Linear Algebra

Academic Year: (2019 / 2020) **Review date: 12-06-2020**

Department assigned to the subject: Mathematics Department

Coordinating teacher: VEIGA VEIGA, MARIA PILAR

Type: Basic Core ECTS Credits : 6.0

Year : 1 Semester : 1

Branch of knowledge: Engineering and Architecture

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Basic knowledge on vectors and Euclidean space.
Basic knowledge on matrices and determinants.
Basic knowledge on systems of linear equations.
Basic trigonometry.

OBJECTIVES

1. Learning objectives: (PO: a)
- To understand the concept of algebraic structures.
- To know the field of complex numbers and their properties.
- To solve systems of linear equations and to interpret the results.
- To know and understand the notion of vector spaces.
- To understand the notion of bases and coordinates in a vector space.
- To represent a linear transformation by a matrix.
- To compute the image and kernel of a linear transformation.
- To compute the eigenvalues and eigenvectors of a matrix.
- To compute the QR decomposition of a matrix.
- To understand the concept of differential equation and know how to solve problems in linear ordinary differential equations with constant coefficients.

2. Specific skills: (PO: a)
- To raise the abstraction.
- To be able to solve real problems using typical linear algebra tools.

3. General skills: (PO: a)
- To improve the oral and written communication ability using the language and signs of mathematics properly.
- To be able to model a real situation by a linear transformation.
- To improve the ability to interpret a mathematical solution and define its limitations and reliability.
- To be able to use mathematical software.

DESCRIPTION OF CONTENTS: PROGRAMME

0. Review Topics
  0.1. Introduction to Linear Systems
  0.2. Basics vectors and matrix

Complex numbers
  1. Definitions
  2. Forms of complex numbers
  3. Properties and operations

1. Systems of linear equations
  1.1. Introduction and definitions
  1.2. Geometrical interpretation
  1.3. Techniques for solving linear systems
  1.4. Matrix methods: Gauss and Gauss-Jordan
  1.5. Homogeneous linear system

2. Vector spaces
  2.1. Definitions
  2.2. Operations and properties
  2.3. Vector subspaces
  2.4. Linear combinations and Span
  2.5. Linear independence

2.6. Bases and dimension of a subspace
2.7. Dot product. Length of a vector. Angle between two vectors
2.8. Orthogonal projection
3. Matrices
3.1. Operations with matrices
3.2. Transpose and inverse of a matrix
3.3. Determinant
3.4. Matrix subspaces
4. Linear transformations
4.1 Definitions, properties and operations
4.2. Inverse of a linear transformation
4.3. Image and kernel of a linear transformation
5. Bases
5.1. Coordinates
5.2. Change of basis
6. Orthogonality
6.1. Definitions
6.2. Orthogonal and orthonormal bases
6.3. Orthogonal matrix and linear transformations
6.4. Orthogonal projections and orthogonal complements
6.5. Gram-Schmidt process and QR factorization
7. Least squares
7.1. Better approximation.
7.2. Approximation using least squares
7.3. Methods and applications in data fitting and approximation of functions by polynomials
8. Eigenvalues and eigenvectors
8.1. Definitions
8.3. Similarity and Diagonalization
8.4. Spectral theorem
9. Introduction to Linear Ordinary Differential Equations with Constant Coefficients
9.1. Introduction to Continuous Dynamical Systems and Differential Equations
9.2. Linear Ordinary Differential Equations
9.3. Linear systems of differentiqal equations with constant coefficients
9.4. Introduction to the Stability of dynamical systems

LEARNING ACTIVITIES AND METHODOLOGY

Lecture sessions (3 credits) (PO: a). During these sessions we will cover the course topics with the aim of using theory to solve problems.

Practicals, working individually and in groups (3 credits) (PO: a) During these sessions we will solve exercises of different levels of difficulty.

ASSESSMENT SYSTEM

We will follow a continuous-assessment system(40%) plus a final exam (60%):

- The continuous-assessment part consists in two written examinations contributing with weight 40% to the final mark. The mid-term examinations will include approximately at two thirds of the semester.

- The final exam, contributing with weight 60% to the final mark, will be held at the end of the semester. (PO: a.)

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

BASIC BIBLIOGRAPHY

- B. KOLMAN "Álgebra lineal con aplicaciones y Matlab", Prentice Hall - Octava edición - 2006.
- B. NOBLE, J. W. DANIEL "Álgebra lineal aplicada", Prentice Hall Hispanoamericana - Tercera edición - 1989.
- D. C. LAY "Álgebra lineal y sus aplicaciones", Addison-Wesley - Tercera edición - 2006.
- D. POOLE "Álgebra Lineal. Una introducción moderna", Thomson - Primera edición - 2004.
- P. J. HERNANDO "Clases de Álgebra Lineal para Ingeniería", Revisión 5.1 - 2018.

ADDITIONAL BIBLIOGRAPHY

- O. BRETSCHER "Linear algebra with applications", Prentice Hall - Segunda edición - 2001.