DEGREE CURRICULUM

LINEAR ALGEBRA

Coordination: GRAU MONTAÑA, MARIA TERESA

Academic year 2022-23

LINEAR ALGEBRA 2022-23

Subject's general information

<table>
<tr><td>Subject name</td><td>LINEAR ALGEBRA</td></tr>
<tr><td>Code</td><td>101401</td></tr>
<tr><td>Semester</td><td>2nd Q(SEMESTER) CONTINUED EVALUATION</td></tr>
<tr><td>Typology</td><td>
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<tr><th>Degree</th><th>Course</th><th>Character</th><th>Modality</th></tr>
<tr><td>Bachelor's Degree in Architectural Technology and Building Construction</td><td>1</td><td>COMMON/CORE</td><td>Attendance-based</td></tr>
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<tr><td>Course number of credits (ECTS)</td><td>6</td></tr>
<tr><td>Type of activity, credits, and groups</td><td>
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<tr><th>Activity type</th><td>PRAULA</td><td>TEORIA</td></tr>
<tr><th>Number of credits</th><td>3</td><td>3</td></tr>
<tr><th>Number of groups</th><td>1</td><td>1</td></tr>
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<tr><td>Coordination</td><td>GRAU MONTAÑA, MARIA TERESA</td></tr>
<tr><td>Department</td><td>MATHEMATICS</td></tr>
<tr><td>Teaching load distribution between lectures and independent student work</td><td>40% at the classroom, 60% autonomous work
See "Development plan".</td></tr>
<tr><td>Important information on data processing</td><td>Consult this link for more information.</td></tr>
<tr><td>Language</td><td>Catalan</td></tr>
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LINEAR ALGEBRA 2022-23

Teaching staff	E-mail addresses	Credits taught by teacher	Office and hour of attention
GRAU MONTAÑA, MARIA TERESA	maite.grau@udl.cat	6	

Subject's extra information

To follow this subject properly the previous knowledge taught in the subject area of Mathematics of the "Bachillerato Tecnológico" (see https://xtec.gencat.cat/ca/curriculum/batxillerat/) is needed. In particular , the sections on arithmetic and algebra and geometry.

Suggestions

Subject that requires continuous work throughout the semester in order to achieve its goals. It requires critical thinking and capacity for abstraction. You can find collections of the materials at the Cappont Campus (Building Aulari) and the Virtual Campus: https://cv.udl.cat

- Collection set of exercises with the numerical solutions.

- Resolutions of exams in previous years.

It is recommended to frequently visit the site at the Virtual Campus since all the information is announced there.

The course as part of the academic plan

This course is in the 2nd semester of 1st year of teaching. It belongs to the module of "Basic Training", specifically in the field "Scientific Basis".

Learning objectives

- Perform elementary Gauss transformations in order to determine the rank of a matrix.
- Apply the Rouché-Frobenius Theorem and solve systems of linear equations.
- Describe vector space and vector subspace.
- Make vector calculations in different bases. In particular, calculating the components of a vector on different bases.
- Determine a linear map from its image on a base.
- Calculate the kernel and image of a linear map.
- Determine the eigenvalues and eigenvectors associated with an endomorphism and interpret them geometrically.
- Determine, classify and construct matrices of orthogonal transformations in the plane and in space.
- Apply vector calculus in the description of geometric objects.
- Classify conics and quadrics from its equation.

Competences

Cross-disciplinary competences of the degree:

EPS1. Capacity to solve problems and prepare and defence arguments inside the area of studies.

EPS2. Capacity to gather and interpret relevant data, within the area of study, to judge and think about relevant subjects of social, scientific and ethical nature.

EPS5. Capacity of abstraction and of critical, logical and mathematical thinking.

EPS6. Capacity of analysis and synthesis.

Specific competences of the degree:

GEE1. Aptitude to apply the knowledge related with numerical and infinitesimal calculus, linear algebra, analytical and differential geometry, techniques and probabilistic methods and statistical analysis.

GEE2. Applied knowledge of the principles of general mechanics, the statics of structural systems, the geometry of masses, the principles and methods of analysis of the elastic behaviour of the solid.

Subject contents

1. Matrices, determinants and systems of linear equations.

1.1 Types of matrices and matrix operations.

1.2 Inversible matrices.

1.3 Determinant of a square matrix of order n. Cases n = 2, n = 3 and n> 3.

1.4 Rank of a matrix.

1.5 Elementary transformations by rows. Gauss elimination method.

1.6 Expression of a system of linear equations by matrices.

1.7 Rouché-Frobenius theorem.

1.8 Cramer Systems

2. Vector spaces.

2.1 Definition, properties and examples.

2.2 Linear combination: linear dependence and linear independence.

2.3 Generating system.

2.4 Basis of a vector space: definition, dimensions, components.

2.5 Vector Subspace. Linear varieties.

2.5.1 Description by using generators and equations.

2.5.2 Gauss Transformations.

2.5.3 Basis and dimension.

2.6 Basis change: matrix.

2.7 Operations on subspaces.

2.7.1 Containment and equality.

2.7.2 Intersection and sum.

2.7.3 Grassman formula.

2.7.4 Complementary and direct sum.

3. Linear transformations and endomorphism diagonalization.

3.1 Definition and properties of a linear transformation.

3.2 Determination by the image in a basis.

3.3 Kernel and image of a linear transformation.

3.4 Matrix representation of a linear transformation.

3.5 Changes of basis. Similar matrices.

3.6 Operations with linear applications.

3.6.1 Sum of applications.

3.6.2 Product by a scalar.

3.6.3 Composition of applications.

3.7 Diagonal matrix: eigenvalues and eigenvectors.

3.8 Characteristic polynomial of an endomorphism: definition and calculation.

3.9 Cayley-Hamilton theorem.

3.10 Algebraic multiplicity.

3.11 Subspace generated by an eigenvector: geometric multiplicity.

3.12 Characterization of diagonalizable endomorphisms.

4. Euclidean Geometry

4.1 Scalar product.

4.2 Norm induced by a scalar product.

4.3 Distances and angles.

4.4 Concepts of orthogonal and orthonormal.

4.5 Gram-Schmidt process of orthonormalization.

4.6 Gram's determinant. Volume of cuboid.

4.7 Vector Product.

4.8 Orthogonal transformations: in the plane and in space.

4.9 Isometries or rigid motions.

5. Classification of conics and quadrics.

5.1 symmetric endomorphisms and scalar product.

5.2 symmetric bilinear form.

5.3 Range and signature: definition and calculation of these invariants.

5.4 Quadratic forms.

5.5 Quadratic varieties: canonical equation.

5.6 Classification of Euclidean conics and quadrics.

5.7 Other examples of curves. Trajectories. Parametrized curves.

5.8 Homothetic transformations.

5.9 Similarities.

Methodology

Lectures: Classes to explain the theory and problem solving on the blackboard.

Resolution of problems: students solve problems individually during these sessions under the supervision of teachers of the subject.

Exam: two written tests are held during the semester. There is also a final retrieval test.

Delivery of exercises: Students deliver a weekly basis statement proposed by a teacher, who corrects and returns it to the student for his/her information.

Development plan

Week	Methodology	Contents	Hours at classroom	Hours of autonomous work
Weeks 1 - 3	Lectures	Chapter 1	6	9
Weeks 1 - 3	Resolution of problems	Chapter 1	6	9

Weeks 4 - 6	Lectures	Chapter 2	6	9
Weeks 4 - 6	Resolution of problems	Chapter 2	6	9
Weeks 7 and 8	Lectures	Chapter 3 (sections 3.1 – 3.6)	4	6
Weeks 7 and 8	Resolution of problems	Chapter 3 (sections 3.1 – 3.6)	4	9
Week 9	1ª test of evaluation (exam)	Contents until the moment	1.5	
Weeks 10 - 12	Lectures	Chapter 3 (sections 3.7 -3.12)	6	9
Weeks 10 - 12	Resolution of problems	Chapter 3 (sections 3.7 -3.12)	6	9
Weeks 13 and 14	Lectures	Chapter 4	4	6
Weeks 13 and 14	Resolution of problems	Chapter 4	4	6
Week 15	Lectures	Chapter 5	2	3
Week 15	Resolution of problems	Chapter 5	2	6
Weeks 16 and 17	2ª test of evaluation (exam)	Contents since the first test and until the moment	1.5	
Week 20	Retrieval test	All the contents of the subject	2	

Evaluation

Exam PA1
Written exam (individual and compulsory)
Date: april and following the school calendar
Percent on the final mark: 40%
Remark: To consider the mark on the delivered exercises a mark of at least 4 (over 10) in PA1 and PA2 is required.

Exam PA2
Written exam (individual and compulsory)
Date: june and following the school calendar
Percent on the final mark: 40%
Remark: To consider the mark on the delivered exercises a mark of at least 4 (over 10) in PA1 and PA2 is required.

Deliver of exercises
Deliver of exercises
Date: in each week of classes, there is one statement to be solved and deliver. Random ask.
Percent of the final mark: 20% (two of the delivered exercises are considered, with a weight of 10% each of them on the final mark)
Remark: To consider the mark on the delivered exercises a mark of at least 4 (over 10) in PA1 and PA2 is required.

Resit exam
Written exam (individual and noncompulsory)
Date: june/july and following the school calendar
Percent on the final mark: 80%
Remarks: The content of this exam covers **all the topics** of the subject. To consider the mark on on the delivered exercises a mark of at least 4 (over 10) in this exam is required. All the student can do this exam in order to improve their mark.

Bibliography

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