Course guide
300500 - ALG - Algebra

Last modified: 04/07/2024

Unit in charge: Castelldefels School of Telecommunications and Aerospace Engineering
Teaching unit: 749 - MAT - Department of Mathematics.

Degree: BACHELOR'S DEGREE IN SATELLITE ENGINEERING (Syllabus 2024). (Compulsory subject).

Academic year: 2024 **ECTS Credits:** 6.0 **Languages:** Spanish

LECTURER

Coordinating lecturer: Definido a la infoweb de la asignatura.

Others: Definido a la infoweb de la asignatura.

TEACHING METHODOLOGY

In the theory lectures the fundamental concepts of the subjet will be introduced, and basic exercises and problem solving techniques will be presented. In the problems' sessions, exercises and problems proposed a priori by the lecturer and autonomously prepared by the students will be dicussed and solved.

There will be some sessions where the students will have to bring their computer, so to design Matlab programs that solve problems of the subject (without using, thus, paper and pen).

LEARNING OBJECTIVES OF THE SUBJECT

CONTENTS

1. Systems of Linear Equations, Matrices, and Determinants

Description:
1.1 Matrices. Matrix operations. Inverse matrix. Rank. Gauss method.
1.2 Determinants.
1.3 Systems of linear equations. Discussion and resolution of systems.

Specific objectives:
Operate with matrices and compute the rank.
Compute determinants.
Discuss and solve systems of linear equations.

Related activities:
Problem solving
Two sessions with PCs for problem solving with Matlab
Control 1
Mid-semester exam

Full-or-part-time: 20h
Theory classes: 7h
Self study : 13h

2. Vector Spaces

Description:
2.1 Vector spaces and subspaces. Subspace generated by a set: linear combination. Linear dependence and independence. Generating systems.
2.2 Bases. Dimension. Coordinates of a vector in a basis. Change of basis.

Specific objectives:
Check linear dependence and independence among vectors in â□□^n.
Compute a basis and the dimension of a vector space.
Compute transformations of vectors between bases.

Related activities:
Problem solving
Two sessions with PCs for problem solving with Matlab
Control 1
Mid-semester exam

Full-or-part-time: 20h
Theory classes: 9h
Self study : 11h

3. Linear Applications. Diagonalization.

Description:
3.1 Definitions and properties. Kernel and image. Matrix associated with a linear application. Change of basis in linear applications.
3.2 Endomorphisms. Eigenvalues and eigenvectors. Diagonalization.
3.3 Scalar product. Orthonormal bases. Orthogonal projection. Rotations in the plane and in space.
3.4 Geometry of the plane and space.

Specific objectives:
Compute the matrix associated with a linear application, its kernel, and its image.
Perform basis changes between linear applications.
Diagonalize matrices, find their eigenvalues and eigenvectors.
Compute orthogonal projections and rotations in the plane and space.
Become familiar with geometric operations in Euclidean plane and space.

Related activities:
Problem solving
Two sessions with PCs for problem solving with Matlab
Control 1
Mid-semester exam

Full-or-part-time: 27h
Theory classes: 12h
Self study : 15h

4. First-Order Ordinary Differential Equations

Description:
4.1 Basic concepts.
4.2 Existence and uniqueness of solutions.
4.3 Separable variable equations.
4.4 Qualitative study of solutions in First-Order Ordinary Differential Equations.

Specific objectives:
Identify problems solved using differential equations.
Understand existence and uniqueness of solutions.
Solve some basic types of first-order ordinary differential equations and perform a qualitative analysis of their solutions.

Related activities:
Problem solving
One session with PCs for problem solving with Matlab
Control 2
Final semester exam

Full-or-part-time: 27h
Theory classes: 12h
Self study : 15h

5. Linear Equations of Order Greater than or Equal to 1 and Systems of Ordinary Differential Equations

Description:
5.1 Linear equations of order greater than or equal to 1 with constant coefficients.
5.2 Transformation of higher-order linear equations into systems of first-order linear equations.
5.3 Homogeneous and non-homogeneous systems.
5.4 Qualitative study of solutions in linear systems. Linearization and qualitative study of solutions in nonlinear systems.
5.5 Applications of Differential Equations and Systems.

Specific objectives:
Solve linear equations with constant coefficients of order 1 or higher.
Transform higher-order differential equations into linear systems.
Solve homogeneous and non-homogeneous systems.
Perform a qualitative analysis of solutions in linear systems and study the stability of critical points.
Applications to satellite engineering problems.

Related activities:
Problem solving
Two sessions with PCs for problem solving with Matlab
Control 2
Final semester exam

Full-or-part-time: 33h
Theory classes: 15h
Self study : 18h

6. Partial Differential Equations

Description:
6.1 Fourier series.
6.2 Classification of partial differential equations.
6.3 Solving the Wave Equation, the One-Dimensional Heat Equation, and the Laplace Equation using the method of separation of variables.

Specific objectives:
Analyzing elements of Fourier series.
Classifying partial differential equations according to their discriminant.
Solving some basic types of partial differential equations using the method of separation of variables.

Related activities:
Problem solving
One session with PCs for problem solving with Matlab
Control 2
Final semester exam

Full-or-part-time: 11h
Theory classes: 5h
Self study : 6h

ACTIVITIES

Control 1

Description:
Written or PC-based test conducted during class hours, covering contents 1 and 2.

Specific objectives:
Continuous assessment, aiming to encourage ongoing engagement with the subject by students.

Full-or-part-time: 7h
Self study: 5h
Theory classes: 2h

Control 2

Description:
Written or PC-based test conducted during class hours, covering contents 4 and 5.

Specific objectives:
Continuous assessment, aiming to encourage ongoing engagement with the subject by students.

Full-or-part-time: 7h
Theory classes: 2h
Self study: 5h

Practice 1 with PCs

Description:
Test conducted during and outside class hours using PCs to solve subject-related problems through programming. Duration in class: 2 hours.

Specific objectives:
Learn programming languages for solving mathematical problems related to satellite engineering. The test will include exercises similar to those practiced in previous classes.

Full-or-part-time: 6h
Theory classes: 2h
Self study: 4h

Practice 2 with PCs

Description:
Test conducted during and outside class hours using PCs to solve subject-related problems through programming. Duration in class: 2 hours.

Specific objectives:
Learn programming languages for solving mathematical problems related to satellite engineering. The test will include exercises similar to those practiced in previous classes.

Full-or-part-time: 6h
Theory classes: 2h
Self study: 4h

Mid-Semester Exam

Description:
Written exam conducted during the midterm exam week, covering contents 1, 2, and 3.

Specific objectives:
Continuous assessment, aiming to encourage ongoing engagement with the subject by students.

Full-or-part-time: 6h 30m
Self study: 5h
Theory classes: 1h 30m

Final Semester Exam

Description:
Written exam conducted during the final exam week, covering contents 4, 5, and 6.

Specific objectives:
Continuous assessment, aiming to encourage ongoing engagement with the subject by students.

Full-or-part-time: 6h 30m
Self study: 5h
Theory classes: 1h 30m

GRADING SYSTEM

Defined at the subjects' infoweb.

EXAMINATION RULES.

Tests are done during lecture sessions, dates are previously announced in ATENEA. Mid and final term exams are done in the dates scheduled by EETAC.
Tests and exams must be done individually. The use of books or notes is not allowed.

BIBLIOGRAPHY

Basic:
- Lay, David C.; Murrieta Murrieta, Jesús Elmer; Alfaro Pastor, Javier.. Álgebra lineal y sus aplicaciones [en línia] [on line]. 3a. . México: Pearson Educación, 2007 [Consultation: 15/05/2020]. Available on: http://www.ingebook.com/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=6765. ISBN 9702609062.
- Amorós, J.. Apuntes J. Amorós, UPC [on line]. [Consultation: 27/06/2024]. Available on: https://web.mat.upc.edu/jaume.amoros/alglin.pdf.
- Braun, M.. Ecuaciones diferenciales y sus aplicaciones. Grupo Editorial Iberoamerica., 1991.
- Nagle, R. Kent. Ecuaciones diferenciales y problemas con valores en la frontera. 3a. Mexico: Pearson Educación, 2001.

Complementary:
- Williams, Gareth; Hano Roa, Ma. del Carmen. Álgebra lineal con aplicaciones . 4ª ed. México [etc.] : McGraw-Hill, cop. 2002. ISBN 970103838X.
- Anton, Howard; Rorres, Chris. Elementary linear algebra with supplemental applications : international student version . 10th ed. Hoboken, New Jersey : Wiley, cop. 2011. ISBN 9780470561577.
- Perko, L.. Differential Equations and Dynamical Systems. Springer-Verlag, 1991.
- Zill, Dennis G; García Hernández, Ana Elizabeth; Filio López, Ernesto. Ecuaciones diferenciales con aplicaciones de modelado . 9a ed. México, D. F. [etc.] : Cengage Learning, cop. 2009. ISBN 9708300551.

RESOURCES

Other resources:
- Course schedule with syllabus.
- Initial knowledge material.
- Slides of the contents of the course.
- List of exercises of the course.
- Examples of tests and exams from previous years.
- Links to notes, summaries and videos related to the concepts of the subject.

All of them are made available through ATENEA.