Course guide
240011 - 240011 - Linear Algebra

Last modified: 14/06/2023

Unit in charge: Barcelona School of Industrial Engineering
Teaching unit: 749 - MAT - Department of Mathematics.

Degree: BACHELOR'S DEGREE IN INDUSTRIAL TECHNOLOGY ENGINEERING (Syllabus 2010). (Compulsory subject).

Academic year: 2023 **ECTS Credits:** 6.0 **Languages:** Catalan, Spanish

LECTURER

Coordinating lecturer: Amorós Torrent, Jaume

Others: Mancebo Sevilla, Antonio
Limón Morón, Antonio
Raventos Lorenzo, Joan
Fernandez Sanchez, Jesus
González Hernández, Laura
Garcia Planas, Maria Isabel
Frias Rodriguez, Jose Antonio
Amoros Torrent, Jaume
Hernando Martin, M.Del Carmen

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CE1. Capacity to solve mathematical problems that can appear in engineering . Aptitude to apply knowledge about: linear algebra; geometry; differential geometry; differential and integral calculus; differential equations and derived partial equations; numerical methods; numerical algorithm; statistics and optimisation.

Transversal:
04 COE. EFFICIENT ORAL AND WRITTEN COMMUNICATION. Communicating verbally and in writing about learning outcomes, thought-building and decision-making. Taking part in debates about issues related to the own field of specialization.
05 TEQ. TEAMWORK. Being able to work as a team player, either as a member or as a leader. Contributing to projects pragmatically and responsibly, by reaching commitments in accordance to the resources that are available.
07 AAT. SELF-DIRECTED LEARNING. Detecting gaps in one's knowledge and overcoming them through critical self-appraisal. Choosing the best path for broadening one's knowledge.

TEACHING METHODOLOGY

In the theory sessions the basic syllabus is introduced, illustrating with examples the main notions and results. In the problem sessions, exercises and problems which the student has previously solved are discussed with a view towards the consolidation of the concepts introduced in the theory lectures. At the same time, modelization problems are laid out in order to contrast the capabilities of Linear Algebra in Applied Science and Engineering.
The student body will be initiated in the solution of Linear Algebra problems with a computer, using the software Matlab / Octave. This introduction is two-pronged:
- At the Mathematics Works, which are the coordinated laboratory class of the Linear Algebra and Calculus 1 courses, the students debut in numerical computation and programation with Matlab.
- At the regular problem class, in each lesson problems on the applicacion of the course to Applied Science and Engineering will be proposed. The scale of the required computations for their solution will make necessary the use of the computer.

LEARNING OBJECTIVES OF THE SUBJECT

The objectives are:
i) To provide a comprehensive treatment of the Theory of Matrices required by the various technological disciplines. In this sense the concepts and techniques that are introduced are illustrated with elementary engineering applications. Suitable for the treatment of cases with high-dimensional tools are presented in the same sense.
ii) Sign in handling matrices for solving systems of equations apply to large differences in different areas of engineering.
iii) Acquisition of knowledge and basic principles on the geometry of vector spaces.
iv) Understanding the role of linear applications in the context of vector spaces and their relationship with matrix algebra.

STUDY LOAD

Type	Hours	Percentage
Hours large group	56,0	37.33
Self study	90,0	60.00
Hours small group	4,0	2.67

Total learning time: 150 h

CONTENTS

UNIT 1: ALGEBRAIC STRUCTURES

Description:
COMPLEX NUMBERS: operations; binomial and exponential forms; roots of complex numbers; applications
POLYNOMIALS: roots; fundamental theorem of algebra; factorization in prime polynomials; Taylor's development.
MATRICES AND DETERMINANTS: operations and particular types of arrays; elemental transformations (reduction of Gauss); rank of a matrix; determining an array (elementary properties, calculation); reverse matrices; applications
EQUATION SYSTEMS: discussion of systems (Rouché-Frobenius); resolution (Gauss, Cramer); matrix systems; examples and applications

Full-or-part-time: 43h
Theory classes: 16h
Laboratory classes: 1h
Self study : 26h

UNIT 2: VECTOR SPACES AND LINEAR APPLICATIONS

Description:
VECTOR SPACES: definition and examples (R ^ n, matrices, spaces of polynomials, etc.); bases; dimension (tma Steinitz); coordinates and base change matrix; examples and applications (color codes, crystal-logistic networks, vector physical magnitudes, electrical magnitudes, vibrations, demographic models for cohorts).
VECTOR SUBSPACES: adapted bases; subspaces defined by equations and by generators; intersection and sum of subspaces direct sum; Grassmann formula.
LINEAR MAPS: matrix of a linear map; Kernel and Image; Range of a linear application; injectivity, exhaustivity and bijectivitat; isomorphisms; Applications.

Full-or-part-time: 60h
Theory classes: 22h
Laboratory classes: 2h
Self study : 36h

UNIT 3: DIAGONALIZATION

Description:
DIAGONALIZATION: invariant subspaces; eigenvectors and values; diagonalizable matrices; calculation of eigenvalues and eigenvectors, characteristic polynomial, algebraic and geometric multiplicity; diagonalization criterion; particular cases (different eigenvalues, symmetric, circulating, applications in Engineering).
NON-DIAGONALIZABLE MATRIX: canonical form of Jordan and base in dimension two.
LINEAR DYNAMICS: powers of a matrix; exponential of an array; discrete linear dynamical systems, asymptotic distributions.

Full-or-part-time: 47h
Theory classes: 18h
Laboratory classes: 1h
Self study : 28h

GRADING SYSTEM

Grade assesment will consist of four components:
- A grade for participation in class (AC), resulting from the participation in the activities that the lecturer in each group proposes.
- A midterm test (EP), on the date determined by the School.
- A test about the Mathematics Workshop (ET).
- The final exam (EF), on the date set by the School.

The final grade (NF) will be calculated as follows:
NF=max(10% AC+10% ET+30% EP + 50% EF, 10% AC+10% ET+80% EF)
In case of not overcoming the subject, the student has the possibility to be re-assessed on the date set by the school (July)
The reassessment note will be calculated as follows:
NF=10% AC+10% ET+80% ER
where ER is the grade obtained for the re-assessment exam and AC, ET are respectively the gradefor participating in class and the grade for the Mathematics Workshop test.

EXAMINATION RULES.

IT material will just be allowed to use in the algebra workshop evaluation.
In all the other evaluations, a one sheet personal formulary will be allowed to check. (one DIN. A4 sheet maximum). calculator may not be used.

BIBLIOGRAPHY

Basic:
- Hernández Rodríguez, Eugenio ; Ma Jesús Vázquez ; Ma Ángeles Zurro. Álgebra lineal y Geometría [on line]. 3a ed. Madrid: Pearson, 2012 [Consultation: 14/07/2022]. Available on: https://www-ingebook-com.recursos.biblioteca.upc.edu/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=1210. ISBN 9788478291298.
- Friedberg, S., Insel, A., Spence, L.. Linear algebra. 4th ed. Harlow, Essex: Pearson Education, 2014. ISBN 9781292026503.

Complementary:
- Palais, Richard s.. A modern course on curves and surfaces [on line]. Virtual Math Museum, 2003 [Consultation: 22/06/2022]. Available on: https://virtualmathmuseum.org/Surface/a/bk/curves_surfaces_palais.pdf.

RESOURCES

Other resources:
On the page of the subject that is located at Athena, the necessary resources for the subject, problems lists, bibliography, etc. will appear.