

Course guide

320001 - M1-2 - Mathematical Methods I-II

Last modified: 18/05/2026

Unit in charge: Terrassa School of Industrial, Aerospace and Audiovisual Engineering
Teaching unit: 749 - MAT - Department of Mathematics.

Degree: Academic year: 2026 **ECTS Credits:** 12.0
Languages: Catalan

LECTURER

Coordinating lecturer: ROSER GUARDIA RIERA

Others: IMMACULADA GALVEZ CARRILLO - JOSEP GIBERGANS BAGUENA - M. JOSE JIMENEZ JIMENEZ
- ENRIC MONSO BURGUES - TERESA NAVARRO GONZALO - ASSUMPTA SABATER PRUNA -
OLIVER PLANES OSORIO

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:

3. (ENG) Capacitat per a la resolució dels problemes matemàtics que puguin platenjar-se a l'enginyeria. Aptitud per aplicar els coneixements sobre: àlgebra lineal; geometria, geometria diferencial; càlcul diferencial i integral; equacions diferencials i amb derivades parcials; mètodes numèrics; algorítmica numèrica; estadística i optimització.

Transversal:

2. 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

- Face-to-face lecture sessions

Lectures are given using digital presentations. The presentations will be made available to students on the virtual campus before classes begin to help them follow them. The assessment will be based on mid-semester examinations (or an optional final examination for students who fail the first one).

- Face-to-face practical work sessions

During practical work sessions, students work individually or in small groups of 2-3 on problems and questions under the lecturer's supervision. A collection of problems will be made available on the virtual campus. Systems for self-assessment (with evaluation criteria or rubrics), co-assessment (among students) and delivery of reports, corrected by the teacher and returned, are made available to facilitate independent learning.

Face-to-face laboratory work sessions

Students work in pairs during laboratory sessions. Guidelines for practicals will be made available to students on the virtual campus at the start of the course. Students must hand in a report for each practical. Marks will be based on the work carried out in the laboratory and the reports handed in.

LEARNING OBJECTIVES OF THE SUBJECT

On completion of the course, students should be able to:

- Correctly use and interpret the language and basic concepts of Chemistry.
- Recognise the structure of matter and relate it to the physical and chemical properties of organic and inorganic substances.
- Apply stoichiometric calculations to solve problems.
- Recognise the equipment and apply the basic techniques of the chemistry laboratory.



STUDY LOAD

Type	Hours	Percentage
Self study	180,0	60.00
Hours large group	60,0	20.00
Hours medium group	60,0	20.00

Total learning time: 300 h

CONTENTS

TOPIC 1: COMPLEX NUMBERS

Description:

- 1.1. The concept of complex numbers.
- 1.2. Graphical representation.
- 1.3. Binomial, polar and trigonometric forms.
- 1.4. Operations with complex numbers.
- 1.5. Euler's formula.
- 1.6. Exponentiation. De Moivre's formula.
- 1.7. N-th root of a complex number.

Specific objectives:

For students to:

- Understand the concept and representations of complex numbers and basic operations with complex numbers.

Full-or-part-time: 10h

Practical classes: 4h

Self study : 6h

TOPIC 2: SYSTEMS OF LINEAR EQUATIONS AND MATRICES

Description:

- 2.1. Matrix representation of a system. Gauss method.
- 2.2. Range of a matrix. Discussion of systems: Rouché-Capelli theorem.
- 2.3. Solving simultaneous systems. Gauss-Jordan elimination.
- 2.4. Operations with matrices.

Specific objectives:

- Solve systems of linear equations using the Gauss method;
- Understand the concept of matrix rank and the Rouché-Frobenius theorem;
- Discuss the functions of different systems;
- Solve systems of simultaneous equations using the Gauss-Jordan method;
- Understand the specific notation of matrix theory and perform basic matrix operations.

Full-or-part-time: 25h

Practical classes: 10h

Self study : 15h

TOPIC 6: LINEAR ALGEBRA

Description:

6.1. Vector spaces. Subspaces of R^n :

- Vector subspaces. Generated subspaces.
- Linear independence. Bases.
- Change of basis.

6.2. Linear transformations:

- Transformation matrices.
- Eigenvectors and eigenvalues.
- Diagonalisation.

Specific objectives:

- Understand the specific concepts and techniques applicable to vector spaces, in particular R^n spaces: vector subspaces, the generating set of a subspace, linear dependence and independence, bases.
- Understand the change of basis technique.
- Understand the concept of linear transformation and its matrix representation.
- Calculate the eigenvalues and eigenvectors of a matrix and understand the diagonalisation technique.

Full-or-part-time: 47h

Practical classes: 20h

Self study : 27h

TOPIC 3: SINGLE-VARIABLE DIFFERENTIAL CALCULUS

Description:

3.1. Elementary functions.

3.2. Limits and continuity.

3.3. Differential calculus of single-variable functions:

- Linear approximation.
- Taylor polynomials.
- Extrema.

Specific objectives:

- Understand the concept of continuous and derivable functions.
- Correctly interpret the meaning of a derivative.
- correctly apply the concepts of linear approximation and Taylor polynomial approximation.
- Correctly carry out basic operations and use the technique of optimisation.

Full-or-part-time: 30h

Practical classes: 15h

Self study : 15h

TOPIC 4: INTRODUCTION TO NUMERICAL ANALYSIS

Description:

- 4.1. Numerical sequences. The concept of convergence.
- 4.2. Introduction to numerical methods. Types of errors and error propagation.
- 4.3. Numerical solution of non-linear equations. Bisection and the Newton-Raphson method.
- 4.4. Interpolation.

Specific objectives:

- Understand the concept of convergent and divergent sequences, especially in the context of numerical methods.
- understand the concepts of numerical method, absolute error and relative error.- Understand the concept of error propagation, numerical stability and efficiency, and well- and ill-conditioned problems.
- . Understand bisection techniques and the Newton-Raphson method for solving equations numerically.
- . Understand the Lagrange interpolation method and Runge's phenomenon.

Full-or-part-time: 30h

Practical classes: 12h

Self study : 18h

TOPIC 5: INTEGRAL CALCULUS

Description:

- 5.1. Introduction to definite integration.
- 5.2. Antidifferentiation. Indefinite integration, quasi-indefinite integration and integration by parts.
- 5.3. Improper integrals.
- 5.4. Numerical integration.

Specific objectives:

For students to:

- Understand the concept of a Riemann definite integral, the fundamental theorem of calculus, and Barrow's rule.
- Carry out indefinite integration, quasi-indefinite integration and integration by parts.
- understand the concept of improper integral and the techniques for calculating them;
- Understand the trapezium method and Simpson's method for numerical integration, as well as error formulas.

Full-or-part-time: 38h

Practical classes: 17h

Self study : 21h

TOPIC 7: MULTIVARIABLE DIFFERENTIAL CALCULUS

Description:

- 7.1. Domains. Continuity and contour lines.
- 7.2. Partial and directional derivatives; gradients.
- 7.3. Linear approximation.
- 7.4. Optimisation.

Specific objectives:

For students to:

- Understand the concepts of continuous and differentiable multivariable functions.
- Correctly interpret the meaning of partial derivatives, directional derivatives and gradient vectors.
- Properly use the concept of linear approximation.
- Correctly use basic operations and the technique of optimisation.

Full-or-part-time: 42h

Practical classes: 18h

Self study : 24h

TOPIC 8: MULTIPLE INTEGRATION

Description:

- 8.1. Concept. Description of domains.
- 8.2. Fubini's theorem.
- 8.3. Applications.

Specific objectives:

For students to:

- Understand the concept of multiple integrals and Fubini's theorem.
- Properly define domains of integration.
- Become familiar with some applications of multiple integration.

Full-or-part-time: 35h

Practical classes: 14h

Self study : 21h

TOPIC 9: VECTOR CALCULUS

Description:

- 9.1. Vector fields. Field lines.
- 9.2. Line integrals. Conservative fields.
- 9.3. Curl and divergence. Classical theorems.

Specific objectives:

For students to:

- Understand the concept of vector fields and field lines.
- Understand the concept of line integrals and how to calculate them.
- Understand the concept of conservative fields.
- Understand the concept and meaning of curl and divergence.
- Understand classical theorems of vector calculus: the divergence theorem and Stokes' theorem.

Full-or-part-time: 25h

Practical classes: 10h

Self study : 15h

ACTIVITIES

ACTIVITY 1: COMPUTER-ASSISTED WORK

Full-or-part-time: 10h

Self study: 10h

ACTIVITY 2: EXAMINATIONS

Full-or-part-time: 8h

Practical classes: 8h

GRADING SYSTEM

Any academic fraud, plagiarism or use or possession of unauthorised means in an assessment activity leads to a mark of zero (0) for the affected test or assignment. Furthermore, in accordance with the University's regulations, if disciplinary proceedings are initiated the subject is recorded as "Pending Assessment" until a decision is reached. These incidents are managed in accordance with the [Action Framework for Academic Integrity in Assessment at the UPC](#).

- First examination: 30%
- Second examination: 40%
- Laboratory sessions: 20%
- Application/practicals: 10%

EXAMINATION RULES.

To pass the subject, students must complete the laboratory practicals and hand in the necessary reports.

BIBLIOGRAPHY

Basic:

- Larson, R.E.; Hostetler, R.P.; Edwards, B.H. Cálculo. 8ª ed. Madrid: Mc Graw-Hill, 2006. ISBN 970-10-5710-4.
- Álvarez Quetglas, M.J. [et al.]. Matemàtiques per a l'òptica i l'optometria [on line]. Barcelona: Edicions UPC, 2008 [Consultation: 11/01/2016]. Available on: <http://hdl.handle.net/2099.3/36847>. ISBN 9788483019603.
- Anton, H. Introducción al álgebra lineal. 3ª ed. México D.F: Limusa, 2003. ISBN 978-968-18-6317-3.
- Chapra, S.C.; Canale, R.P. Métodos numéricos para ingenieros. 6ª ed. México: McGraw-Hill, 2011. ISBN 9786071504999.

Complementary:

- Grossman, S.I. Álgebra lineal. 3ª ed. México D.F: Mc Graw-Hill, 1992. ISBN 968-422-984-4.
- Salas, S.; Hille, E.; Etgen, G.J. Calculus: una y varias variables (vol. 1 i vol. 2). 4ª ed. Barcelona: Reverté, 2002. ISBN 84-291-5157-5.
- Bonet Reves, C. Càlcul numèric [on line]. Barcelona: Edicions UPC, 1995 [Consultation: 11/01/2016]. Available on: <http://hdl.handle.net/2099.3/36356>. ISBN 84-89636-71-0.