# COURSE DATA

| Data Subject | |
|---|---|
| **Code** | 34237 |
| **Name** | Algebra and geometry II |
| **Cycle** | Grade |
| **ECTS Credits** | 6.0 |
| **Academic year** | 2024 - 2025 |

**Study (s)**

| Degree | Center | Acad. year | Period |
|---|---|---|---|
| 1105 - Degree in Physics | Faculty of Physics | 1 | Second term |
| 1929 - Double Degree Program in Physics and Chemistry | Double Degree Program Physics and Chemistry | 1 | Second term |

**Subject-matter**

| Degree | Subject-matter | Character |
|---|---|---|
| 1105 - Degree in Physics | 2 - Mathematics | Basic Training |
| 1929 - Double Degree Program in Physics and Chemistry | 1 - Primer Curso (Obligatorio) | Obligatory |

**Coordination**

| Name | Department |
|---|---|
| MARTI PUIG, JOSE MARIA | 16 - Astronomy and Astrophysics |
| PERUCHO PLA, MANEL | 16 - Astronomy and Astrophysics |

# SUMMARY

**Objectives**:
To acquire basic knowledge of mathematics in the area of algebra and geometry, essential for studies in Physics.

**Descriptor of the subject in the curriculum (Algebra and Geometry I and II):**

Complex numbers. Algebraic structures. Vector spaces. Matrices and determinants. Systems of linear equations. Linear operators. Diagonalization. Euclidean geometry. Tensors.

**Relationship with other materials prior, concurrent and future:** instrumental course, a primary to study physics in any of their specialities. Complementary to other subjects of Mathematics and Mathematical Methods.

## PREVIOUS KNOWLEDGE

### Relationship to other subjects of the same degree

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

### Other requirements

Secondary school Mathematics:
Vector spaces. Matrices. Determinants. Linear equation systems. Vectors. Geometry. Metric problems. Successions and numerical series. Function limits. Continuity. Derivatives. Taylor developments. Integration.

## COMPETENCES (RD 1393/2007) // LEARNING OUTCOMES (RD 822/2021)

### 1105 - Degree in Physics

- To know how to apply the knowledge acquired to professional activity, to know how to solve problems and develop and defend arguments, relying on this knowledge.
- Be able to understand and master the use of the most commonly used mathematical and numerical methods.
- Modelling & Problem solving skills: be able to identify the essentials of a process / situation and to set up a working model of the same; be able to perform the required approximations so as to reduce a problem to an approachable one. Critical thinking to construct physical models.
- Foreign Language skills: Have improved command of English (or other foreign languages of interest) through: use of the basic literature, written and oral communication (scientific and technical English), participation in courses, study abroad via exchange programmes, and recognition of credits at foreign universities or research centres.
- Communication Skills (written and oral): Being able to communicate information, ideas, problems and solutions through argumentation and reasoning which are characteristic of the scientific activity, using basic concepts and tools of physics.
- Students must have acquired knowledge and understanding in a specific field of study, on the basis of general secondary education and at a level that includes mainly knowledge drawn from advanced textbooks, but also some cutting-edge knowledge in their field of study.

- Students must be able to apply their knowledge to their work or vocation in a professional manner and have acquired the competences required for the preparation and defence of arguments and for problem solving in their field of study.
- Students must have the ability to gather and interpret relevant data (usually in their field of study) to make judgements that take relevant social, scientific or ethical issues into consideration.
- Students must be able to communicate information, ideas, problems and solutions to both expert and lay audiences.
- Students must have developed the learning skills needed to undertake further study with a high degree of autonomy.

## LEARNING OUTCOMES (RD 1393/2007) // NO CONTENT (RD 822/2021)

-Linear equation systems.
-Eigenvalues and eigenvectors of linear operators.
-Introduction to euclidean vector spaces. Vector spaces with scalar product.
-Changes of coordinate systems in the affine space. Basic ideas on rotation and reflection.
-Dual spaces. Multilinear applications. Tensor algebra.
-Linear equation systems.

## DESCRIPTION OF CONTENTS

### 1. Matrices, determinants and linear equations

Matrix NxM (definition and operations; transposed and adjoint). Determinant of a matrix (definition and calculation, properties). Inverse of a matrix (definition and calculation. Range of a matrix). Resolution of linear equations (Cramers rule).

### 2. Linear operators

Linear operators. Matrix of a linear operator. Adjoint operator (matrix representation). Normal operators (self-adjoint and unitary operators, change of base). Projector representation.

### 3. Spectral theory

Eigenvalues and eigenvectors. Eigenvalues and eigenvectors of normal operators (self-adjoint and unitary operators). Diagonalization of an operator (Change of base. Function of an operator). Spectral decomposition of a normal operator.

### 4. Tensors. Algebraic theory

Dual space. Multilinear applications. Covariant and contravariant tensors. Change of base formula. Symmetric and antisymmetric tensors.

### 5. Affine space

Affine space (introduction, Cartesian coordinates). Change of reference in the affine space. Orthogonal transformations in the affine space (rotations and reflections in two and three dimensions). Curvilinear coordinate systems (polar coordinates, cylindrical and spherical coordinates).

### 6. Spatial analytic geometry

Position problems and metric problems in the three-dimensional space (definition of lines and planes, use of vectors to find distances and angles). Introduction to quadratic forms.

## WORKLOAD

| ACTIVITY | Hours | % To be attended |
|---|---|---|
| Theory classes | 45,00 | 100 |
| Tutorials | 15,00 | 100 |
| Development of individual work | 15,00 | 0 |
| Study and independent work | 65,00 | 0 |
| Preparation of evaluation activities | 10,00 | 0 |
| **TOTAL** | **150,00** | |

## TEACHING METHODOLOGY

**Contact teaching (40%)**

Theoretical and practical classes: It addresses the conceptual and formal matter and resolution of problems or cases as the application of theoretical concepts. They are based on lectures and mainly the use of dialogued teaching tools as graphical representation of solutions, design presentations, etc.

Group tutoring sessions in small working groups, focused on active student participation: dealing with doubts in theoretical concepts and problem solving, reinforcement in areas of greatest difficulty, conceptual questionnaires, experimental demonstrations relevant to studied cases, and associated with an ongoing evaluation and monitoring the student’s progress in the field.

**Student's Personal work (60%):**

- Study of the theoretical concepts.

- Resolution of exercises and problems, individually and in groups.

-Individual tutorials: questions addressed to the teacher on difficulties encountered in the study and resolution of problems or discussion on topics of interest, bibliography, etc.

## EVALUATION

The assessment system is as follows:

1) Written examinations: One part will assess the understanding of the theoretical-conceptual and formal nature of the subject, both through theoretical questions, conceptual questions and numerical or simple particular cases. Another part will assess the applicability of the formalism, by solving problems and critical capacity regarding the results. Proper argumentations and adequate justifications will be important in both cases. The minimum mark to be got in each of the parts to pass the course is 3/10.

2) Continuous assessment: assessment of exercises and problems presented by students, questions proposed and discussed in class, oral presentation of problems solved or any other method that involves an interaction with students.

3) The final mark will be the maximum of the examination mark and the examination mark weighted with the mark of the continuous assessment, with a 30% weight for the continuous assesment (and 70% for the exam).

COMMENTS: Subject to compliance with the compensation criteria established for this purpose, note this course can be averaged with others belonging to the same matter, so as to pass the course.

## REFERENCES

### Basic

- K. F. Riley, M. P. Hobson, S. J. Bence, Mathematical Methods for Physicist and Engineering. Cambridge University Press (1998).
- D. J. E. Puertas, P. M. Marqués, Matemática Universitaria. Álgebra. Bello (1973).
- Riley,K.F., Hobson, M. P, Student solutions manual for mathematical methods for physics and engineering. Cambridge University Press (2003).
- J. J. Ferrando, J. M. Martí, M. Perucho, S. Planelles, Àlgebra i Geometria, Publicacions Universitat de València, 2024.

## Additional

- F. Granero, Álgebra y geometría Analítica. McGraw Hill (1985).
- J. De Burgos, Curso de Álgebra y Geometría. Alhambra S.A. (1976).
- G. Strang, Introduction to linear algebra. Wellesley-Cambridge Press (1993).
- A. G. Kurosch, Curso de álgebra superior. Mir (1977).