Universitat Autònoma de Barcelona

2019/2020

Linear Algebra

Code: 104381
ECTS Credits: 6

Degree	Type	Year	Semester
2503740 Computational Mathematics and Data Analytics	FB	1	1

Contact

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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

Teachers

Marc Masdeu Sabate

Prerequisites

Although the course is essentially self-contained, the student will be required to know how to solve systems of linear equations, the basic arithmetic of numbers and polynomials, and how to perform algebraic manipulations.

Objectives and Contextualisation

In order to acquire a proper mathematical training, it is essential to understand linear algebra in depth. One needs to learn how to manipulate the objects introduced in such a class and to interpret their meanings. The tools provided in this course are essential not only in all branches of Mathematics, but also in most Sciences and Engineering studies.

Among the many goals we underline the following: to understand and correctly use mathematical language, to appreciate the need for proofs, and to develop a critical approach to mathematical statements.

As more specific goals: the student will learn to manipulate matrices as a basic tool to analyze systems of linear equations, to formalize the necessary language in order to understand the concepts of vector space and linear map, as well as to manipulate bilinear forms. All of this will be reinforced with the introduction of the appropriate software.

Competences

- Apply a critical spirit and rigour for the validation or rejection of your own arguments and those of others.
- Calculate and reproduce certain mathematical routines and processes with ease.
- Demonstrate a high capacity for abstraction and translation of phenomena and behaviors to mathematical formulations.
- Formulate hypotheses and think up strategies to confirm or refute them.
- Make effective use of bibliographical resources and electronic resources to obtain information.

- Relate new mathematical objects with other known objects and deduce their properties.
- Students must be capable of collecting and interpreting relevant data (usually within their area of study) in order to make statements that reflect social, scientific or ethical relevant issues.
- Students must be capable of communicating information, ideas, problems and solutions to both specialised and non-specialised audiences.
- 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.
- Using criteria of quality, critically evaluate the work carried out.
- Work cooperatively in a multidisciplinary context assuming and respecting the role of the different members of the team.

Learning Outcomes

1. "Explain ideas and mathematical concepts pertinent to the course; additionally, communicate personal reasonings to third parties."
2. Apply a critical spirit and rigour for the validation or rejection of your own arguments and those of others.
3. Calculate determinants and decompositions for matrices.
4. Calculate orthonormal bases and projections.
5. Contrast, if possible, the use of calculation with the use of abstraction in solving a problem.
6. Describe the concepts and mathematical objects pertaining to the subject.
7. Develop autonomous strategies for solving problems such as identifying the ambit of problems within the course, discriminate routine from non-routine problems, design an a priori strategy to solve a problem, evaluate this strategy.
8. Evaluate the advantages and disadvantages of using calculation and abstraction.
9. Identify the essential ideas in the demonstration of ceratin basic theorems and know how to adapt these to obtain other results.
10. In an orderly and accurately manner, draft brief mathematical texts (exercises, resolution of theoretical questions, etc.).
11. Make effective use of bibliographical resources and electronic resources to obtain information.
12. Read and understand a mathematical text at the current level of the course.
13. Solve and discuss systems of linear equations.
14. Students must be capable of collecting and interpreting relevant data (usually within their area of study) in order to make statements that reflect social, scientific or ethical relevant issues.
15. Students must be capable of communicating information, ideas, problems and solutions to both specialised and non-specialised audiences.
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. Using criteria of quality, critically evaluate the work carried out.
18. Work cooperatively in a multidisciplinary context, taking on and respecting the role of the distinct members in the team.
19. Work with different bases of finite-dimension vector spaces.

Content

The course is structured in 4 parts: a first, more computational one, where the emphasis is put in the algebraic manipulation of matrices, introducing their basic operations. In the second part the concepts of abstract vector space and linear map are formalized, as well as their relation with the contents of the first block. The third and fourth parts are devoted to more advanced concepts that build on the structure of vector space and linear map.

Parts

1. Matrices and linear equations
2. Vector spaces and linear maps
3. Diagonalization

4. Orthogonality and quadratic forms

Methodology

The course has 4 weekly hours grouped in blocks of 2 hours during the semester. Each of these blocks will combie theoretical contents and resolution of problems, which may be on paper or with the use of software.

In order to introduce the software, more time will be devoted to this part in the first sessions.

The last half hour of five of these classes will be devoted to a small test that students will have to do individually. The dates in which these tests will be announced at the beginning of the course.

In addition, this subject will have the corresponding Moodle classroom in the UAB's servers to complement the explanations made in class, offer the necessary material, open forums and make deliveries.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Lectures	27.5	1.1	2, 17, 8, 4, 3, 5, 6, 7, 1, 9, 12, 16, 15, 14, 10, 13, 19, 18, 11
Practice sessions	11	0.44	2, 17, 8, 4, 3, 5, 6, 7, 1, 9, 12, 16, 15, 14, 10, 13, 19, 18, 11
Problem sessions	12	0.48	2, 17, 8, 4, 3, 5, 6, 7, 1, 9, 12, 16, 15, 14, 10, 13, 19, 18, 11
Type: Autonomous			
Preparation of problems to deliver	15	0.6	2, 17, 8, 4, 3, 5, 6, 7, 1, 9, 12, 16, 15, 14, 10, 13, 19, 18, 11
Problem solving	30	1.2	2, 17, 8, 4, 3, 5, 6, 7, 1, 9, 12, 16, 15, 14, 10, 13, 19, 18, 11
Theory study	26	1.04	2, 17, 8, 5, 6, 7, 1, 9, 12, 16, 15, 14, 10, 19, 18, 11
Use of software	20	0.8	2, 17, 8, 4, 3, 5, 6, 7, 1, 9, 12, 16, 15, 14, 10, 13, 19, 18, 11

Assessment

At the beginning of the course, the dates of each test or evaluation will be announced. There will be second oportunity for the final exam and the practice exam.

The mark corresponding to Tests in class will be obtained from the average of the three best qualifications out of the five tests that will be made, and will not be recoverable.

There will be three problems that the student must do on their own and turn in.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Final exam	50%	4	0.16	2, 17, 8, 4, 3, 5, 6, 7, 1, 9, 12, 16, 15, 14, 10, 13, 19, 11
Practice exam	20%	2	0.08	17, 8, 4, 3, 5, 6, 7, 1, 9, 16, 15, 14, 13, 19, 11

Problems to turn in	15%	0	0	2, 17, 8, 4, 3, 5, 6, 7, 1, 9, 12, 16, 15, 14, 10, 13, 19, 18, 11
Tests in class	15%	2.5	0.1	2, 17, 8, 4, 3, 5, 6, 7, 16, 15, 14, 13, 19, 18, 11

Bibliography

Teaching notes:

- Marc Masdeu, Albert Ruiz, *Apunts d'Àlgebra Lineal*. Available at the Moodle classroom.

Basic:

- Otto Bretscher, *Linear Algebra with Applications*. Pearson, 2013.
- Enric Nart, Xavier Xarles, *Apunts d'àlgebra lineal*. Materials UAB, 2016.

Complementary:

- Sheldon Axler, *Linear algebra done right*. Springer UTM, 2015.
- Manuel Castellet i Irene Llerena, *Àlgebra lineal i geometria*. Manuals UAB, 1991.
- Ferran Cedó i Agustí Reventós, *Geometria plana i àlgebra lineal*. Manuals UAB, 2004.