Linear Algebra

Academic Year: (2023 / 2024) **Review date: 19/12/2023 13:13:07**

Department assigned to the subject: Mathematics Department

Coordinating teacher: MOLERA MOLERA, JUAN MANUEL

Type: Basic Core ECTS Credits : 6.0

Year : 1 Semester : 1

Branch of knowledge: Engineering and Architecture

LEARNING OUTCOMES

RA1: Acquire knowledge and understanding of the basic general fundamentals of engineering and biomedical sciences.
RA2: Be able to solve basic engineering and biomedical science problems through a process of analysis, identifying the problem, establishing different methods of resolution, selecting the most appropriate one and its correct implementation.
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.
CB2: Students are able to apply their knowledge to their work or vocation in a professional manner and possess the competences usually demonstrated through the development and defence of arguments and problem solving within their field of study.
CG1: Adequate knowledge and skills to analyse and synthesise basic problems related to engineering and biomedical sciences, solve them and communicate them efficiently.
CG3: Knowledge of basic scientific and technical subjects that enables them to learn new methods and technologies, as well as providing them with great versatility to adapt to new situations.
CG4: Ability to solve problems with initiative, decision-making, creativity, and to communicate and transmit knowledge, skills and abilities, understanding the ethical, social and professional responsibility of the biomedical engineer's activity. Capacity for leadership, innovation and entrepreneurial spirit.
CG8: Ability to solve mathematical, physical, chemical and biochemical problems that may arise in biomedical engineering.
CG12: Ability to solve mathematically formulated problems applied to biology, physics and chemistry, using numerical algorithms and computational techniques.
ECRT1: Ability to solve mathematical problems that may arise in engineering and biomedicine. Ability to apply knowledge of: linear algebra; geometry; differential and integral calculus; differential and partial derivative equations; numerical methods; numerical algorithms; statistics and optimisation.
CT1: Ability to communicate knowledge orally and in writing to both specialised and non-specialised audiences.

OBJECTIVES

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

The student is expected to acquire and develop the ability to:
- Operate and solve equations with complex 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 orthogonally 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. Matrix algebra
   · Matrix Operations
   · Transpose of a Matrix
   · Conjugate Transpose of a Matrix
   · Inverse of a Matrix
4. The vector space Rn
   · 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
5. Eigenvalues and eigenvectors
   · Determinants
   · Eigenvalues & Eigenvectors
   · The Characteristic Equation
   · Diagonalization
   · Change of Basis
6. Orthogonality
   · Dot Product and Modulus
   · Orthogonal Sets
   · Orthogonal Complement
   · Orthogonal Projection
   · The Gram-Schmidt Process
   · Least-Squares Problems

7. Symmetric matrices
   · Symmetric Matrices & Orthogonal Diagonalization

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

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

- Continuous evaluation: It corresponds to 40% of the final mark. It consists of tests held along the course to assess the student's progression.

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

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

- Gilbert Strang . Linear Algebra: https://ocw.mit.edu/courses/mathematics/18-06-linear-algebra-spring-2010/

- Nicholson . Linear Algebra with Apllications: https://lyryx.com/linear-algebra-applications/