Linear Algebra

Academic Year: (2019 / 2020) **Review date: 03-06-2019**

Department assigned to the subject: Mathematics Department

Coordinating teacher: SANCHEZ RUIZ, JORGE

Type: Basic Core ECTS Credits : 6.0

Year : 1 Semester : 1

Branch of knowledge: Engineering and Architecture

OBJECTIVES

The student is expected to know and understand the fundamental concepts of:
- Systems of linear equations
- Matrix and vector algebra.
- Vector subspaces in C^n.

The student is expected to acquire and develop the ability to:
- Operate and solve equations with comples numbers
- Discuss the existence and uniqueness of solutions of a system of linear equations
- Solve a consistent system of linear equations
- Carry out basic operations with vectors and matrices
- Determine whether a square matrix is invertible or not, and compute the inverse matrix if it exists
- Determine whether a subset of a vector space is a subspace or not
- Find bases of a vector subspace, and compute change-of-basis matrices
- Compute eigenvalues and eigenvectors of a square matrix
- Determine whether a square matrix is diagonalizable or not
- Obtain an orthonormal basis from an arbitrary basis of a subspace
- Solve least-squares problems
- Determine whether a square matrix is unitarily diagonalizable or not

DESCRIPTION OF CONTENTS: PROGRAMME

1. Complex numbers
   · Numbers sets
   · Necessity of complex numbers
   · Binomial form of a complex number
   · Graphical representation
   · Operations
   · Complex conjugate, modulus, argument
   · Polar form of a complex number
   · Roots of complex numbers
   · Exponential of a complex number
   · Solving equations
2. Systems of linear equations
   · Introduction to Linear Equations
   · Geometrical Interpretation
   · Existence and Uniqueness
   · Matrix Notation
   · Gaussian Elimination
   · Row Equivalence and Echelon Forms
   · Solving Linear Systems
   · Homogeneous Systems
   · Simultaneous Solving
   · Systems with parameters
3. The vector space Cn
   · Vectors
   · Linear Subspace
   · Linear Combinations
   · Subspace Spanned by Vectors
   · Column and Row Spaces

· The Matrix Equation Ax=b
· Null Space
· Revisiting Linear Systems
· Linear Independence
· Basis for a Linear Subspace
· Dimension of a Linear Subspace
· Basis for Col A, Row A and Nul A
· Rank of a Matrix
· Coordinate Systems
· Introduction to Linear Transformations

4. Matrix algebra
   · Matrix Operations
   · Transpose of a Matrix
   · Conjugate Transpose of a Matrix
   · Inverse of a Matrix
   · Partitioned Matrices
   · Determinants
5. Eigenvalues and eigenvectors
   · Eigenvalues & Eigenvectors
   · The Characteristic Equation
   · Diagonalization
   · Change of Basis
   · Transformations between Linear Subspaces
   · Applications to linear systems of differential equations
6. Orthogonality
   · Dot Product and Modulus
   · Orthogonal Sets
   · Unitary Matrices
   · Orthogonal Complement
   · Orthogonal Projection
   · The Gram-Schmidt Process
   · The QR decomposition
   · Least-Squares Problems
7. Normal matrices
   · Schur Decomposition
   · Normal Matrices & Unitary Diagonalization
   · Particular Cases of Normal Matrices

LEARNING ACTIVITIES AND METHODOLOGY

The teaching methodology will include:

- Theoretical lectures in large groups, where knowledge that students should acquire will be presented. The course weekly schedule will be available to students and they are expected to prepare the classes in advance.

- Resolution of exercises by the student, which will serve them as a self-assessment and to acquire the necessary skills

- Problem classes, during which problems are discussed and solved

- Tutorships

ASSESSMENT SYSTEM

- Continuous evaluation: It corresponds to 40% of the final mark. Students must hand in the proposed problems in the problem class.

- Final exam: It corresponds to 60% of the final mark. It helps assess the student's general understanding of the subject.

ATTENTION: To pass the subject, the student MUST pass the final exam.

% end-of-term-examination: 60

% of continuous assessment (assigments, laboratory, practicals…): 40

BASIC BIBLIOGRAPHY

- David C. Lay, Linear Algebra and its Applications,, Addison Wesley.

ADDITIONAL BIBLIOGRAPHY

- B. Noble and J. W. Daniel Applied Linear Algebra, Prentice Hall.
- David Poole Linear Algebra: A Modern Introduction, Cengage Learning, 2010 (3rd Edition)
- G. Strang Linear Algebra and its Applications, 4th Edition, Wellesley-Cambridge.
- Jim DeFranza, Daniel Gagliardi Introduction to Linear Algebra with Applications, McGraw Hill, 2009
- W. Keith Nicholson Linear Algebra with Applications, McGraw Hill, 2009 (6th edition)

BASIC ELECTRONIC RESOURCES

- Kahn Academy . Linear Algebra: https://www.khanacademy.org/math/linear-algebra
- Professor Gilbert Strang . ALGEBRA (MIT OpenCourseWare): http://ocw.mit.edu/courses/mathematics/18-06-linear-algebra-spring-2010/video-lectures/