Syllabus
2023 - 2024

GENERAL INFORMATION

Data of the subject	
Subject name	Algebra and Geometry
Subject code	DMA-GITI-101
Mainprogram	Bachelor's Degree in Engineering for Industrial Technologies
Involved programs	Grado en Ingeniería en Tecnologías Industriales y Grado en Administración y Dirección de Empresas [First year] Grado en Ingeniería en Tecnologías Industriales [First year]
Level	Reglada Grado Europeo
Quarter	Anual
Credits	9,0 ECTS
Type	Básico
Department	Department of Applied Mathematics
Coordinator	Estrella Alonso Pérez

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DESCRIPTION OF THE SUBJECT

Contextualization of the subject

Prerequisites

This course is an introduction to Linear Algebra and Differential Geometry. It focuses on providing the basic tools from the lineal algebra and differential geometry and in showing some of their applications in the engineering field. All the contents will be analyzed including several examples taken from the real life or other sciences like physics, economics, etc. The theoretical classes complement each other with the laboratory where the problems are solved using the computer.

Basic knowledge of Algebra, Geometry and Real Analysis is required for attending this course.

Course contents

Contents

Part I

1. Matrices. Elementary matrix operations. Rank of a matrix. Inverse matrix. Elementary square matrices. Determinants and Linear Systems. Properties of determinants. Gauss elimination. Numerical methods: Triangular factorization and iterative methods.
2. Introduction to Vector Spaces. Vector subspaces. Linear independence and dependence. Basis and dimension. Coordinates and change of basis.
3. Introduction to Linear Transformations. Kernel and range. The associated matrix to a linear transformation. Composition of linear transformations.
4. Eigenvalues and Eigenvectors. The Jordan Canonical Form. Characteristic Polynomial. Invariant subspaces. Diagonalization. Cayley-Hamilton theorem. Approximation of eigenvalues and eigenvectors.

Part II

1. Inner Product Spaces. Inner products and norms. Orthogonal projections. Gram-Schmidt process. Least squares. Diagonalization of symmetric matrices.
2. Affine Spaces. Definition and properties. Affine subspaces. Orthogonal transformations and Affine transformations. Introduction and properties. Movements on affine spaces.
3. Introduction to curves. Length of an arc of curve. The moving frame. The Frenet formulas. The Helix. Evolutes and involutes. Envelope of a family of curves in the plane.
4. Introduction to surfaces. The tangent plane. Revolution surfaces. Ruled surfaces. Curves on a surface.

Laboratory

There will be five 1-hour sessions during the course, between the third and the last lecture week.

1. Introduction to MATLAB. Matrices and Determinants.
2. Systems of Linear Equations.
3. Vector Spaces.
4. Linear Transformations. Eigenvalues, Eigenvectors and Jordan Canonical Form.
5. Euclidean Vector Space.

EVALUATION AND CRITERIA

Evaluation activities	Evaluation criteria	Weight
Theoretical-practical exams: • Mid term exams (1.5-hour long) (25%) • Final term exams (60%)	• Understanding of concepts • Application of concepts, techniques and procedures to problem solving • Analysis and interpretation of the results obtained in the resolution of problems • Presentation and written communication	85
Continuous performance evaluation: • Short continuous assessment tests	• Understanding of concepts • Application of concepts, techniques and procedures to problem solving • Analysis and interpretation of the results obtained in the resolution of problems • Presentation and written communication	10
Evaluation of the experimental wok: • Practice exam with MATLAB (at the end of the second semester)	• Understanding of concepts • Application of concepts, techniques and procedures to practice problem solving • Mastery in solving problems with the help of the computer and specific software • Analysis and interpretation of the results obtained in the problems solved with a computer	5

Grading

- The grade obtained in the partials/final exams must be at least 4 over 10 to take into account the previous ponderations of the overall assessment criteria. In other case, the term overall grade will be the grade obtained in the exam.
- The final second term exam will only cover the contents taught in the second term, if the first term overall grade is at least 4 over 10. In other casa, it will cover all the contents of the course.
- The following conditions must be accomplished to pass the course:
    - If the first term overall grade was at least 4, then the second term overall grade must be at least 4 over 10 and the average of both overall grades (first and second terms) must be at least 5 over 10.
    - If the first term overall grade was less than 4, then the second term overall grade must be at least 5 over 10.

BIBLIOGRAPHY AND RESOURCES

Basic References

- De la Villa, A. Problemas de Álgebra con esquemas teóricos. Ed. CLAGSA. Madrid 2010.
- López de la Rica, A. y De la Villa, A. Geometría Diferencial. Ed. CLAGSA. Madrid 1997.
- Strang G. Introduction to Linear Algebra (4th edition).
- Bretscher O. Linear Algebra with applications (4th edition).