COURSE DATA

DATA SUBJECT

Code: 36580
Name: Linear Algebra and Geometry I P-M
Cycle: Undergraduate Studies
ECTS Credits: 12
Academic year: 2026-27

STUDY (S)

Degree	Center	Acad. year	Period
1928 - Double Degree Program Physics-Mathematics	Facultat de Ciències Matemàtiques	1	Annual

SUBJECT-MATTER

Degree	Subject-matter	Character
1928 - Double Degree Program Physics-Mathematics	Primer Curso (Obligatorio)	COMPULSORY

COORDINATION

TENT JORQUES JOAN FRANCESC

COSME LLOPEZ ENRIC

SUMMARY

The contents of this course are fundamental for the later development of other subjects, both within the field of algebra and in other areas of mathematics and physics.

Some of the initial topics in linear algebra will be familiar to students who have studied mathematics in high school. However, the course curriculum starts from the minimum possible level of prior knowledge, which is also necessary for other first-year subjects and will be addressed in the Basic Mathematics P-M course. This foundational knowledge includes:

· The basic concepts and terminology related to sets.
· Addition and multiplication operations within the sets of natural, integer, rational, and real numbers, along with their basic operations.

We must point out that, in order to facilitate learning and make the content accessible -without giving up the highest possible degree of generality, which is considered necessary- the definition of a field will be introduced as a direct generalization of the algebraic properties of the real or rational numbers with respect to addition and multiplication, all of which are well known to the students. It will also be indicated that, in the development of the content, the field considered as a reference will be the field of real numbers; however, unless expressly stated otherwise, all results will be valid for an arbitrary field.

PREVIOUS KNOWLEDGE

RELATIONSHIP TO OTHER SUBJECTS OF THE SAME DEGREE

There are no specified enrollment restrictions with other subjects of the curriculum.

OTHER REQUIREMENTS

For the development of some of the descriptors of this course, it is necessary to know and be able to use content covered in the Basic Mathematics P-M course.

COMPETENCES / LEARNING OUTCOMES

DESCRIPTION OF CONTENTS

1. Matrices and Systems of Linear Equations

Matrix algebra over a field. Row equivalence of matrices. Gauss-Jordan method. Solution of systems of linear equations.

2. Vector Spaces

Vector spaces. Subspaces. Intersection and sum of subspaces. Generating sets. Linear independence. Bases. Infinite-dimensional vector spaces.

3. Linear Transformations

Kernel and image of a linear transformation. Injective, surjective, and bijective linear transformations. Classification of finite-dimensional vector spaces by isomorphism.
Matrix representation of a linear transformation. Isomorphism theorem. Vector spaces of linear transformations. Linear forms and the dual vector space V*. Dual basis. Canonical isomorphism between V and (V*)*.

4. Rank and Equivalence of Matrices

Row and column rank of a matrix. Rank and equivalence of matrices.

5. Determinants

Definition and properties of the determinant of a matrix.

6. Diagonalization of Endomorphisms

Characteristic polynomial. Eigenvalues and eigenvectors of endomorphisms and matrices. Diagonalization.

7. Euclidean Vector Spaces

Bilinear forms. Scalar product. Norm and angle between vectors. Cauchy-Schwarz and triangle inequalities. Orthonormal bases. Gram-Schmidt method. Orthogonal complement.

8. Tensors

Multilinear forms. Covariant and contravariant tensors. Tensor product. Bases for Tqp(V). Tensor contraction. Symmetric and antisymmetric tensors.

9. Affine Space

Reference systems. Affine varieties. Equations of an affine variety. Intersection and sum of varieties. Relative position of affine varieties. Affine transformations.

10. Euclidean Affine Space

Orthogonality. Distance and angle between two varieties.

WORKLOAD

PRESENCIAL ACTIVITIES

Activity	Hours
Theory	60,00
Other activities	15,00
Classroom practices	45,00
Total hours	**120,00**

NON PRESENCIAL ACTIVITIES

Activity	Hours
Attendance at other activities	0,00
Individual or group project	0,00
Independent study and work	25,00
Preparation of lessons	105,00
Preparation for assessment activities	50,00
Resolution of case studies	0,00
Total hours	**180,00**

TEACHING METHODOLOGY

The theoretical in-person work will consist of attending the lectures given by the professor responsible for teaching the course.

The practical in-person work will consist of attending problem-solving classes in which, under the professor's guidance, the student will solve problems proposed by the professor, either individually or in groups.

Through such attendance, the necessary information to achieve the expected competency levels should be guaranteed.

Periodically, once the information for a basic objective has been completed, the professor will assign voluntary tasks for the student to complete individually, with a set deadline. The professor will not only grade these tasks but also assess the student's progress in using the specialized language of the subject.

EVALUATION

The grade obtained in the exam will count for 80% of the final grade. The seminar grade will count for 10%, and continuous assessment will count for 10%.

To pass, it is necessary to obtain a minimum grade of 4 out of 10 on the exam. There will be a midterm exam during the first exam call.

In the second exam call, the evaluation system will be the same. Participation and seminar grades will not be transferable to the second exam call.

REFERENCES

- Anton, H. (2003). Introducción al álgebra lineal. 3ª edición. México: Ed. Limusa.
- Burgos, J. (2006). Álgebra lineal y geometría cartesiana. 3ª edición. Madrid: Ed. McGraw-Hill.
- Castellet, M.- Llerena, I. (1991). Álgebra lineal y geometría. Barcelona: Ed. Reverté.
- Moretó, A. (2020). Un curso de Álgebra Lineal y Geometría I. https://alexmoqui.wordpress.com/2020/03/31/un-curso-de-algebra-lineal-y-geometria-i/
- Strang, G. (2006). Linear algebra and its applications. Belmont, CA: Ed. Thomson, Brooks/Cole

Additional Bibliography

- Andrilli, S. - Hecker, D. (1999). Elementary linear algebra. San Diego: Ed. Harcourt Brace Jovanovich.
- Burgos, J. (1977). Curso de álgebra y geometría. Madrid: Ed. Alhambra.
- Jacob, B. (1990). Linear algebra. New York: Ed. W. H. Freeman.
- Robinson, Derek J. S. (1991). A course in linear algebra with applications. Singapore: Ed. World Scientific.
- Spindler, K. (1994). Abstract algebra with applications (Volume I: Vector spaces and groups). New York: Ed. Marcel Dekker, Inc.