Course guide
820007 - CAL - Calculus

Last modified: 02/10/2025

Unit in charge: Barcelona East School of Engineering
Teaching unit: 749 - MAT - Department of Mathematics.

Degree: BACHELOR'S DEGREE IN BIOMEDICAL ENGINEERING (Syllabus 2009). (Compulsory subject).
BACHELOR'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2009). (Compulsory subject).
BACHELOR'S DEGREE IN ELECTRICAL ENGINEERING (Syllabus 2009). (Compulsory subject).
BACHELOR'S DEGREE IN ENERGY ENGINEERING (Syllabus 2009). (Compulsory subject).
BACHELOR'S DEGREE IN INDUSTRIAL ELECTRONICS AND AUTOMATIC CONTROL ENGINEERING (Syllabus 2009). (Compulsory subject).
BACHELOR'S DEGREE IN MECHANICAL ENGINEERING (Syllabus 2009). (Compulsory subject).
BACHELOR'S DEGREE IN MATERIALS ENGINEERING (Syllabus 2010). (Compulsory subject).

Academic year: 2025 **ECTS Credits:** 6.0 **Languages:** Catalan, Spanish, English

LECTURER

Coordinating lecturer: JOSE JAVIER MUÑOZ ROMERO - FRANCESC POZO MONTERO - NURIA PARES MARINE

Others: Primer quadrimestre:
FRANCISCO MANUEL ALVAREZ MARTINEZ - Grup: X11, Grup: X22
ANDREW MICHAEL CLARKE - Grup: M31, Grup: M32, Grup: M71, Grup: M72
ANA MARÍA CORTÉS HINOJOSA - Grup: M61, Grup: M62
ANA BELEN DE FELIPE PARAMIO - Grup: M61, Grup: M81
RAIMON ELGUETA MONTO - Grup: M22, Grup: M62, Grup: T11, Grup: T12, Grup: T21, Grup: T22, Grup: X12
ALFONSO ESCOBOSA FERNANDEZ - Grup: T21, Grup: T22, Grup: X21, Grup: X22
ALBERT MAS BLESA - Grup: M21, Grup: M51, Grup: M52, Grup: M92
CATALINA OLMO OLMO - Grup: M82, Grup: T11, Grup: T12
NURIA PARES MARINE - Grup: M11, Grup: M31, Grup: M71, Grup: M72, Grup: X21
FRANCESC POZO MONTERO - Grup: M11
JOAN QUINTANA COMPTE - Grup: M41, Grup: M42, Grup: M52
MIGUEL ANDRES RODRIGUEZ OLMOS - Grup: M21, Grup: M22, Grup: M81, Grup: M82, Grup: M91, Grup: M92
MAGDA LILIANA RUIZ ORDOÑEZ - Grup: M32, Grup: M51
DANIEL TORRES MORAL - Grup: M61, Grup: M62, Grup: X11, Grup: X12

PRIOR SKILLS

This course requires no previous skills.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
2. Solve mathematical problems that may arise in engineering. Apply knowledge of linear algebra; geometry; differential geometry; differential and integral calculus; differential equations and partial differential equations; numerical methods; numerical algorithms; statistics and optimisation.

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.

TEACHING METHODOLOGY

The course uses the expositive methodology by 40% and individual work by 60%.

LEARNING OBJECTIVES OF THE SUBJECT

General objectives: Students will learn the set of complex numbers, the fundamental concepts of single variable calculus, developing the capacity of abstraction and applying these techniques to mathematical problems encountered in engineering, as well as a brief introduction to linear algebra..

STUDY LOAD

Type	Hours	Percentage
Hours small group	15,0	10.00
Hours large group	45,0	30.00
Self study	90,0	60.00

Total learning time: 150 h

CONTENTS

Sets of numbers

Description:
-The sets of natural, integer, rational, and real numbers.
-The set of complex numbers. Standard, polar, and exponential form. Operations with complex numbers. Powers and roots. Euler's formula. Relationship between trigonometric functions (circular and hyperbolic) and complex numbers.

Specific objectives:
Describe the different numerical sets. Operate with complex numbers and be able to establish the relationships between the standard, polar, and exponential representations.

Related activities:
Computer lab session. Introduction to Maple.
Computer lab session. Complex numbers and their representation.
Computer lab session. Operations with complex numbers.

Full-or-part-time: 27h 30m
Theory classes: 8h
Laboratory classes: 3h
Self study : 16h 30m

Functions of real variable. Limits and continuity.

Description:
-Concept of function. Domain and range. Basic functions in engineering. Operations with functions. Composition of functions. Inverse function.
-Limit of a function at a point. Definition and properties of the limit. One-sided limits. Calculation of limits. Squeeze theorem. Extension of the limit concept (infinite limits, limits at infinity). Indeterminate forms. Local equivalence of functions. Locally equivalent functions with zero-limit and equivalent infinities. Relative rates of growth.
-Continuity. Definition and properties. Types of discontinuities. Continuity theorems (Weierstrass, Bolzano, intermediate value).

Specific objectives:
To represent a real-valued function, understand the importance of the concept of limit, and its relationship with continuity.

Related activities:
Computer lab session. Functions. Graphical representation.
Computer lab session. Limits and continuity.

Full-or-part-time: 30h
Theory classes: 10h
Laboratory classes: 2h
Self study : 18h

Differentiation of real-valued functions

Description:
-Derivative of a function at a point. Relationship between differentiability and continuity. The derivative as a function. Geometric interpretation: Tangent line. The chain rule. Implicit derivative. Calculus of derivatives.
-Local approximation of a function. Taylor polynomials. Error formula. Evaluating limits using Taylor series.
-Mean value theorems (Rolle, Cauchy, Lagrange).
-Extrema of a function in an interval.

Specific objectives:
Remember the basic concepts of the derivative and the derivative function. Understand the geometric concept of the derivative and its applications in engineering. Master and apply the elementary properties of differentiable functions. Master the basic calculation of derivatives, both analytically and with the help of mathematical software. Be able to model and solve various problems through the calculation of derivatives, optimization, function approximation, and function analysis.

Related activities:
Computer lab session. Differentiation.
Computer lab session. Applications of the derivative.

Full-or-part-time: 35h
Theory classes: 12h
Laboratory classes: 2h
Self study : 21h

Integration of real-value functions

Description:
-Primitive functions.
-Integration methods: direct methods, change of variable, integration by parts, rational function (decomposition into partial fractions), trigonometric integrals.
-Definite integral (Riemann integral). Integrable functions. The fundamental theorem of calculus. Barrow's rule.
-Computation of areas of plane regions. Applications.
-Improper integrals.

Specific objectives:
Formulate the problem of calculating the area of a plane region in terms of integrals. Understand the relationship between derivatives and integrals, given by the fundamental theorem of calculus, and know how to use Barrow’s rule. Calculate some improper integrals of continuous functions defined on an unbounded interval.

Related activities:
Computer lab session. Integration.
Computer lab session. Applications of the definite integral.
Computer lab session. Laboratory exam (10%).
Computer lab session. Problem-solving with Maple for the preparation of the second partial exam.

Full-or-part-time: 42h 30m
Theory classes: 13h
Laboratory classes: 4h
Self study : 25h 30m

Linear algebra

Description:
Matrices. Determinant. Rank of a matrix.
Systems of linear equations. Gaussian elimination.
Inverse matrix.
Linear geometry: equation of a straight line and a plane; orthogonality and parallelism; distances.

Specific objectives:
To solve systems of linear equations analytically and represent their solutions graphically.

Related activities:
Computer lab session. Matrices. Determinant. Rank of a matrix.
Computer lab session. Gaussian elimination. Inverse matrix.
Computer lab session. Systems of linear equations.
Computer lab session. Laboratory exam (10%, generic competence).

Full-or-part-time: 15h
Theory classes: 2h
Laboratory classes: 4h
Self study : 9h

GRADING SYSTEM

First partial exam: 32%
Second partial exam: 36%
First laboratory exam (Maple, generic competence): 16%
Second laboratory exam (Maple): 16%

The evaluation will be carried out through assessment by the teaching staff.

Students can pass the subject through continuous assessment based on two partial exams (the first partial exam in the middle of the course and the final partial exam in the period designated by the school for these tests) and the completion of computer lab sessions.

The evaluation of the computer lab sessions will be done through an exam during the last computer lab session and another exam that will assess the generic competence. In this subject, the generic competence of autonomous learning is assessed through an exam in one of the computer lab sessions.

The subject does not have a re-evaluation exam.

EXAMINATION RULES.

No material can be consulted (neither printed papers, books, nor handwritten notes) nor any type of mobile, tablets or any electronic device can be used, except for a scientific calculator.

BIBLIOGRAPHY

Basic:

- Pozo, Francesc; Parés, Núria; Vidal, Yolanda. Matemáticas para la ingeniería [on line]. 2a ed. Madrid: García-Maroto Editores, 2019 [Consultation: 02/10/2019]. Available on: http://www.ingebook.com/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=8434. ISBN 9788417969028.
- Pozo, Francesc; Parés, Núria; Vidal, Yolanda. Mathematics for Engineers. 1st Edition. Chapman & Hall, CRC Press, 2025. ISBN 9781032505442.
- Franco Brañas, José Ramón. Introducción al cálculo : problemas y ejercicios resueltos [on line]. Madrid [etc.]: Prentice Hall, cop. 2003 [Consultation: 29/04/2020]. Available on: http://www.ingebook.com/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=1242. ISBN 9788483229620.
- Rogawski, Jon. Calculus : single variable. 2nd ed. New York: W.H. Freeman and Company, cop. 2012. ISBN 9781429231831.
- Rogawski, Jon. Cálculo : una variable. Segunda edición, 2016 (a todo color). Barcelona: Reverté, 2016. ISBN 9788429151947.
- Salas, Saturnino L.; Hille, Einar; Etgen, Garret J. Calculus : una y varias variables [on line]. 4a ed. Barcelona [etc.]: Reverté, 2011 [Consultation: 16/04/2020]. Available on: http://www.ingebook.com/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=7715. ISBN 8429151567.
- Thomas, George Brinton. Cálculo : una variable. 12ª ed. México, D.F: Addison Wesley Longman, 2010. ISBN 9786073201643.

Complementary:

- Lay, David C. Algebra lineal y sus aplicaciones. 4a ed. México [etc.]: Pearson Educación, 2012. ISBN 9786073213981.
- Gibergans Bàguena, Josep [et al.]. Matemáticas para la ingeniería con Maple. Barcelona: Edicions UPC, 2008. ISBN 9788483019672.

RESOURCES

Hyperlink:
- Khan Academy. Resource

Other resources:
Webpage: https://es.khanacademy.org