Course guide
390104 - FM1 - Mathematics I

Unit in charge:	Barcelona School of Agri-Food and Biosystems Engineering
Teaching unit:	749 - MAT - Department of Mathematics.

Degree:	BACHELOR'S DEGREE IN BIOSYSTEMS ENGINEERING (Syllabus 2009). (Compulsory subject).
	BACHELOR'S DEGREE IN FOOD ENGINEERING (Syllabus 2009). (Compulsory subject).
	BACHELOR'S DEGREE IN AGRONOMIC SCIENCE ENGINEERING (Syllabus 2018). (Compulsory subject).

Academic year: 2023 **ECTS Credits:** 6.0 **Languages:** Catalan, Spanish

LECTURER

Coordinating lecturer:

    Herranz Sotoca, Javier

Others:

    Saseta Ibáñez, Fede
    Herranz Sotoca, Javier
    Garcia Martinez, Yamila
    Boza Rocho, Santiago
    Espona Donés, Margarida

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
2. Fundamentals of computer use and programming, operating systems, data bases, software for engineering applications.
3. Ability to solve mathematic problems in an engineering context . Ability to apply the knowledge of linear algebra, geometry, differential geometry, differential and integral calculus.

Generical:
1. Ability to solve problems.

TEACHING METHODOLOGY

Large group sessions are used to introduce the basic concepts covered in the subject and to present basic techniques for completing exercises and solving specific problems. There will be discussion of the exercises and problems set by the teaching staff. Expositive sessions will be combined with other activities requiring the active participation of students (direct questions, exercises resolution, etc.)

In the small groups sessions, participation of students will be much more active, focused on the resolution of exercises and problems. In those questions there will also be tests and questionnaires that will be useful for both teachers and students, to know the level of acquisition of the presented notions so far.

Autonomous learning will focus on actions basically dedicated to solving exercises and problems. In the virtual campus some questionnaires related to various contents will be proposed to contribute to personal learning.

LEARNING OBJECTIVES OF THE SUBJECT

On completion of Mathematics 1, students should be able to:

· Work with matrices and represent with matrices an affine multivariate function.
· Find the pre-image of a vector for a given affine function.
· Solve problems where the derivative of a real univariate function appears.
· Use the rule by l'Hôpital to calculate some limits.
· Know the formula for the Taylor polynomial, and its application for the approximation of functions.
· Identify conic curves and quadric surfaces, from their equations.
· Have ability in computations involving curves and surfaces.
· Understand and interpret from a geometric point of view the notions of directional and partial derivative, and the notion of gradient vector.
· Find the equation of tangent and orthogonal lines and planes, to curves and surfaces in the space R^3.
· Find local and absolute extremes for univariate and multivariate functions.
· Apply the computation of absolute extremes to the resolution of optimization problems.
· Use linear programming techniques to solve optimization problems in polygonal regions of the plane R^2.

STUDY LOAD

Type	Hours	Percentage
Hours large group	40,0	26.67
Self study	90,0	60.00
Hours small group	20,0	13.33

Total learning time: 150 h

CONTENTS

LINEAR AND AFFINE MULTIVARIATE FUNCTIONS

Description:
Definition of linear and affine functions. Matrix representation. Operations with matrices and vectors. Homogeneous functions. Resolution of systems of linear equations to find pre-images of affine functions.

Related competencies :
CG-RP1. Ability to solve problems.
CE-BC-1.1. Ability to solve mathematic problems in an engineering context . Ability to apply the knowledge of linear algebra, geometry, differential geometry, differential and integral calculus.
CE-BC-2. Fundamentals of computer use and programming, operating systems, data bases, software for engineering applications.

Full-or-part-time: 17h
Theory classes: 6h
Practical classes: 2h
Self study : 9h

REAL UNIVARIATE FUNCTIONS

Description:
Basic notions: elementary functions, domain, continuity. The graph of a real function and other curves in R^2: conic curves.
Derivative of a real univariate function and its applications: tangent and orthogonal lines, l'Hôpital rule, Taylor polynomial,
increase/decrease intervals, local and absolute extremes.

Related competencies :
CG-RP1. Ability to solve problems.
CE-BC-1.1. Ability to solve mathematic problems in an engineering context . Ability to apply the knowledge of linear algebra,
geometry, differential geometry, differential and integral calculus.
CE-BC-2. Fundamentals of computer use and programming, operating systems, data bases, software for engineering applications.

Full-or-part-time: 29h
Theory classes: 7h
Practical classes: 4h
Self study : 18h

UNIVARIATE FUNCTIONS IN R^2 AND R^3

Description:
Parametrized equations of curves. Tangent vector and line to a curve at a given point. Intersection angle between two curves.
Tangent curves. Practical use case: kinematics of an object in the plane R^2 and in the space R^3.

Related competencies :
CG-RP1. Ability to solve problems.
CE-BC-1.1. Ability to solve mathematic problems in an engineering context . Ability to apply the knowledge of linear algebra,
geometry, differential geometry, differential and integral calculus.
CE-BC-2. Fundamentals of computer use and programming, operating systems, data bases, software for engineering applications.

Full-or-part-time: 17h
Theory classes: 6h
Practical classes: 2h
Self study : 9h

REAL MULTIVARIATE FUNCTIONS

Description:
Graph of a function f: R^2 --> R and level curves. Other surfaces in R^3: the quadric surfaces. Partial derivatives, gradient
vectors and their applications: directional derivative, tangent plane and orthogonal line to a surface at a given point. Tangent
surfaces. Critical points, extrems, saddle points. The Hessian matrix.

Related competencies :
CG-RP1. Ability to solve problems.
CE-BC-1.1. Ability to solve mathematic problems in an engineering context . Ability to apply the knowledge of linear algebra,
geometry, differential geometry, differential and integral calculus.
CE-BC-2. Fundamentals of computer use and programming, operating systems, data bases, software for engineering applications.

Full-or-part-time: 44h
Theory classes: 11h
Practical classes: 6h
Self study : 27h

OPTIMIZATION AND LINEAR PROGRAMMING

Description:
Optimization problems that can be solved by searching extremes of an univariate real function.
Basic topological notions in R^2 and R^3: compact regions. Weierstrass Theorem and (geometrical) search of absolute extrems for multivariate functions in R^2 and R^3 compact regions.
Linear Programming (LP) problems. Linear objective function. Linear constraints. Set of feasible solutions. Optimal solution. Case of functions of two variables in polygonal regions. Use of an auxiliary line. Study of the vertices.

Related competencies :
CG-RP1. Ability to solve problems.
CE-BC-1.1. Ability to solve mathematic problems in an engineering context . Ability to apply the knowledge of linear algebra, geometry, differential geometry, differential and integral calculus.
CE-BC-2. Fundamentals of computer use and programming, operating systems, data bases, software for engineering applications.

Full-or-part-time: 43h
Theory classes: 10h
Practical classes: 6h
Self study : 27h

GRADING SYSTEM

N1: A mark about continuous evaluation, computed by teachers of the small groups, through questionnaires and some small exam performed inside those sessions.
N2: The mark of the medium semester exam.
N3: There will be one action of assessment at the end of the semester.

The final mark, of certificates character, will be computed as:
Nfinal = 0.20 N1 + 0.32 N2 + 0.48 N3

In case of suspending the subject, the student will have the possibility of a reevaluation in the extraordinary period of reevaluation exams. The reevaluation note will replace the previous notes N2 and N3.
Students who have already passed the exam will not be able to attend the reevaluation of the subject. Students qualified as "not presented" will also not be able to attend the reevaluation.

EXAMINATION RULES.

The length of the medium semester exam will be 2 hours
The length of the final semester exam will be 3 hours

BIBLIOGRAPHY

Basic:
- Estela Carbonell, M. Rosa; Saà Seoane, Joel. Cálculo con soporte interactivo en Moodle [on line]. Madrid: Pearson Educación, 2008 [Consultation: 15/07/2022]. Available on: https://www-ingebook-com.recursos.biblioteca.upc.edu/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=4668. ISBN 9788483224809.
- Fernández Pérez, Carlos; Vázquez Hernández, Francisco José; Vegas Montaner, José Manuel. Cálculo diferencial de varias variables. Madrid: Thomson, cop. 2002. ISBN 8497320565.

Complementary:
- Haeussler, Ernest F; Paul, Richard S; Wood, Richard J. Matemáticas para administración y economía [on line]. Decimotercera edición. México: Pearson Educación, 2015 [Consultation: 26/07/2022]. Available on: https://www-ingebook-com.recursos.biblioteca.upc.edu/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=6148. ISBN 9786073229166.

- Pelayo Melero, Ignacio M.; Rubio Montaner, Francisco. Álgebra lineal básica para ingeniería civil. Barcelona: Edicions UPC, 2008. ISBN 9788483019610.
- Burgos Román, Juan de. Álgebra lineal y geometría cartesiana [on line]. 3ª ed. Madrid [etc.]: McGraw-Hill, 2006 [Consultation: 26/07/2022]. Available on: https://www-ingebook-com.recursos.biblioteca.upc.edu/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=4141. ISBN 8448149009.
- Gibergans Bàguena, Josep. Matemáticas para la ingeniería con Maple. Barcelona: Edicions UPC, 2008. ISBN 9788483019672.
- Hillier, Frederick S; Lieberman, Gerald J. Introducción a la investigación de operaciones. 3ª ed. México D.F., [etc.]: McGraw-Hill, 1991. ISBN 9684229933.
- Marsden, Jerrold E; Tromba, Anthony. Cálculo vectorial [on line]. Sexta edición. Madrid: Pearson, [2018] [Consultation: 21/07/2022]. Available on: https://www-ingebook-com.recursos.biblioteca.upc.edu/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=7634. ISBN 9788490355787.

RESOURCES

Audiovisual material:
- Khan Academy/maths: Lliçons, cursos i pràctica de matemàtiques. https://www.khanacademy.org/math

Hyperlink:
- WIRIS: la solución global para la enseñanza de matemáticas. http://www.wiris.com/- Wolfram|Alpha: Computational Knowledge Engine. http://www.wolframalpha.com/