1. OVERVIEW

Subject area	Linear Algebra and Analytical Geometry
Degree	Bachelor's Degree in Physics
School/Faculty	Architecture, Engineering and Design
Year	First
ECTS	6 ECTS
Type	Core
Language(s)	Spanish
Delivery mode	On campus
Semester	First semester

2. INTRODUCTION

Linear Algebra and Analytical Geometry is a core 6 ECTS subject area in the first year of the Bachelor's Degree in Physics. It belongs to the subject Mathematical Methods in Physics.

Algebra provides the basic knowledge and tools needed for many of the subject areas on this degree programme. It develops elements associated with Mathematics, such as abstraction, critical perspective, the need for verification, evaluation of accuracy and the questioning of intuitive judgements. It allows us to study the theoretical and practical concepts of Linear Algebra, which are essential in subsequent subject areas that, for example, require the use of matrices and algebraic transformations. In addition, it promotes reasoning and the application of mathematical methodology in multiple aspects of professional training.

3. SKILLS AND LEARNING OUTCOMES

Key skills (CB, by the acronym in Spanish):

- CB3 - Students have the ability to gather and interpret relevant data (usually within their study area) to form opinions which include reflecting on relevant social, scientific or ethical matters.

Transversal skills (CT, by the acronym in Spanish):

- CT4 - Written communication/Oral communication: Ability to communicate and gather information, ideas, opinions and viewpoints in order to understand and be able to act upon them, whether they are through spoken word and gestures, or through written word and/or visual aids.
- CT5 - Problem solving: Be able to critically evaluate information, separate complex situations into their constituent parts, recognise patterns, and consider alternatives, different approaches and perspectives in order to find optimal solutions and negotiate efficiently.

Specific skills (CE, by the acronym in Spanish):

- CE04 - To understand the laws and principles of physics, to identify their logical and mathematical structure, their experimental basis and the phenomena described through them.
- CE05 - To understand and know how to use the mathematical and numerical methods used in physics and in handling experimental data.

Learning outcomes (RA, by the acronym in Spanish):

- To skilfully perform typical operations in matrix algebra and use Gaussian elimination to solve and discuss systems of linear equations or to determine the range of a matrix.
- To fluently apply concepts from matrix and vector algebra, such as vector space, linear dependence and independence, basis, subspace and dimension.
- To solve geometric plane and space problems that involve linear and/or affine transformations (isometries, translations).
- To master the concept of eigenvalues, eigenvectors and invariant subspace, and to know how to use the necessary tools to diagonalize an endomorphism.
- To understand the concept of scalar product in a vector space and its relationship with linear transformations (self-adjoint operators) and geometry problems.

The following table shows how the skills developed in the subject area match up with the intended learning outcomes:

Skills	Learning outcomes
CB3, CT4, CT5, CE04	To skilfully perform typical operations in matrix algebra and use Gaussian elimination to solve and discuss systems of linear equations or to determine the range of a matrix.
CB3, CT5, CE05, CE04	To fluently apply concepts from matrix and vector algebra, such as vector space, linear dependence and independence, basis, subspace and dimension
CB3, CT5, CE04	To solve geometric plane and space problems that involve linear and/or affine transformations (isometries, translations).
CB3, CT5, CE05, CE04	To master the concept of eigenvalues, eigenvectors and invariant subspace, and to know how to use the necessary tools to diagonalize an endomorphism.
CB3, CT5, CE05, CE04	To understand the concept of scalar product in a vector space and its relationship with linear transformations (self-adjoint operators) and geometry problems.

4. CONTENTS

This subject area will cover the following content:

1. Fundamentals of algebra: Algebraic structures. Matrices, classification and operations. Determinants and inverses.
2. Systems of linear equations.
3. Vector spaces. Linear transformations.
4. Scalar product. Pre-Hilbert spaces. Orthonormal systems.
5. Diagonalization of endomorphisms: eigenvalues and eigenvectors.

6. Affine space and analytic geometry.
7. Bilinear and quadratic forms. Introduction to conic sections.

5. TEACHING/LEARNING METHODS

The types of teaching/learning methods are as follows:

- Collaborative learning: Students learn to collaborate with other people (classmates and professors) in order to find creative, comprehensive and constructive solutions to questions and problems that arise from the given case studies, using all relevant knowledge and material resources available.
- Problem-based learning: Students are given problems and asked to solve them, working individually or in groups.
- Lectures: Presentations by the professor with the necessary technological tools to maximise comprehension of the learning content.
- Guided academic activities: Individual and group work that is more independent, including information searches, written summaries, debates and the public defence of projects.

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6. LEARNING ACTIVITIES

The types of learning activities, plus the amount of time spent on each activity, are as follows:

On campus:

Learning activity	Number of hours
Lectures	50
Oral presentations of projects and debates	6
Report writing	20
Assessment	6
Practical activities (problems, written work, projects, workshops and/or lab work)	20
Tutorials	16
Independent working	32h
TOTAL	**150**

7. ASSESSMENT

The assessment systems, plus their weighting in the final grade for the subject area, are as follows:

On campus:

Assessment system	Weighting
Individual on-campus knowledge tests (theory and/or practice).	50%
Submission of group and/or individual reports, written work, projects or exercises	30%
Oral defence	10%
Performance observation	10%

On the Virtual Campus, when you open the subject area, you'll find details of your assessable tasks, including the submission dates and assessment procedures for each task. All work needs to be submitted on time and in the correct format. Both self-assessed tasks and peer assessment may be included.

8. BIBLIOGRAPHY

The recommended reading for the subject area is listed below. All publications are available in the Dulce Chacón University Library for reference or loan.

- C.D. Meyer. Matrix Analysis and Applied Linear Algebra. SIAM. 2000
- D.C. Lay. Álgebra lineal y sus aplicaciones. Pearson. 2007
- G. Strang. Introducción al Álgebra lineal. Cambridge. 2016
- S.A. García and R.A. Horn. A second course in linear algebra. Cambridge. 2017

Supplementary bibliography

- B. Noble and J.W. Daniel. Applied Linear Algebra. Prentice Hall. 1988
- R.A. Horn and C.R. Johnson. Matrix Analysis, 2nd edition. Cambridge. 2013

Other resources

- We recommend watching the videos on the AulaUE YouTube channel: https://www.youtube.com/user/AulaUE