IDENTIFYING DATA

Mathematics: Linear algebra

Subject	Mathematics: Linear algebra
Code	V05G301V01102
Study programme	Degree in Telecommunications Technologies Engineering

Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Basic education	1st	1st

Teaching language	Spanish
Department	
Coordinator	Martín Méndez, Alberto Lucio
Lecturers	Bajo Palacio, Ignacio Calvo Ruibal, Natividad Martín Méndez, Alberto Lucio
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General description	The subject Linear Algebra is taught in the first quadmester of the first course of the Grado en Ingeniería de Tecnologías de Telecomunicación, with the main objective of providing students with a clear understanding of the complex numbers, systems of linear equations and elementary techniques of matrix algebra as well as an introduction to the fundamental concepts of Vector Spaces which will be needed in later subjects. It will be paid special attention to the applications of Linear Algebra.

Competencies

Code	
B3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations
B4	CG4: The ability to solve problems with initiative, to make creative decisions and to communicate and transmit knowledge and skills, understanding the ethical and professional responsibility of the Technical Telecommunication Engineer activity.
C1	CE1/FB1: The ability to solve mathematical problems in Engineering. The aptitude to apply knowledge about linear algebra, geometry, differential geometry, differential and integral calculus, differential and partial differential equations; numerical methods, numerical algorithms, statistics and optimization
D2	CT2 Understanding Engineering within a framework of sustainable development.
D3	CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc.

Learning outcomes

Expected results from this subject	Training and Learning Results		
Skill development the basic operations of matrix algebra.	B3 B4	C1	D2 D3
Knowledge of numerical methods for solving systems of linear equations and knowledge of the basic concepts involving vector spaces and linear maps.	B3		D3
Knowledge of the properties of vector spaces with inner product.		C1	
Skill development some applications of linear algebra: the method of least squares, singular value decomposition and classification of quadratic forms	B3	C1	D3
To know the arithmetic of complex numbers.	B3 B4	C1	D2 D3

Contents

Topic	
Topic 1. Complex numbers.	Operations with complex numbers. Geometric concepts associated with complex numbers. Euler's formula and its consequences.
Topic 2. Matrices, determinants and systems of linear equations	Matrix operations: addition, scalar multiplication and product of matrices. Matrix inverse. LU decomposition. Block matrices. Determinants. Systems of linear equations. The matrix equation Ax=b. Solution set of a system of linear equations. The matrix of a system of linear equations. Elementary row operations and Gauss' method. Numerical methods for the systems of linear equations.
Topic 3. Vector Spaces and Linear transformations	Linear independence. Subspaces. Basis. Dimension. Rank of a system of vectors and rank of a matrix. Introduction to linear transformations. Matrix of a linear transformation. Composition of linear transformations and the product of matrices.
Topic 4. Matrix diagonalization.	Eigenvalues and eigenvectors. Eigenspace. Matrix diagonalization and diagonalizable matrices.
Topic 5. Orthogonallity.	Real Euclidean inner product. Complex Hermitian inner product. Orthogonallity. Gram-Schmidt. Unitary Diagonalization. Singular value decomposition. Matrix rank reduction. The method of least squares. Quadratic forms.

Planning

	Class hours	Hours outside the classroom	Total hours
Laboratory practical	2	2	4
Lecturing	38	76	114
Problem solving	9	9	18
Problem and/or exercise solving	5	5	10
Essay questions exam	2	2	4

*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

Methodologies

	Description
Laboratory practical	Solving assigned exercises and model problems. Use of the computer tool MATLAB. Individual. Through this methodology the competences CG3, CG4, CE1, CT2 and CT3 are developed.
Lecturing	Explanation and development by the teacher of the contents of the various topics in the syllabus. Individual. Through this methodology the competences CG3, CE1 and CT3 are developed.
Problem solving	Resolution by part of the professor of suitable exercises adapted to each topic. Individual. The students will also have to take part in the resolution of exercises in order to strengthen their knowledge. Through this methodology the competences CG3, CG4, CE1, CT2 and CT3 are developed.

Personalized assistance

Methodologies	Description
Problem solving	Personalized tutoring will be available from all the teachers of the subject.
Laboratory practical	Personalized tutoring will be available from all the teachers of the subject.
Lecturing	Personalized tutoring will be available from all the teachers of the subject.
Tests	**Description**
Problem and/or exercise solving	Personalized attention will be available for assistance in the revision of tests and exams.

Assessment

Description	Qualification	Training and Learning Results

Problem and/or exercise solving	Continuous evaluation consists in four short tests to be given in the class hour. The approximate planning will be the following: 1. Exam of topic 1. 2. Exam of topic 2 and 3. 3. Exam of topic 4. 4. Exam of topic 5. The tests 1 and 3 will have a weight of 10% in the final grade. The tests 2 and 4 will have a weight of 15% in the final grade. The total weight of the continuous evaluation in the final grade will therefore be of 50%. The planning of the different intermediate evaluation tests will be approved in an Academic Commission of Degree and it will be available at the beginning of the semester.	50	B3 B4	C1
Essay questions exam	A written two-hour exam of topics 1, 2, 3, 4, and 5 at the end of the semester in date, time and venue determined in the official exams calendar of the School.	50	B3 B4	C1

Other comments on the Evaluation

First call:

Continuous assessment:

A student who chooses to be graded by continuous evaluation must do it in writing way in the manner and date indicated by the professors of the subject. In that case the final grade is calculated by the formula:

$$N = (\ (E1 + (1.5 \times E2) + E3 + (1.5 \times E4)\ ) + 5\ EF\ )\ /\ 10$$

where E1, E2, E3 y E4 are the points, in a scale 0 to 10, obtained in the four test of the continuous evaluation and where EF represents the points, in a scale 0 to 10, obtained in the final exam. A passing grade is N greater or equal to 5. Before doing each test, the procedure and date of revising the grading of that test will be announced. After the test, the grades will be announced in a reasonable amout of time. If a student ⬜for any circumstance⬜ cannot attend a particular test on the date for which it is scheduled, he or she will miss that test and it will not be repeated.

The points obtained in the tests of continuous evaluation will be valid only for the academic year in which they are obtained.

 Eventual assessment**:**

The students who do not choose to be graded by continuous evaluation, will be graded by means of a final exam (which will not be necessarily the same as the one for the students who chosed continuous evaluation) of all the topics of the subject. This exam will be graded in a scale of 10 points and the passing grade cutoff will be 5.

Second call:

The students who at the end of the semester do not obtain a passing grade will have the opprtunity of writing a second final exam on date, time and venue determined in the official exams calendar of the School. This exam will cover topics 1, 2, 3, 4 and 5. On the day of this second final, the students who were graded by continuous evaluation may choose to be graded exclusively by the second final or to be graded taking into account the points obtained in their continuous evaluation by the same formula used earlier, that is:

$$M = (\ (E1 + (1.5 \times E2) + E3 + (1.5 \times E4)\ ) + 5\ EFR\ )\ /\ 10$$

where now EFR is the grade, in a scale 0 to 10, in the second final.

The students who choose to be graded exclusively by the second final will be graded with the result of the symmetric rounding to a decimal of the grade, between 0 and 10, obtained in the second final (which will not be necessarily the same as the one for the students who made the opposite choice). This second final will also cover the topics 1, 2, 3, 4 and 5.

Remark: During the exam correction period some students could be contacted by phone or telematically by the teacher to clarify aspects of their answers; in that case, such answers may have an impact on the exam grade.

"No presentado":

A student will obtain a cualification of "No Presentado" in the first edition of the final grades if and only if that student did not choose the continuous evaluation and did not attend the final exam.

A student will obtain a cualification of "No Presentado" in the second edition of the final grades if and only if that student obtained "No Presentado" in the first editin and did not attend the second final.

Extraordinary call:

The students which attend the Extraordinary call will write an exam covering topics 1, 2, 3, 4 and 5 which will be graded in a scale of 10 points and the passing grade cutoff will be 5. Individual assessment.

Ethical Behavior:

It is expected a correct and ethical behavior of all students in all written tests and exams, which are meant to truly reflect the knowledge and abilities attained by each studen. Any unethical behavior detected in a particular test (such as copying or using prohibited material) will result in a grading of 0 in that test and the issue of the corresponding report for the School Director's Office.

Sources of information

Basic Bibliography

D. Poole, **Álgebra lineal: Una introducción moderna**, 2º,

L. Merino; E. Santos, **Álgebra lineal con métodos elementales**, 1ª,

J. de Burgos, **Álgebra lineal y geometría cartesiana**, 2ª,

Complementary Bibliography

D. C. Lay, **Álgebra lineal y sus aplicaciones**, 3ª,

Recommendations

Subjects that continue the syllabus

Physics: Analysis of Linear Circuits/V05G301V01108

Mathematics: Calculus 2/V05G301V01106

Physics: Fields and Waves/V05G301V01202

Subjects that are recommended to be taken simultaneously

Mathematics: Calculus 1/V05G301V01101

Contingency plan

Description

If teaching is totally online, continuous evaluation consists in two short tests and also un some homework. The approximate planning of the two tests will be the following:

1. Exam of topics 1, 2 and 3.
2. Exam of topics 4 and 5.

Bothn tests will have a wheight of 20% in the final grade and the homework will have a wheight of 10% in the final grade.

The total weight of the continuous evaluation in the final grade will therefore be of 50%.

The planning of the different intermediate evaluation tests will be approved in an Academic Commission of Degree and it will be

available at the beginning of the semester.

The teaching and the rest of the evaluation will follow its planning, but it will be carried out through the technical means provided by the UVIGO