

Course guide 310607 - 310607 - Mathematical Methods

Last modified: 04/04/2025

Unit in charge: Teaching unit:	Barcelona School of Building Construction 749 - MAT - Department of Mathematics.		
Degree:	BACHELOR'S DEGREE IN GEOINFORMATION AND GEOMATICS ENGINEERING (Syllabus 2016). (Compulsory subject).		
Academic year: 2024	ECTS Credits: 6.0	Languages: Catalan	

LECTURER			
Coordinating lecturer:	Guillamon Grabolosa, Antoni		
Others:	Tous Fernández, Ramon		

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.

To know the graph of elementary functions.

Know the analysis of several variables functions: directional derivatives, differential application.

Apply the concept of linearization of a function.

Understand 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

Have passed Calculus and Algebra of previous term (recommended).

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, stadistics 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

Large group face-to-face sessions, both theoretical exposition and problem solving. They are basically blackboard classes with the support of material that can be projected from a computer such as presentations or symbolic calculation program files. In the problem classes, resolution activities will also be proposed in small groups and subsequent oral exposition.

Independent 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.

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 charater and also the more basic ones. In addition there is an instrumental goal, that consists in learning the calculus tecniques 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

Туре	Hours	Percentage
Self study	90,0	60.00
Hours large group	24,0	16.00
Hours medium group	36,0	24.00

Total learning time: 150 h



CONTENTS

C1 Differential geometry of curves and surfaces

Description:

- C1.1. Differential geometry of curves:
- Differentiable curves. Parameterized curves and regular curves.
- Arc length. Curvature and torsion. Frenet trihedron.

C1.2: Differential geometry of surfaces:

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

Specific objectives:

Know 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

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

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

Related activities: L1 and AC (C1.1 and C1.2).

Full-or-part-time: 58h Theory classes: 9h Practical classes: 9h Self study : 40h

C2 Differential equations

Description:

Concept of differential equation and solution. Basic methods of solving first-order ordinary differential equations.

Specific objectives:

Know the concept of differential equation and general solution and particular solution. Know how to solve linear and exact differential equations. Know how to use the appropriate symbolic calculus software to solve differential equations and represent the solutions.

Related activities: L2 and AC (C2).

Full-or-part-time: 26h

Theory classes: 4h Practical classes: 4h Self study : 18h



C3 Complex variable

Description:

The complex numbers. The body of complex numbers. Polar and trigonometric form of a complex number. Moivre's formulas.

Complex variable functions. Differentiation. Cauchy-Riemann equations. Holomorphic functions. Conformal transformations. Harmonic functions. Laplace's equation

Specific objectives:

Know how to operate with complex numbers. Geometrically interpret the concept of derivation in the complex filed. Know the Cauchy-Riemann equations. Know the properties of the elementary complex variable functions. Understand the concept of conform transformation. Interpret the complex variable functions as transformations of the plane.

Related activities:

L3 and AC (C3).

Full-or-part-time: 32h Theory classes: 5h Practical classes: 5h Self study : 22h

C4 Statistics

Description:

Descriptive statistics. -Central tendency and dispersion measures. -Graphs.

Probability and random variables. -Probability, density and distribution functions. -Expectation and variance of a random variable.

Discrete random variables. Binomial and Poisson.

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: L4 and AC (C4).

Full-or-part-time: 29h Theory classes: 4h 30m Practical classes: 4h 30m Self study : 20h



ACTIVITIES

L1, L2 DIFERENTIAL GEOMETRY AND DIFFERENTIAL EQUATIONS LABS

Description:

L1: Curves and surfaces. L2: Differential equations. Tools will be provided to solve problems with the help of symbolic and numerical software. 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. Use the first fundamental quadratic form for calculating length curvas. Know how to solve differential equations

Material:

Available at the UPC software distribution platform. Guide of the practice and other materials in ATENEA

Full-or-part-time: 1h

Laboratory classes: 1h

L3, L4: COMPLEX VARIABLE AND STATISTICS LABS

Description:

Use of complex variable in symbolic calculation programs. Statistical study of practical cases. Continuous random variables. The language of this activity is English.

Specific objectives:

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

Material:

Available at the UPC software distribution platform. Guide of the practice and other materials in ATENEA.

Full-or-part-time: 1h Laboratory classes: 1h



P1: MIDTERM EXAM

Description: Midterm exam

Specific objectives:

Solve problems related with curves and surfaces. Solving differential equations exercices. Write the result clearly and reasonably.

Material:

List of questions and problems distributed at the beginning of the session.

Delivery:

Delivery of the writing to the end of the activity. Part of the evaluation is represented.

Full-or-part-time: 2h 30m Laboratory classes: 2h 30m

P2: FINAL EXAM

Description: Test at the end of the term.

Specific objectives:

To evaluate the achievement of the skills on complex variable and statistics.

Material:

List of questions and problems to be solved

Delivery:

Delivery of the written solution to the end. Part of the evaluation is represented.

Full-or-part-time: 2h 30m Laboratory classes: 2h 30m

COMPETENCE

Description:

The statements in the L1, L2, L3 and L4 practice dossiers are in English. During these activities, the language of communication will be, as much as possible, English.

Specific objectives: Test competence 04 COE N1



RP1: REEVALUATION EXAM

Description:

Optional writen exam to increase the mark obtained in P1 and/or P2.

Specific objectives:

Give the option to recover the first and/or second partial.

Material:

List of problems and questions to be solved.

Delivery:

Reasoned answers to the statement distributed at the beginning of the test.

Full-or-part-time: 3h

Laboratory classes: 3h

AC: CONTINUOUS EVALUATION OF CONTENTS

Description:

At the end of each topic (C1.1, C1.2, C2, C3 and C4), a problem-solving test with class notes will be conducted.

Specific objectives: Improve continuous monitoring of the subject.

Material: Written statements.

Delivery: Written resolution.

Full-or-part-time: 5h Laboratory classes: 5h

GRADING SYSTEM

It consists of evaluating the midterm exams (P1, P2) and the continuous assessment (AC). The weight distribution of each modality is:

- Midterm exams

P1: Half semester. Value of the exam 35% P2: End of semester. Value of the exam 40%.

- AC: 25%

AC assesses the attendance and active participation in class and essentially, the exercises proposed in class periodically.

The reassessment test will consist of a single test of problems and questions from the content of the entire course. AC grades will be maintained.



BIBLIOGRAPHY

Basic:

- Peñarrocha, P. ; Santamaria, A. ; Vidal, J. Mètodes matemàtics : variable complexa. 2a ed. corregida. València: Universitat de València, 1997. ISBN 8437033226.

- Kreyszig, E. Matemáticas avanzadas para la ingenieria. Vols 1 i 2. 3a ed. México: Limusa, 2000.
- Churchill, R. V. ; Brown, J.W. Variable compleja y aplicaciones. 2a ed. Madrid: McGraw-Hill, 1992. ISBN 8476157304.
- Ferrer, A. [et al.]. Fonaments d'estadística aplicada. Barcelona: Romargraf, 1995. ISBN 8460545857.

Complementary:

- Gimbert, J. [et al.]. Apropament a la teoria de grafs i als seus algorismes. Lleida: Edicions de la Universitat de Lleida, 1998. ISBN 8489727651.

- Derrick, W. R. Variable compleja con aplicaciones. México: Grupo Editorial Iberoamericana, 1987. ISBN 9687270357.
- Carmo, Manfredo Perdigão do. Geometria diferencial de curvas y superficies. Madrid: Alianza, 1990. ISBN 8420681350.

- Gross, J. L.; Yellen, J. Graph theory and its applications. 2nd. Boca Raton, FL [etc.]: Chapman and Hall/CRC, 2006. ISBN 158488505X.