
- Self study: 15h
### Differential equations

**Description:**
- Concept of differential equation and solution
- Basic methods of solving ordinary differential equations

**Related activities:**
- L4, P2

**Learning time:** 23h
- Theory classes: 5h
- Practical classes: 4h
- Laboratory classes: 1h
- Self study: 13h
# Planning of activities

| **L1, L2 DIFFERENTIAL GEOMETRY AND COMPLEX VARIABLE LABS** | **Hours:** 2h  
Laboratory classes: 2h |
<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td><strong>Description:</strong></td>
<td><strong>Laboratory classes: 2h</strong></td>
</tr>
<tr>
<td>L1: Curves and surfaces</td>
<td></td>
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<tr>
<td>L2: Complex variable</td>
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<tr>
<td>Practices to do individually in the computer lab</td>
<td></td>
</tr>
<tr>
<td>The language of these activities is English</td>
<td></td>
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<tr>
<td><strong>Support materials:</strong></td>
<td></td>
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<tr>
<td>Available software.</td>
<td></td>
</tr>
<tr>
<td>Guide of the practice and other materials in ATENEA</td>
<td></td>
</tr>
<tr>
<td><strong>Descriptions of the assignments due and their relation to the assessment:</strong></td>
<td></td>
</tr>
<tr>
<td>The practice will be uploaded using ATENEA</td>
<td></td>
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<tr>
<td>It is a part of the total grade.</td>
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<tr>
<td><strong>Specific objectives:</strong></td>
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<tr>
<td>Parameterize curves and its representation.</td>
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<tr>
<td>Identify properties of planar curves.</td>
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<tr>
<td>Know how to calculate the tangent, binormal and normal vectors in a regular point of a curve.</td>
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<tr>
<td>Know how to calculate the tangent plane and the normal line of a regular parametrized surface.</td>
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<tr>
<td>Know how to work with complex variable functions</td>
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<tr>
<td>Use the first fundamental quadratic form for calculating length curves.</td>
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| **L3, L4: STATISTICS AND DIFFERENTIAL EQUATIONS LABS**     | **Hours:** 2h  
Laboratory classes: 2h |
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<tbody>
<tr>
<td><strong>Description:</strong></td>
<td><strong>Laboratory classes: 2h</strong></td>
</tr>
<tr>
<td>Statistical study of practical cases.</td>
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<tr>
<td>Problems with random variables</td>
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<tr>
<td>Resolution of ordinary differential equations</td>
<td></td>
</tr>
<tr>
<td>The language of this activity is English.</td>
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<tr>
<td>Practice to perform individually in the computer lab.</td>
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</tr>
<tr>
<td><strong>Support materials:</strong></td>
<td></td>
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<tr>
<td>Available software.</td>
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<tr>
<td>The practice will be uploaded using ATENEA</td>
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<tr>
<td>It is a part of the total grade.</td>
<td></td>
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<tr>
<td><strong>Specific objectives:</strong></td>
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<tr>
<td>Solve practical cases in which are involved the concepts of the unit.</td>
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| **P1: MIDTERM EXAM**                                       | **Hours:** 2h  
Laboratory classes: 2h |
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<thead>
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</thead>
<tbody>
<tr>
<td><strong>Description:</strong></td>
<td><strong>Laboratory classes: 2h</strong></td>
</tr>
<tr>
<td>Midterm exam</td>
<td></td>
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</tbody>
</table>
### Support materials:
List of questions and problems.

### Descriptions of the assignments due and their relation to the assessment:
Delivery of the writing to the end of the activity. It is a part of the evaluation.

### Specific objectives:
Solve problems related with curves and surfaces. Solving complex number exercises.

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<table>
<thead>
<tr>
<th><strong>P2: LAST TERM EXAM</strong></th>
<th><strong>Hours:</strong> 2h</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>Laboratory classes: 2h</td>
</tr>
<tr>
<td>End term exam</td>
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</tbody>
</table>

**Support materials:**
list of questions and problems to be solved

**Descriptions of the assignments due and their relation to the assessment:**
Delivery of the written solution to the end of the activity. It is a part of the evaluation.

**Specific objectives:**
To evaluate the achievement of the skills on complex variable, statistics, graph theory and shortest path algorithms.

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<table>
<thead>
<tr>
<th><strong>COMPETENCE</strong></th>
<th><strong>Hours:</strong> 1h</th>
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<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>Theory classes: 1h</td>
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<tr>
<td>Labs L1 and L2 will be written in English. Oral communication language will be English.</td>
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</table>

**Specific objectives:**
Test competence 04 COE N1

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<table>
<thead>
<tr>
<th><strong>RP1: REEVALUATION TEST</strong></th>
<th><strong>Hours:</strong> 2h 30m</th>
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<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>Theory classes: 2h 30m</td>
</tr>
<tr>
<td>Optional written exam to increase the previous mark.</td>
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</table>

**Support materials:**
List of problems and questions to be solved.

**Descriptions of the assignments due and their relation to the assessment:**
Well written answers to the questions.

**Specific objectives:**
Option to increase previous mark.
### TW: WEEKLY PROJECT

**Description:**
Weekly homework to deliver at the end of the week

**Support materials:**
Weekly homework

**Descriptions of the assignments due and their relation to the assessment:**
Each week

**Specific objectives:**
Improve the commitment with the subject

### Qualification system

It consists in evaluate the practical laboratories (L1-L4), the midterm exams (P1, P2) and the everyday work (TQ).

The week of realization and the value of each test/practice is:
- **Laboratories**
  - L1: Week 3. Value of the practice 5%.
  - L2: Week 6. Value of the practice 5%.
  - L3: Week 11. Value of the practice 5%.
  - L4: Week 14. Value of the practice 5%.
- **Midterm exams**
  - P1: Half semester. Value of the exam 30%
  - P2: End of semester. Value of the exam 30%
- **TQ**: 20%

TQ values the attendance and active participation in class and essentially, the exercises given weekly as an everyday work.

The retake exam will consist in an only exam of problems and questions about the content of the whole subject. The marks of L1, L2 and TQ are maintained.

### Regulations for carrying out activities

Only in cases where is possible to justify the no attendance to one of the practical laboratories, it will be allowed to carry out the practice another day.
310607 - Mathematical Methods

Bibliography

Basic:


Complementary:


