

## Linear Algebra I

Code: 107838  
ECTS Credits: 6

**2025/2026**

Degree	Type	Year
Mathematics	FB	1

### Contact

Name: Joaquim Roé Vellvé  
Email: joaquim.roe@uab.cat

### Teaching groups languages

You can view this information at the [end](#) of this document.

### Prerequisites

Even though the course is mostly self-contained, every student should be familiar with the solution of systems of linear equations, basic arithmetic of numbers and polynomials, and be capable to correctly manipulate symbolic algebraic expressions.

### Objectives and Contextualisation

The goals are twofold: to get basic mathematic training, and skills and knowledge in Linear Algebra. The student should be able to understand and use correctly mathematical language, grasp the need of proofs, and develop a critical eye for mathematical claims. The tools and concepts of Linear Algebra studied in the course are used not just in all areas of Mathematics but also in most sciences and technological studies.

### Learning Outcomes

1. CM01 (Competence) Write elementary proofs in the field of algebra and analysis in an orderly and precise manner.
2. CM02 (Competence) Develop autonomous strategies for solving basic mathematical problems.
3. KM01 (Knowledge) Identify the basics of linear algebra and single-variable analysis.
4. KM04 (Knowledge) Describe the procedure for solving systems of linear equations in several variables.
5. SM01 (Skill) Apply the rules of algebra and single-variable analysis to the classification of applications according to various criteria (rank, determinant, Jordan forms, existence of maxima and minima, asymptotes).
6. SM02 (Skill) Apply the basics of linear algebra and analysis to a variable to solve mathematical problems.
7. SM03 (Skill) Relate the concepts of linear algebra to those of single-variable analysis (linearity of differential and integral operators or continuity of matrix operations, etc.).

### Content

1. Matrices
  1. Systems of linear equations
  2. Matrices and their operations
  3. Invertible matrices
3. Linear dependence
  1. Linear combinations and dependence
  2. Rank of a matrix
  3. PAQ-reduction
  4. Rouché's theorem
  5. Determinant
5. Vector spaces
  1. Commutative group, field, vector space
  2. Vector subspace
  3. Basis and dimension
  4. Grassmann's formula
7. Linear maps
  1. Definition and first properties
  2. Kernel and image
  3. Quotient space and isomorphism theorems

## Activities and Methodology

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Lecture	30	1.2	CM01, KM01, KM04, SM01, SM03, CM01
Problem sessions	14	0.56	CM01, CM02, KM04, SM01, SM02, CM01
Type: Supervised			
Seminars	6	0.24	CM01, CM02, KM04, SM01, SM02, CM01
Type: Autonomous			
Preparing written exercises to hand in	3	0.12	
Problem solving	60	2.4	CM01, CM02, KM04, SM01, SM02, CM01
Studying theory of the course	30	1.2	CM01, KM01, SM03, CM01

This course includes two weekly hours of lectures, one weekly hour of problem-solving sessions, and three seminar sessions. However, as in all Mathematics courses, achieving a solid understanding primarily depends on the student's personal work and effort, and the course methodology has been designed with this in mind.

In the lectures, the professor will present and develop the course content. These lectures set the pace for the entire course; the rest of the activities are organized around them.

Understanding the notions introduced in the lectures, the statements of the theorems, and their applications is essential in order to tackle the problems. However, it is also crucial to understand the proofs of the theorems and propositions in order to deepen comprehension of the concepts and to solve problems using similar techniques.

During the lectures or in office hours, students are encouraged to ask any questions they may have. Special attention will be paid to the use of language and terminology to guide students in using proper mathematical language and to highlight the precision required in formal writing. Students are encouraged to consult the recommended bibliography to supplement the classroom explanations and to explore alternative approaches. Specific comments and suggestions will be made throughout the course.

There will be a one-hour weekly problem-solving session in which the problems from the lists distributed periodically will be explained.

These problems are based on the lecture content and are intended to help students develop and apply the results and ideas from the lectures-sometimes in an abstract setting, and sometimes through concrete examples.

It is extremely important that students engage thoroughly with the problems beforehand, preparing the exercises prior to class so that they can compare their approaches with those of classmates and the instructor.

The seminars both complete and complement the lecture and problem-solving sessions.

Each seminar session will propose a list of exercises focused on exploring a particular technique or idea from the course in depth, or on allowing students to experiment with a concept that has been or is about to be introduced in the lectures.

Each seminar list will specify the key objectives that students are expected to achieve by working through the problems.

During seminars, students will work in groups on the problem list, asking the professor for help as needed and discussing possible strategies for approaching the problems.

At the end, the professor will explain the solutions to the most representative problems from the list.

Student participation is essential in all course activities, but in the seminars it is especially important, as the sessions are structured around student contributions.

Since solving the exercises requires familiarity with some theoretical content, students are expected to study the relevant material in advance to make the most of the seminar sessions.

In addition to all this, students have access to office hours with the professors in charge of the lectures, problem classes, and seminars, where they can ask questions and seek help with their work.

The course also has a page on the Virtual Campus, where problem and seminar lists, additional materials, and all relevant course information will be posted.

Note: 15 minutes of one class session, within the schedule established by the department/program, will be reserved for students to complete surveys evaluating the teaching performance and the course/module itself.

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.

## Assessment

### Continuous Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Problem exams	25% + 35%	5	0.2	CM02, KM04, SM01, SM02
Theory exams	25%	1	0.04	CM01, KM01, SM03
Written assignments	15%	1	0.04	CM01, CM02, KM01, KM04, SM01, SM02

15% of the final grade corresponds to the submission of problems associated with the seminar sessions.

The remaining grade is based on exams taken throughout the course, broken down as follows: 25% for the mid-semester exam, 35% for the end-of-semester exam, and 25% for the theory component. The theory will be assessed partly during the mid-semester exam and partly through an interview (oral exam).

The course is considered passed if the student obtains, according to the weighting described, a final grade equal to or higher than 5 out of 10, provided that they also obtain at least 3.5 out of 10 in both the theory and the end-of-semester exam.

After the final exam, students will have the opportunity to take a resit exam, where they may recover or improve the part of the assessment corresponding to the problem-solving exams. This resit exam will count for 60% of the final grade. If the student has not achieved a 3.5 in the theory component, they will be given the chance to retake the oral exam. The 15% corresponding to the problem submissions cannot be recovered.

After the final exam, clear cases of "matrícula de honor" (highest distinction) will be awarded. These will be final. If the maximum number of such distinctions allowed has not been reached, the possibility of awarding more will be reconsidered after the resit exam.

A student will be considered not assessable if they have participated in assessment activities corresponding to less than 50% of the final grade, according to the established weighting.

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#### Single assessment:

Students who choose the single assessment option will take one final exam covering both the theory and problem-solving components of the course. On the day of the exam, they must also submit a dossier containing the various assignments given during the course.

The exam will count for 85% of the final grade, and the remaining 15% will be based on the contents of the submitted dossier.

The exam will take place on the same day as the second partial exam of the course. The same resit policy as for the continuous assessment will apply.

## Bibliography

1. S. Axler, Linear Algebra Done Right, 3rd ed, Springer, 2015
2. M. Castellet, I. Llerena. Àlgebra lineal i geometria. Manuals de la UAB, Servei de Publicacions de la UAB, Bellaterra, 1988.
3. F. Cedó, A. Reventós. Geometria plana i àlgebra lineal. Manuals de la UAB, Servei de Publicacions de la UAB, Bellaterra, 2004.
4. W. Greub, Linear Algebra, Springer 1975.
5. J. Hefferon, Linear Algebra. Accessible online at: <http://joshua.smcvt.edu/linearalgebra/>
6. M. Masdeu i A. Ruiz, Apunts d'Àlgebra Lineal. Accessible online at <https://mmasdeu.github.io/algebraalineal/>
7. G. Strang, Linear algebra and its applications. 4th ed, Thomson, 2006

## Software

When appropriate, we might use the software Sagemath (freely available from <https://www.sagemath.org/>).

## 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	1	Catalan	first semester	morning-mixed
(SEM) Seminars	2	Catalan	first semester	morning-mixed
(SEM) Seminars	3	Catalan	first semester	morning-mixed
(SEM) Seminars	4	Catalan	first semester	morning-mixed
(TE) Theory	1	Catalan	first semester	morning-mixed