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300200 - AG - Algebra and Geometry

Coordinating unit: 300 - EETAC - Castelldefels School of Telecommunications and Aerospace Engineering
Teaching unit: 749 - MAT - Department of Mathematics
Academic year: 2018
Degree: BACHELOR'S DEGREE IN AEROSPACE SYSTEMS ENGINEERING (Syllabus 2015). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN AEROSPACE SYSTEMS ENGINEERINGS/BACHELOR'S DEGREE IN TELECOMMUNICATIONS SYSTEMS ENGINEERING - NETWORK ENGINEERING (AGRUPACIÓ DE SIMULTANEÏTAT) (Syllabus 2015). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN AEROSPACE SYSTEMS ENGINEERING/BACHELOR'S DEGREE IN TELECOMMUNICATIONS SYSTEMS ENGINEERING (Syllabus 2015). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN AEROSPACE SYSTEMS ENGINEERING/BACHELOR'S DEGREE IN NETWORK ENGINEERING (Syllabus 2015). (Teaching unit Compulsory)
ECTS credits: 6 Teaching languages: Catalan, Spanish

Teaching staff

Coordinator: Definit a la infoweb de l'assignatura.

Others: Definit a la infoweb de l'assignatura.

Opening hours

Timetable: Available in the EETAC infoweb

Prior skills

Upper secondary school mathematics.
The ability to work with abstract concepts.
Familiarity with the concept of a function and the graphic representation of a function.
The ability to perform mathematical calculations, simplifications of algebraic expressions and calculus of elementary functions of one variable.

Degree competences to which the subject contributes

Specific:

1. CE 1 AERO. Capacidad para la resolución de los problemas matemáticos que puedan plantearse en la ingeniería. Aptitud para aplicar los conocimientos sobre: álgebra lineal; geometría; geometría diferencial; cálculo diferencial e integral; ecuaciones diferenciales y en derivadas parciales; métodos numéricos; algorítmica numérica; estadística y optimización. (CIN/308/2009, BOE 18.2.2009)

Transversal:

2. SELF-DIRECTED LEARNING - Level 1. Completing set tasks within established deadlines. Working with recommended information sources according to the guidelines set by lecturers.
3. TEAMWORK - Level 1. Working in a team and making positive contributions once the aims and group and individual responsibilities have been defined. Reaching joint decisions on the strategy to be followed.

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Teaching methodology

Theory sessions are used to explain theoretical concepts and to solve example problems. These sessions combine expository and participatory (cooperative learning) models. There are two sessions lasting 90 minutes each per week.
In problem-solving classes, the focus is on students solving the problems themselves, although the lecturer will provide guidance if they have any questions. There is one hour of problem-solving each week, in which students solve problems from the course list.
Directed activities may include independent preparation of class material for the following week, for a laboratory activity or for individual or group work on problems in class.
Individual feedback is given to each student in the form of comments or corrections on his or her coursework, tests and examinations, in person or via the digital campus.
Work group attendance, organisation and conflict resolution are monitored during the course, as is the reorganisation of groups at the end of the course).

Learning objectives of the subject

On completion of Algebra and Geometry, students will be able to:
- carry out operations with complex numbers in binomial and exponential form (Euler's formula) and apply the fundamental theorem of algebra to polynomial root calculation;
- solve linear equation systems;
- carry out operations with matrices;
- enumerate and apply the properties of vector spaces;
- characterise linear applications, apply changes of basis and diagonalise matrices;
- carry out operations with scalar products, manipulate bases and use basic orthonormalisation techniques;
- geometrically interpret and solve the most common first-order differential equations, linear differential equations of order n and systems of first-order linear differential equations with constant coefficients, and find specific solutions;
- define the Laplace transform and its main properties;
- calculate the Laplace transform of common functions and the inverse transform of rational functions by partial fraction decomposition and using the convolution theorem;
- apply the Laplace transform to initial value problems and solve initial value problems with general functions (Dirac delta) and continuous piecewise functions.

Study load

Total learning time: 150h	Hours large group:	39h	26.00%
	Hours medium group:	12h	8.00%
	Guided activities:	15h	10.00%
	Self study:	84h	56.00%

Content

Complex Numbers	Learning time: 12h 30m Theory classes: 3h 30m Practical classes: 1h Laboratory classes: 0h Guided activities: 1h Self study : 7h

Description:

1.1 Binomial, polar and exponential forms; Operations: Sum, product, quotient, powers, roots of unity.
1.2 Fundamental theorem of algebra and polynomial decomposition.

Related activities:

Test 1, AD T1.

Linear Equation Systems, Matrices and Determinants	Learning time: 34h 15m Theory classes: 8h 15m Practical classes: 2h Laboratory classes: 0h Guided activities: 3h Self study : 21h

Description:

2.1 Matrices; Operations with matrices; Inverse matrices; Rank; Gauss method.
2.2 Determinants.
2.3 Linear equation systems; Discussion and solution of systems; Cramer's rule; The superposition principle.
2.4 Vector spaces and subspaces; Subspace generated by a set: Linear combinations; Linear dependence and independence; Generator systems.
2.5 Bases; Dimension; Coordinates of a vector basis; Change of basis.
2.6 Operations with subspaces: Direct sum.

Related activities:

Test 1, ADs T2.

Linear Operators. Diagonalisation.	Learning time: 36h 15m Theory classes: 8h 15m Practical classes: 3h Laboratory classes: 0h Guided activities: 4h Self study : 21h

Description:
3.1 Definitions and properties; Kernel and image; Matrix of a linear application; Change of basis in linear applications.
3.2 Diagonalisable endomorphisms and matrices; Eigenvectors and eigenvalues; Characteristic polynomial.
3.3 Diagonalisation; First decomposition theorem.

Related activities:
ADs T3.

Differential Equations	Learning time: 24h 20m Theory classes: 6h 20m Practical classes: 2h Laboratory classes: 0h Guided activities: 2h Self study : 14h

Description:
4.1 First-order differential equations; Definition; Separable, linear and homogeneous equations; Exact differential equations.
4.2 Higher-order linear differential equations with constant coefficients; Test method for obtaining a specific solution in the inhomogeneous case.

Related activities:
Test 2, AD T4.

Laplace Transform	Learning time: 42h 40m Theory classes: 12h 40m Practical classes: 4h Laboratory classes: 0h Guided activities: 5h Self study : 21h

Description:

5.1 The Laplace transform; Definition; Properties; Inverse of a rational function; Application to initial value problem solving; Heaviside function; Laplace transform of piecewise functions; General functions; Dirac delta; Impulse response and transfer function; Convolution theorem.
5.2 Linear differential systems of equations with constant coefficients; Substitution method; Homogeneous and inhomogeneous systems; Application of the Laplace transform.

Related activities:

Test 2, ADs T5.

Planning of activities

TEST 1

Hours: 10h 45m
Theory classes: 0h 45m
Practical classes: 0h
Laboratory classes: 0h
Guided activities: 0h
Self study: 10h

Description:
Test at the end of Topic 2.

Descriptions of the assignments due and their relation to the assessment:
Work to submit: Completed test
Proportion of final mark: 15%

Specific objectives:
To assess each student's assimilation of Topics 1 and 2.

TEST 2

Hours: 10h 45m
Theory classes: 0h 45m
Practical classes: 0h
Laboratory classes: 0h
Guided activities: 0h
Self study: 10h

Description:
Test at the end of Topic 4.

Descriptions of the assignments due and their relation to the assessment:
Work to submit: Completed test
Proportion of final mark: 10%

Specific objectives:
To assess each student's assimilation of Topic 4 and first properties of Topic 5.

DIRECTED ACTIVITIES, TOPIC 1

Hours: 3h
Theory classes: 0h
Practical classes: 0h
Laboratory classes: 0h
Guided activities: 1h
Self study: 2h

Description:
During the AD session we will work on exercises related to complex numbers, that students will have already solve at home. Some of the problems will be solved on the blackboard by teachers and/or students. We will discuss collectively both, the method used and the solutions obtained.

Support materials:
The individual notes and the list of exercises of the subject.

Descriptions of the assignments due and their relation to the assessment:
Work to submit voluntary with the report on the coursework completed.

Specific objectives:
To acquire confidence with operations on binomial and exponential form of complex numbers, and calculating roots. To develop the capacity of solving problems. To acquire, independently, the knowledge that is necessary to solve outside the classroom the list of problems. To develop the capacity to communicate orally, in a clear and efficient way.

DIRECTED ACTIVITIES, TOPIC 2	Hours: 8h Theory classes: 0h Practical classes: 0h Laboratory classes: 0h Guided activities: 4h Self study: 4h

Description:
Linear algebra methods. Solving systems of equations using the Gauss method, with the corresponding programming. Computer programming for solving determinants.
Applications: adjacency matrices of graphs. Activities are completed in groups but there will be an individual test.

Support materials:
Individual notes of the subject and other materials that will be available on Atenea.

Descriptions of the assignments due and their relation to the assessment:
Work to submit: Report on the coursework completed for each AD.

Specific objectives:
To acquire confidence in the application of computer-based methods for solving common problems in linear algebra, in particular the Gauss method for systems of equations. Computational resources are used to solve linear algebra problems that cannot be solved manually (systems with multiple equations and unknowns, etc.).
Introduction to linear programming with two variables.

DIRECTED ACTIVITY, TOPIC 3	Hours: 6h Theory classes: 0h Practical classes: 0h Laboratory classes: 0h Guided activities: 4h Self study: 2h

Description:
The students have to solve some basic exercises and more elaborated problems about linear applications and diagonalizations. In some of the cases, they will do it individually and in others in groups. The problems will be explained in the classroom.

Support materials:
The individual notes of the subject.

Descriptions of the assignments due and their relation to the assessment:
Work to submit voluntary: Report on the coursework completed.

Specific objectives:
To acquire confidence with linear applications and specially to endomorphisms. To develop the capacity of solving problems. To acquire, independently, the knowledge that is necessary to solve outside the classroom the list of problems. To promote the efficient oral and specially written communication, with special attention to the mathematical language.

DIRECTED ACTIVITY, TOPIC 4

Hours: 4h
Theory classes: 0h
Practical classes: 0h
Laboratory classes: 0h
Guided activities: 2h
Self study: 2h

Description:
Apply a numerical method to solve a mathematical problem (Euler's method for solving differential equations). Activity completed in groups and individually. Students complete a series of questions on a specific problem to be solved using computers.

Support materials:
Material de l'activitat, available on Atenea.

Descriptions of the assignments due and their relation to the assessment:
Work to submit: Report on the coursework completed for the AD.

Specific objectives:
To acquire advanced knowledge of numerical methods, program a method for solving an ODE. This helps students to assimilate the concepts of exact and approximate differential equations and how they are solved.

DIRECTED ACTIVITIES, TOPIC 5

Hours: 9h
Theory classes: 0h
Practical classes: 0h
Laboratory classes: 0h
Guided activities: 5h
Self study: 4h

Description:
The students have to solve some basic exercises and more elaborated problems about linear applications and diagonalizations. In some of the cases, they will do it individually and in others in groups. The problems will be explained in the classroom.

Support materials:
The individual notes of the subject and other materials available on Atenea.

Descriptions of the assignments due and their relation to the assessment:
Work to submit voluntay: Report on the coursework completed.

Specific objectives:

Calculate the inverse Laplace transform of rational functions with simple complex roots by partial fraction decomposition. Compare the three methods according to the type of decomposition and the resulting function equations.

Transform piecewise functions using the Heaviside function. Calculate the inverse transforms of functions that are a product of a F(s) for an exponential e^{-as}. Solve initial value problems involving the aforementioned functions.

Qualification system

The qualification criteria that will apply are defined in the infoweb of the subject

Regulations for carrying out activities

1) The two examinations, each lasting the standard 90 minutes, are carried out during the official periods established by the School. Students must work individually and without assistance of any kind.
2) The two tests last approximately 45 minutes each and are held during lecture hours. Each student must work in class and individually. The tests are used to complete the learning process for Topics 2 and 4. The end of Topic 3 coincides approximately with the scheduled date of the mid-semester examination.
3) The directed activities are completed either individually or in groups of 2 o 3 people.

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Bibliography

Basic:

Braun, Martin. Ecuaciones diferenciales y sus aplicaciones. México, D.F.: Grupo Editorial Iberoamérica, 1990. ISBN 9687270586.

Spiegel, Murray R. Transformadas de Laplace. Mexico [etc.]: McGraw-Hill, 1991. ISBN 9684228813.

Lay, David C.; Murrieta Murrieta, Jesús Elmer; Alfaro Pastor, Javier. Álgebra lineal y sus aplicaciones. 3a. México [etc.]: Pearson Educación, 2007. ISBN 9702609062.

Pelayo Melero, Ignacio M.; Rubio Montaner, Francisco. Álgebra lineal básica para ingeniería civil. Barcelona: Edicions UPC, 2008. ISBN 9788483019610.

Complementary:

Anton, Howard; Rorres, Chris. Elementary linear algebra with supplemental applications : international student version. 10th. Hoboken, New Jersey: Wiley, 2011. ISBN 9780470561577.

Williams, Gareth; Hano Roa, Ma. del Carmen. Álgebra lineal con aplicaciones. 4a ed. México [etc.]: McGraw-Hill, cop. 2002. ISBN 970103838X.

Marcellán, Francisco; Casasus, Luis; Zarzo, Alejandro. Ecuaciones diferenciales : problemas lineales y aplicaciones. Madrid, [etc.]: McGraw-Hill, 1990. ISBN 8476155115.

Others resources:

Material available on the digital campus (Atenea):
- Lists of example problems.
- Course notes.
- Question sheets for directed activities.

Web link about ordinary differential equations:
http://canek.uam.mx/index ?secc=8