Linear Algebra

Academic Year: (2024 / 2025) **Review date: 20-01-2025**

Department assigned to the subject: Mathematics Department

Coordinating teacher: DEL RIO VEGA, ADRIAN

Type: Basic Core ECTS Credits : 6.0

Year : 1 Semester : 1

Branch of knowledge: Engineering and Architecture

LEARNING OUTCOMES

CB1: Students have demonstrated possession and understanding of knowledge in an area of study that builds on the foundation of general secondary education, and is usually at a level that, while relying on advanced textbooks, also includes some aspects that involve knowledge from the cutting edge of their field of study
CG3: Knowledge of basic and technological subject areas which enable acquisition of new methods and technologies, as well as endowing the technical engineer with the versatility necessary to adapt to any new situation.
RA1: Knowledge and Understanding. Knowledge and understanding of the general fundamentals of engineering, scientific and mathematical principles, as well as those of their branch or specialty, including some knowledge at the forefront of their field.

OBJECTIVES

The student will acquire the basic concepts of:
1. Complex numbers.
2. Linear systems.
3. Matrix and vector algebra.
4. The determinant of a square matrix.
5. Vector subspaces in Rn and other vector spaces.
6. Eigenvalues and eigenvectors of square matrices.
7. Orthogonality and orthonormality of vectors in Rn.

The student will acquire the skills that enable them:
1. To work with complex numbers.
2. To decide about the existence and uniqueness of solutions for a system of linear equations.
3. To find, in the case when they exist, the solutions of a system of linear equations.
4. To work with vectors and matrices.
5. To compute, in the case when it exists, the inverse of a square matrix.
6. To find bases for a vector space or subspace.
7. To compute the eigenvalues and eigenvectors of a square matrix.
8. To decide whether a square matrix is diagonalizable or not.
9. To obtain an orthonormal basis from an arbitrary basis.
10. To solve least-squares problems.
11. To orthogonally diagonalize a symmetric matrix.

DESCRIPTION OF CONTENTS: PROGRAMME

Lecture 0. Introduction to Complex Numbers.
0.1. Definition. Sum and Product.
0.2. Conjugate, Modulus and Argument.
0.3. Complex Exponential.
0.4. Powers and Roots of Complex Numbers.

Lecture 1. Systems of Linear Equations.

1.1. Introduction to Systems of Linear Equations.
1.2. Row Reduction and Echelon Forms.
1.3. Vector Equations.
1.4. The Matrix Equation Ax=b.
1.5. Solution Sets of Linear Systems.
1.6. Linear Independence.
1.7. Introduction to Linear Transformations.
1.8. The Matrix of a Linear Transformation.

Lecture 2. Matrix Algebra.
2.1. Matrix Operations.
2.2. The Inverse of a Matrix.
2.3. Block-Partitioned Matrices.

Lecture 3. Determinants.
3.1. Introduction to Determinants.
3.2. Properties of Determinants.
Lecture 4. Vector Spaces.
4.1. Vector Spaces and Subspaces.
4.2. Null Space and Column Space of a Matrix.
4.3. Linearly Independent Sets and Bases.
4.4. Coordinate Systems.
4.5. The Dimension of a Vector Space.
4.6. Rank.
4.7. Change of Basis.

Lecture 5. Eigenvalues and Eigenvectors.
5.1. Introduction to Eigenvalues and Eigenvectors.
5.2. The Characteristic Equation.
5.3. Diagonalization of Square Matrices.

Lecture 6. Orthogonality and Least Squares.
6.1. Inner Product, Norm, and Orthogonality.
6.2. Orthogonal Sets.
6.3. Orthogonal Projections.
6.4. The Gram-Schmidt Method and the QR Factorization.
6.5. Least-Squares Problems.

Lecture 7. Symmetric Matrices.
7.1. Diagonalization of Symmetric Matrices.

LEARNING ACTIVITIES AND METHODOLOGY

The teaching methodology will include:
- Theory classes in large groups, where basic theoretical knowledge and skills will be presented. To facilitate their development, a textbook (Linear Algebra and its Applications, by David C. Lay, 4th edition) could be followed. The chronogram of the course will be available to the students, allowing them to prepare the classes in advance.
- Solving exercises by the student, which will serve as self-assessment and to acquire the necessary skills.
- Problem solving classes in small groups, where exercises proposed to students will be explained and discussed.
- Using the electronic resources that the teacher will make available to students in the Aula Global platform.
- Tutorial sessions, individual and voluntary, in which students will have the possibility to consult the teacher their doubts and questions on the subject. The time and place of these sessions will be set by the teacher at the beginning of the course.

ASSESSMENT SYSTEM

% end-of-term-examination:	60
% of continuous assessment (assigments, laboratory, practicals…):	40

- Continuous evaluation: It will be carried out through partial exams, which will test the acquisition by the student of the basic concepts and skills of the subject. Its percentage in the final grade will be 40%. At the beginning of the course, the teacher will inform the students about the number of exams to be

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performed, as well as their exact dates and contents.

- Optionally, the teacher may propose homework, to be done either individually or in group, as a part of the continuous evaluation. Its percentage in the final grade will be less than or equal to 15%, while the partial exams will then correspond to the remaining percentage until completing the 40% of the continuous evaluation.

- Final exam: It will test the global knowledge and understanding of the subject by the student. Its percentage in the final grade will be 60%.

BASIC BIBLIOGRAPHY

- David C. Lay Linear Algebra and Its Applications, 4th Edition, Prentice-Hall, 2012

ADDITIONAL BIBLIOGRAPHY

- B. Noble, J.W. Daniel, Applied Lineal Algebra, Prentice, 1977

- K. Nicholson Elementary Linear Algebra, Mc Graw Hill, 2003

- L. Spence, A. Insel y S. Friedberg Elementary Linear Algebra. A Matrix Approach, Prentice Hall , 2000