Course guide
310607 - 310607 - Mathematical Methods

Unit in charge: Barcelona School of Building Construction
Teaching unit: 749 - MAT - Department of Mathematics.
Degree: BACHELOR’S DEGREE IN GEOINFORMATION AND GEOMATICS ENGINEERING (Syllabus 2016). (Compulsory subject).
Academic year: 2022  ECTS Credits: 6.0  Languages: Catalan, Spanish, English

LECTURER

Coordinating lecturer: Joan J. Rodríguez Jordana

Others:

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 knowlege 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.
TEACHING METHODOLOGY

Face-to-face sessions in large groups where the teacher presents each topic, with examples and exercises. They are basically blackboard classes with the support of projected material from a computer such as presentations or files of symbolic calculation programs.

Autonomous work sessions by each student to deepen and study what has been exposed in class with the help of textbooks and to do the proposed exercises.

Face-to-face sessions in a small group where teachers resolve doubts and do practical work. They are developed in the computer room to be able to use the available software.

The problem classes will consist of different ways of working:
- Resolution on the blackboard by the teachers of previously proposed problems
- Problem solving and exercises in small groups and subsequent oral presentation.

The practical sessions will consist of solving problems that require the use of symbolic calculation packages. Each practice is organized from a previously prepared file with the instructions, functions and necessary material from which the proposed problem has to be solved.

LEARNING OBJECTIVES OF THE SUBJECT

The main goal of the subject is to 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 character 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 predefined files in order to be used in the computer.

STUDY LOAD

<table>
<thead>
<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
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</thead>
<tbody>
<tr>
<td>Hours large group</td>
<td>24,0</td>
<td>16.00</td>
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<tr>
<td>Self study</td>
<td>90,0</td>
<td>60.00</td>
</tr>
<tr>
<td>Hours medium group</td>
<td>36,0</td>
<td>24.00</td>
</tr>
</tbody>
</table>

Total learning time: 150 h
## CONTENTS

### C1 Differential geometry of curves and surfaces

**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.

**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.

**Related activities:**
L1, P1

**Full-or-part-time:** 48h
Theory classes: 9h 
Practical classes: 6h
Laboratory classes: 3h 
Self study : 30h

### C2 Complex variable

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


**Specific objectives:**
Operate with complex numbers. 
Interpret geometrically the concept of derivation in the complex field. 
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.

**Related activities:**
P1,P2

**Full-or-part-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

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.

Related activities:
L2, P2

Full-or-part-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

Full-or-part-time: 23h
Theory classes: 5h
Practical classes: 4h
Laboratory classes: 1h
Self study: 13h
ACTIVITIES

L1, L2 DIFFERENTIAL GEOMETRY AND COMPLEX VARIABLE LABS

Description:
L1: Curves and surfaces  
L2: Complex variable  
Practices to do individually with computer  
The language of these activities is English

Specific objectives:
Parameterize curves and its representation.  
Identify properties of planar curves.  
Know how to calculate the tangent, binormal and normal vectors in a regular point of a curve.  
Know how to calculate the tangent plane and the normal line of a regular parametrized surface.  
Know how to work with complex variable functions  
Use the first fundamental quadratic form for calculating length curvas.

Material:
Available software.  
Guide of the practice and other materials in ATENEA

Delivery:
The practice will be uploaded using ATENEA  
It is a part of the total grade.

Full-or-part-time: 2h  
Laboratory classes: 2h

L3, L4: STATISTICS AND DIFFERENTIAL EQUATIONS LABS

Description:
Statistical study of practical cases.  
Problems with random variables.  
Resolution of ordinary differential equations.  
The language of this activity is English.  
Practice to perform individually in the computer lab.

Specific objectives:
Solve practical cases in which are involved the concepts of the unit.

Material:
Available software.  
Guide of the practice and other materials in ATENEA

Delivery:
The practice will be uploaded using ATENEA  
It is a part of the total grade.

Full-or-part-time: 2h  
Laboratory classes: 2h
**P1: MIDTERM EXAM**

**Description:**
Midterm exam

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

**Material:**
List of questions and problems.

**Delivery:**
Delivery of the writing to the end of the activity. It is a part of the evaluation.

**Full-or-part-time:** 2h
Laboratory classes: 2h

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**P2: LAST TERM EXAM**

**Description:**
End term exam

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

**Material:**
List of questions and problems to be solved

**Delivery:**
Delivery of the written solution to the end of the activity. It is a part of the evaluation.

**Full-or-part-time:** 2h
Laboratory classes: 2h

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**COMPETENCE**

**Description:**
Labs L1 and L2 will be written in English. Oral communication language will be English.

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

**Full-or-part-time:** 1h
Theory classes: 1h
**RP1: REEVALUATION TEST**

**Description:**
Optional written exam to increase the previous mark.

**Specific objectives:**
Option to increase previous mark

**Material:**
List of problems and questions to be solved.

**Delivery:**
Well written answers to the questions

**Full-or-part-time:** 2h 30m
Theory classes: 2h 30m

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**TW: WEEKLY PROJECT**

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

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

**Material:**
Weekly homework

**Delivery:**
Each week

**Full-or-part-time:** 2h 30m
Theory classes: 2h 30m

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**GRADING 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.
EXAMINATION RULES.

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.

BIBLIOGRAPHY

Basic:

Complementary: