Linear Algebra

Academic Year: (2022 / 2023) **Review date: 05-04-2022**

Department assigned to the subject: Mathematics Department

Coordinating teacher: SANCHEZ SANCHEZ, ANGEL

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)

Mathematics in scientific-technological "bachillerato" (high school)

OBJECTIVES

CB1. Students have demonstrated knowledge and understanding in a field of study that builds upon their general secondary education, and is typically at a level that, whilst supported by advanced textbooks, includes some aspects that will be informed by knowledge of the forefront of their field of study
CB2. Students can apply their knowledge and understanding in a manner that indicates a professional approach to their work or vocation, and have competences typically demonstrated through devising and sustaining arguments and solving problems within their field of study
CB3. Students have the ability to gather and interpret relevant data (usually within their field of study) to inform judgments that include reflection on relevant social, scientific or ethical issues
CB4. Students can communicate information, ideas, problems and solutions to both specialist and non-specialist audiences
CB5. Students have developed those learning skills that are necessary for them to continue to undertake further study with a high degree of autonomy
CG2. Learn new methods and technologies from basic scientific and technical knowledge, and being able to adapt to new situations.
CG3. Solve problems with initiative, decision making, creativity, and communicate and transmit knowledge, skills and abilities, understanding the ethical, social and professional responsibility of the engineering activity. Capacity for leadership, innovation and entrepreneurial spirit.
CG4. Solve mathematical, physical, chemical, biological and technological problems that may arise within the framework of the applications of quantum technologies, nanotechnology, biology, micro- and nano-electronics and photonics in various fields of engineering.
CG5. Use the theoretical and practical knowledge acquired in the definition, approach and resolution of problems in the framework of the exercise of their profession.
CE1. Solve mathematical problems that may arise in engineering and apply knowledge of linear algebra, differential and integral calculus, numerical methods, numerical algorithms, statistics, differential equations and in partial derivatives, complex and transformed variables.
CE22. Design, plan and estimate the costs of an engineering project.
CT1. Work in multidisciplinary and international teams as well as organize and plan work making the right decisions based on available information, gathering and interpreting relevant data to make judgments and critical thinking within the area of study.
RA1. To have acquired sufficient knowledge and proved a sufficiently deep comprehension of the basic principles, both theoretical and practical, and methodology of the more important fields in science and technology as to be able to work successfully in them;
RA2. To be able, using arguments, strategies and procedures developed by themselves, to apply their knowledge and abilities to the successful solution of complex technological problems that require creating and innovative thinking;
RA3. To be able to search for, collect and interpret relevant information and data to back up their conclusions including, whenever needed, the consideration of any social, scientific and ethical aspects relevant in their field of study;
RA6. To be aware of their own shortcomings and formative needs in their field of specialty, and to be able to plan and organize their own training with a high degree of independence.

DESCRIPTION OF CONTENTS: PROGRAMME

1. Complex numbers
- Number sets
- The need for complex numbers
- Binomial form of complex numbers
- Graphical representation
- Operations
- Conjugate, module and 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 systems
- Geometric interpretation
- Existence and uniqueness
- Matrix notation
- Gaussian elimination
- Equivalence by rows, echelon form
- Resolution of linear systems
- Homogeneous systems
- Simultaneous resolution
- Systems with parameters

3. The vector space Cn
- Vectors
- Vector subspaces
- Linear combinations
- Subspace spanned by a set
- Column and row spaces
- The matrix equation Ax=b
- Null space
- Revisiting linear systems
- Linear independence
- Base of a vector subspace
- Dimension of a vector subspace
- Bases of Col A, Row A and Nul A
- Rank of a matrix
- Coordinate systems
- Introduction to linear transformations

4. Matrix algebra
- Operations with matrices
- Transposition of a matrix
- Conjugated transposition of a matrix
- Inverse of a matrix
- Block matrices
- Determinants

5. Eigenvalues and eigenvectors
- Eigenvectors and eigenvalues
- The characteristic equation
- Diagonalization
- Change of basis
- Linear transformations between vector spaces

6. Orthogonality
- Scalar product and module
- Orthogonal sets
- Unitary matrices
- Orthogonal complement
- Orthogonal projections
- The Gram-Schmidt process
- Least squares problems
- Singular value decomposition

LEARNING ACTIVITIES AND METHODOLOGY

AF1. THEORETICAL-PRACTICAL CLASSES. Knowledge and concepts students mustacquire. Receive course notes and will have basic reference texts.Students partake in exercises to resolve practical problems

AF2. TUTORING SESSIONS. Individualized attendance (individual tutoring) or in-group (group tutoring) for students with a teacher.Subjects with 6 credits have 4 hours of tutoring/ 100% on- site attendance.
AF3. STUDENT INDIVIDUAL WORK OR GROUP WORK.Subjects with 6 credits have 98 hours/0% on-site.
AF9. FINAL EXAM. Global assessment of knowledge, skills and capacities acquired throughout the course. It entails 4 hours/100% on-site
MD1. THEORY CLASS. Classroom presentations by the teacher with IT and audiovisual support in which the subject`s main concepts are developed, while providing material and bibliography to complement student learning
MD2. PRACTICAL CLASS. Resolution of practical cases and problem, posed by the teacher, and carried out individually or in a group
MD3. TUTORING SESSIONS. Individualized attendance (individual tutoring sessions) or in-group (group tutoring sessions) for students with teacher as tutor. Subjects with 6 credits have 4 hours of tutoring/100% on-site.

ASSESSMENT SYSTEM

SE1. FINAL EXAM. Global assessment of knowledge, skills and capacities acquired throughout the course.The percentage of the evaluation will be 60%.
SE2. CONTINUOUS EVALUATION. Two partial tests covering at least 70% of the subject with a percentage of 40% of the final grade.

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

BASIC BIBLIOGRAPHY

- B. Noble and J.W. Daniel Applied linear algebra, Prentice Hall, 1988
- D.C. Lay, S.R. Lay and J.J MacDonald Linear algebra and its applications, Pearson, 2016
- G. Strang Introduction to Linear Algebra, Cambridge, 2016
- S.A. García and R.A. Horn A second course in linear algebra, Cambridge, 2017
- Sergei Treil Linear Algebra Done Wrong, Edited by the author, available from https://www.math.brown.edu/~treil/papers/LADW/LADW.html, 2017 (last update)

ADDITIONAL BIBLIOGRAPHY

- C.D. Meyer Matrix Analysis and Applied Linear Algebra, SIAM, 2000
- R.A. Horn and C.R. Johnson Matrix Analysis, 2nd edition, Cambridge, 2013

BASIC ELECTRONIC RESOURCES

- Sergei Treil . Linear Algebra done wrong: https://www.math.brown.edu/~treil/papers/LADW/LADW.html