UAB
Universitat Autònoma de Barcelona

# Algebra

Code: 107597
ECTS Credits: 6

2025/2026

| Degree | Type | Year |
|---|---|---|
| Physics | FB | 1 |

## Contact

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## Teachers

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## Teaching groups languages

You can view this information at the end of this document.

## Prerequisites

Although this subject does not have specific prerequisites, it is advisable to have achieved the contents of the baccalaureate, especially the systems of linear equations and matrices.

## Objectives and Contextualisation

This subject is dedicated to basic aspects of Linear Algebra of the Degree in Physics. The main objective of the subject is to provide the student with some algebraic tools necessary to understand the rest of the subjects of the degree. Another objective, no less important than the previous one, is to train the student in deductive thinking, so that he is later able to learn to use other mathematical tools not explicitly taught in the degree.

## Learning Outcomes

1. CM09 (Competence) Justify the use of calculus in one and several variables and differential equations in the resolution of general problems.
2. CM10 (Competence) Adapt the basic mathematical strategy when approaching a given problem from an analytical point of view.
3. KM09 (Knowledge) Identify the basic concepts of limits, continuity, derivatives and integrals, vector and subspace space, linear and scalar product and the methodology of matrix diagonalisation.

4. KM09 (Knowledge) Identify the basic concepts of limits, continuity, derivatives and integrals, vector and subspace space, linear and scalar product and the methodology of matrix diagonalisation.
5. KM12 (Knowledge) Describe a linear operator and eigenvalue theorems.
6. SM07 (Skill) Apply the mathematical knowledge acquired to the resolution of mathematical and physical problems with mathematical representation.

## Content

1. Vector spaces: Definitions, linear combination, subspaces, bases, dimension, coordinates, base change.

2. Linear applications: Definitions, kernel and image, matrix of a linear application, change of bases.

3. Diagonalization: Vectors and eigenvalues of an endomorphism, characteristic polynomial, diagonalization criteria.

4. Bilinear forms: Definitions, orthogonality, orthonormal bases, scalar product.

5. Multilinear Algebra: Dual space and tensors.

## Activities and Methodology

| Title | Hours | ECTS | Learning Outcomes |
|---|---|---|---|
| Type: Directed | | | |
| Lectures | 28 | 1.12 | CM10, KM09, KM12, SM07, CM10 |
| Problem sessions | 14 | 0.56 | KM09, SM07, KM09 |
| Seminars | 8 | 0.32 | CM10, KM09, SM07, CM10 |
| Type: Autonomous | | | |
| Prepare exercises to deliver | 8 | 0.32 | KM09, SM07, KM09 |
| Problem solving | 42 | 1.68 | CM09, CM10, KM09, SM07, CM09 |
| Studying theory of the course | 40 | 1.6 | KM09, KM12, KM09 |

There will be two hours a week of lectures, one hour a week of problems sessions, and 4 seminar sessions. Nevertheless, as in every mathematics course, what is most needed to reach the necessary level is the personal work and effort of the student. The course has been designed with this idea in mind.

During the lectures, the professor will explain and develop the contents of the course. These set the pace of the course and all other activities revolve around the contents explained in the lectures. In order to tackle the problems it is needed to know the definitions introduced in the lectures, and the statements of results, but it is also needed to understand the proofs, as similar techniques are used in solving the problems. Students must ask about all doubts they may have, both during lectures and in office hours. Special attention will be given to the correct and precise use of mathematical language. It is recommended to consult the references suggested as bibliography to complete the material covered and see different points of view.

During problem sessions, the resolution of problems proposed periodically will be explained. These problems are given in lists based on the material covered in the lectures and guide the student to develop and apply the

results and ideas seen in them. It is most important that the student tries hard to solve the problems before attending the problem sessions, to compare their ideas with peers and with the professors'.

Seminars are a complement of lectures and problem sessions. During each seminar session a list of exercises will be proposed, to develop some idea or technique of the course in depth. In the classroom the students will work in small groups on the exercises, checking with the lecturer as much as needed, and discussing in group possible strategies. The lecturer will explain the most significant aspects of the solutions. In all activities of the course the participation of students is essential, but in the case of seminars the session is structured around students' inputs, so it is of the greatest importance that they study the material given in the lectures before each seminar.

Along the course, exercises will be proposed that the students have to complete and hand in.

All professors and lecturers will have office hours to answers students' questions.

The course also has a webpage in the Campus Virtual of the UAB where exercise lists will be available, alongside all material deemed relevant.

Annotation: Within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

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## Assessment

## Continous Assessment Activities

| Title | Weighting | Hours | ECTS | Learning Outcomes |
|---|---|---|---|---|
| Delivery of exercises | 15% | 1 | 0.04 | KM09, SM07 |
| Final exam | 45% | 3 | 0.12 | CM10, KM09, KM12, SM07 |
| Mid-term exam | 40% | 3 | 0.12 | CM10, KM12, SM07 |
| Second-chance exam | 85% | 3 | 0.12 | CM09, CM10, KM09, KM12, SM07 |

This subject will be evaluated through two exams (one partial and one final), delivery of exercises to the seminar and delivery of problems proposed by the teaching staff that will be announced conveniently through the Virtual Campus. The grades of these activities will give rise to a final grade that will be obtained by adding:

40% of the grade of the partial P1,
45% of the final grade P2 and
15% of the mark of exercises in seminars (10%) and written problems (5%).

That is,
Final Note 0.15E + 0.4P1 + 0.45P2

In order to pass the subject, it will be necessary to obtain a final grade of more than 5 and it will be necessary to have a grade of the mid-term exam greater than 3 (out of 10) and a grade of the final exam greater than 3 (out of 10).

In the event that the student does not pass the subject with the previous evaluations, or wants to improve the grade (renounce to the one already obtained), he/she may take the recovery exam in which the entire subject will be evaluated. It will have a weight of 85%. The part of the deliveries is not recoverable.

After the final exam, honors that professors find clear will be awarded. These grades will now be final. If the maximum number of honors allowed has not been reached, the possibility of granting more will be reconsidered after the recovery exam.

A student will be considered not presented if it is not presented in any of the tests.

The dates of the different evaluation tests or the deadlines for the delivery of problems will be announced conveniently.

Single assessment

Students who have taken the single assessment modality must take a final test that will consist of an exam of the entire course of theory and problems, with the possibility of a personal interview with the teachers.These tests will be carried out on the same day, time and place as the tests of the final exam of the continuous evaluation modality.

If the final grade does not reach 5, the student has another opportunity to pass the subject through the recovery exam that will be held on the date established by the coordination of the degree. In this test, 100% of the grade of the subject can be recovered. These tests will be carried out on the same day, time and place as the tests of the recovery exam of the continuous evaluation modality.

## Bibliography

The contents of the course are covered, in part or totally, in many basic texts of Linear Algebra. The library of the Faculty of Sciences has an exceptional bibliographic collection of Mathematics, so it is highly recommended that you use these resources, either to search for other reference books or to deepen and expand knowledge. The references cited below are, therefore, only indicative.

S. Axler, *Linear Algebra Done Right*, 3rd ed, Springer, 201

O. Bretscher, *Linear Algebra with Applications*. Pearson, 2013.

F. Cedó, A. Reventós. *Geometria plana i àlgebra lineal.* Manuals de la UAB, Servei de Publicacions de la UAB, Bellaterra, 2004.

R. Camps, E. Nart, G. Solanes i X. Xarles. *Apunts d'Àlgebra Lineal i Multilineal.*

M. Masdeu i A. Ruíz, *Apunts d'Àlgebra Lineal.*

W. Greub, *Linear Algebra*, Springer 1975.

J. Hefferon, *Linear Algebra*. Accessible online a: http://joshua.smcvt.edu/linearalgebra/

A. Kostrikin, Y. Manin. *Linear algebra and Geometry.* Gordon and Breach Science Publishers, Amsterdam 1989. (Segona edició: 1997.)

L. Merino, E. Santos. *Álgebra lineal con métodos elementales.* Ed. Thomson, Madrid, 2006.

F. Pablos Romo. Álgebra lineal y geometría. Volumen I: Álgebra lineal básica, geometría afín y geometría euclídea. Ed. Aula Magna. McGraw-Hill.

F. Pablos Romo. Álgebra lineal y geometría. Volumen II: Álgebra Lineal Avanzada. Ed. Aula Magna 2025. McGraw-Hill.

G. Strang, *Linear algebra and its applications*.4th ed, Thomson, 2006

Exercise books:

F. Cedó i V. Gisin. *Àlgebra bàsica.* Manuals de la UAB, Servei de Publicacions de la UAB, Bellaterra, 1997.

J. Rojo e I. Martín. *Ejercicios y problemas de Álgebra lineal.* Mc. Graw-Hill, Madrid, 1994.

## Software

SAGE or other algebraic manipulators can be very useful to students to check their calculations and work with dimensions higher than 3 or 4.

## Groups and Languages

Please note that this information is provisional until 30 November 2025. You can check it through this link. To consult the language you will need to enter the CODE of the subject.

| Name | Group | Language | Semester | Turn |
|---|---|---|---|---|
| (PAUL) Classroom practices | 1 | Catalan | first semester | morning-mixed |
| (PAUL) Classroom practices | 2 | Catalan | first semester | morning-mixed |
| (SEM) Seminars | 11 | Catalan | first semester | morning-mixed |
| (SEM) Seminars | 12 | Catalan | first semester | morning-mixed |
| (SEM) Seminars | 21 | Catalan | first semester | morning-mixed |
| (SEM) Seminars | 22 | Catalan | first semester | morning-mixed |
| (TE) Theory | 1 | Catalan | first semester | morning-mixed |
| (TE) Theory | 2 | Catalan | first semester | morning-mixed |