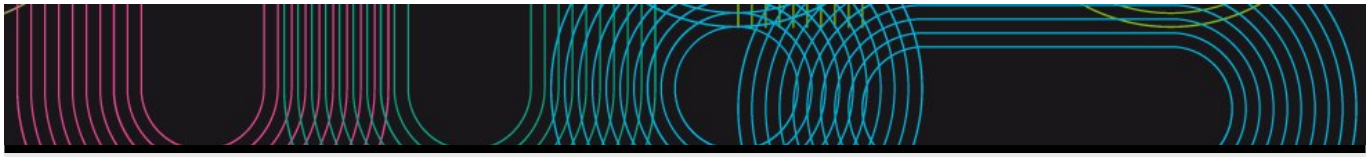

| IDENTIFYING DATA | | | | |
|---|---|---|---|---|
| **Mathematics: Linear algebra** | | | | |
| Subject | Mathematics: Linear algebra | | | |
| Code | V05G300V01104 | | | |
| Study programme | Degree in Telecommunications Technologies Engineering | | | |
| Descriptors | ECTS Credits | Choose | Year | Quadmester |
| | 6 | Basic education | 1st | 1st |
| Teaching language | Spanish | | | |
| Department | | | | |
| Coordinator | Martín Méndez, Alberto Lucio | | | |
| Lecturers | Martín Méndez, Alberto Lucio<br>Prieto Gómez, Cristina | | | |
| E-mail | amartin@dma.uvigo.es | | | |
| Web | http://faitic.uvigo.es/ | | | |
| 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 | | |
|---|---|---|---|
| To know of the basic techniques of linear algebra and matrix algebra which are needed in other subjects that should be studied subsequently in the programme. | B3<br>B4 | C1 | D2<br>D3 |
| Skill development the basic operations of matrix algebra. | B3<br>B4 | C1 | D2<br>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<br>B4 | C1 | D2<br>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 practises | 2 | 2 | 4 |
| Master Session | 38 | 76 | 114 |
| Troubleshooting and / or exercises | 9 | 9 | 18 |
| Troubleshooting and / or exercises | 5 | 5 | 10 |
| Long answer tests and development | 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 practises | Solving assigned exercises and model problems. Use of the computer tool MATLAB.<br><br>Through this methodology the competences CG3, CG4, CE1, CT2 and CT3 are developed. |
| Master Session | Explanation and development by the teacher of the contents of the various topics in the syllabus.<br><br>Through this methodology the competences CG3, CE1 and CT3 are developed. |
| Troubleshooting and / or exercises | Resolution by part of the professor of suitable exercises adapted to each topic.<br><br>The students will also have to take part in the resolution of exercises in order to strengthen their knowledge.<br><br>Through this methodology the competences CG3, CG4, CE1, CT2 and CT3 are developed. |

**Personalized attention**

| **Methodologies** | **Description** |
|---|---|
| Troubleshooting and / or exercises | Personalized tutoring will be available from all the teachers of the subject. They will be held in the respective offices of the teachers unless announced otherwise. |
| Laboratory practises | Personalized tutoring will be available from all the teachers of the subject. They will be held in the respective offices of the teachers unless announced otherwise. |
| Master Session | Personalized tutoring will be available from all the teachers of the subject. They will be held in the respective offices of the teachers unless announced otherwise. |
| **Tests** | **Description** |
| Troubleshooting and / or exercises | Personalized attention will be available for assistance in the revision of tests and exams. |

**Assessment**

| | Description | Qualification | Training and Learning Results |
|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| Troubleshooting and / or exercises | Continuous evaluation consists in four short tests to be given in the class hour and also on homework to be turned-in in class. The approximate planning will be the following:<br>Four one hour tests:<br>1. Test of topic 1 (week 3 approximately).<br>2. Test of topic 2 and 3 (week 8 approximately).<br>3. Test of topic 4 (week 11 approximately).<br>4. Test of topic 5 (week 15 approximately).<br>Each of these tests will have a weight of 10% in the final grade.<br>Homework will have a weight of 10% in the final grade.<br>The total weight of the continuous evaluation in the final grade will therefore be of 50%. | 50 | B3<br>B4 | C1 |
| Long answer tests and development | 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<br>B4 | C1 |

**Other comments on the Evaluation**

**Continuous evaluation:**

A student chooses to be graded by continuous evaluation when, after knowing his grade in the first test (topic 1), accepts being evaluated by that method. In that case the final grade is calculated by the formula:

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

where E1, E2, E3 y E4 are the points, in a scale 0 to 10, obtained in the four test of the continuous evaluation, P represents the total points, in a scale 0 to 10, obtained in the homework 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.

**End-of-semester evaluation:**

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 choosed continuous evaluation). This exam will be graded in a scale of 10 points and the passing grade cutoff will be 5.

**July evaluation:**

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:

$$NR = ( (E1 + E2 + E3 + E4) + P + 5\ EFR ) / 10$$

where now EFR is the grade, in a scale 0 to 10, in the second final. Again, the passing grade cutoff will be 5.

The students who choose to be graded exclusively by the second final will write an exam (which will not be necessarily the same as the one for the students who made the opposite choice) 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.

The final grade of a student is the maximum of the grade obtaines by continuous evaluation and the mark obtained in the final exam. A passing grade is the one that is greater or equal to 5.

**"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.

**Éthical 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/V05G300V01201
Physics: Fields and Waves/V05G300V01202
Mathematics: Calculus 2/V05G300V01203
Mathematics: Probability and Statistics/V05G300V01204
Digital Signal Processing/V05G300V01304
Computer Networks/V05G300V01403

### Subjects that are recommended to be taken simultaneously

Mathematics: Calculus 1/V05G300V01105