Universitat Autònoma de Barcelona

2020/2021

Linear algebra

Code: 100088
ECTS Credits: 12

Degree	Type	Year	Semester
2500149 Mathematics	FB	1	A

The proposed teaching and assessment methodology that appear in the guide may be subject to changes as a result of the restrictions to face-to-face class attendance imposed by the health authorities.

Contact

Name: Joaquim Roe Vellve
Email: Joaquim.Roe@uab.cat

Use of Languages

Principal working language: catalan (cat)
Some groups entirely in English: No
Some groups entirely in Catalan: Yes
Some groups entirely in Spanish: No

Other comments on languages

This document is a translation of the Catalan original. In case of inaccuracies or errors, the Catalan version is the valid, official, guide for the course.

Teachers

Francesc Mañosas Capellades
Albert Ruíz Cirera
Joaquim Roe Vellve
Marc Masdeu Sabate
Guillermo Carrión Santiago
Francesc Bars Cortina

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 some ability with manipulation of symbolic algebraic expressions.

Objectives and Contextualisation

The goals are twofold: to get basic mathematic traninig, 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 critial 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.

Competences

- Actively demonstrate high concern for quality when defending or presenting the conclusions of ones work.
- Apply critical spirit and thoroughness to validate or reject both ones own arguments and those of others.
- Assimilate the definition of new mathematical objects, relate them with other contents and deduce their properties.
- Calculate and reproduce certain mathematical routines and processes with agility.
- Formulate hypotheses and devise strategies to confirm or reject them.
- Students must be capable of applying their knowledge to their work or vocation in a professional way and they should have building arguments and problem resolution skills within their area of study.
- Students must have and understand knowledge of an area of study built on the basis of general secondary education, and while it relies on some advanced textbooks it also includes some aspects coming from the forefront of its field of study.
- Understand and use mathematical language.

Learning Outcomes

1. Actively demonstrate high concern for quality when defending or presenting the conclusions of ones work.
2. Apply critical spirit and thoroughness to validate or reject both ones own arguments and those of others.
3. Assimilate the mathematical concepts and objects of the subject as described in its contents.
4. Calculate orthogonal bases and orthogonal projections.
5. Classify matrixes and linear applications by different criteria (range, forms, diagonal and Jordan).
6. Contrast, if possible, the use of calculus with the use of abstraction in order to solve a problem. Evaluate the advantages and disadvantages of the two methods.
7. Demonstrate knowledge and application of the basic concepts of linear algebra, as described in the subject contents.
8. Develop autonomous strategies for problem-solving such as identifying the field of course-related problems, discriminating routine problems from non-routine ones, designing an a priori strategy to solve a problem, evaluating a strategy and modifying it if necessary and in the context of a specific problem translate theoretical results that could be useful for resolving it.
9. Draft short, orderly and accurate mathematical texts (exercises, resolution of theoretical questions, etc.)
10. Follow and understand an oral explanation of a mathematical subject related with the course.
11. Know how to explain ideas and concepts from the course, and know how to communicate ones own reasoning to third parties.
12. Read and understand course level mathematical texts.
13. Relate these concepts with the methods and objects of other fields.
14. Resolve and discuss systems of linear equations. Calculate matrix determinants and decompositions.
15. Students must be capable of applying their knowledge to their work or vocation in a professional way and they should have building arguments and problem resolution skills within their area of study.
16. Students must have and understand knowledge of an area of study built on the basis of general secondary education, and while it relies on some advanced textbooks it also includes some aspects coming from the forefront of its field of study.
17. Work with different finite-dimensional vector spaces.

Content

I. Matrices

II. Vector spaces

III. Linear maps

IV. Classification of endomorphisms

V. Symmetric bilinear forms

Methodology

There will be two hours a week of lectures, one hour a week of problems sessions, and 8 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. There will be an interview relative to the given exercises. Each student will keep a copy to prepare the interview.

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.

Restrictions imposed by the authorities to deal with the Covid-19 pandemic may affect the methodology and the number of hours devoted to each activity.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Lectures	54	2.16	6, 1, 7, 9, 13, 11, 17
Problem sessions	27	1.08	4, 5, 6, 7, 14, 17
Seminars	16	0.64	4, 5, 6, 7, 9, 14, 11, 17
Type: Autonomous			
Preparing for interviews	4	0.16	4, 5, 1, 7, 14, 11, 17
Preparing written exercises to hand in	8	0.32	4, 5, 7, 9, 14, 17
Problem solving	118	4.72	4, 5, 6, 7, 14, 17
Studying theory of the course	56	2.24	6, 7, 17

Assessment

The course lasts for the whole academic year, and it results in a single grade, determined at the end, in July.

20% of the grade corresponds to submitted exercises and the interviews corresponding to them. The rest of the grade corresponds to exams done throughout the year, with 10% for each midterm exam, 25% for the exam at the end of the first semester, and 35% for the exam at the end of the second semester.

The course is passed if, according to the fixed weights, the grade is equal to or larger than 5, with the requirement that the grade obtained in the exam at the end of the second semester is at least 3.

After this exam there will be a second-chance final exam, in which it is possible to improve the part of the grade corresponding to exams. Thus, this (non-mandatory) exam will account for 80% of the grade, and the remaining 20% will still correspond to the submitted exercises and interviews (which have no second-chance).

A student who does not take part in assessment activities corresponding to at least 50% of the grade will not be evaluated.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Final exam	70%	4	0.16	3, 4, 5, 6, 1, 7, 8, 16, 15, 9, 13, 14, 17
Parcial exam, first semester	25%	4	0.16	6, 1, 7, 9, 13, 14, 11, 17
Parcial exam, second semester	35%	4	0.16	4, 5, 6, 1, 7, 8, 16, 15, 9, 13, 14, 11, 17
Two mid-term exams	10% each one	4	0.16	5, 6, 1, 7, 9, 14, 11, 17
Written exercises and interviews	20%	1	0.04	2, 5, 6, 1, 7, 12, 9, 14, 11, 10, 17

Bibliography

The contents of the course are covered, totally or in part, in many basic texts on Linear Algebra. You will find an exceptional variety of such books in the library of the Facultat de Ciències. We strongly recommend to use the opportunity to look there for additional resources. Therefore, the references below are only suggestions to start.

S. Axler, *Linear Algebra Done Right*, 3rd ed, Springer, 2015

M. Castellet, I. Llerena. *Àlgebra lineal i geometria.* Manuals de la UAB, Servei de Publicacions de la UAB, no.1, Bellaterra, 1988 (versió castellana per Ed. Reverté, Barcelona, 1991).

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

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.

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

Problem 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.