# Course guide
# 300200 - AG - Algebra and Geometry

**Last modified:** 01/06/2023

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

**Degree:** BACHELOR'S DEGREE IN AEROSPACE SYSTEMS ENGINEERING (Syllabus 2015). (Compulsory subject).

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

## LECTURER

**Coordinating lecturer:** Definit a la infoweb de l'assignatura.

**Others:** Definit a la infoweb de l'assignatura.

## 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:**
CE1. 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)

**Generical:**
CG1. (ENG) CG1 - Capacidad para el diseño, desarrollo y gestión en el ámbito de la ingeniería aeronáutica que tengan por objeto, de acuerdo con los conocimientos adquiridos, los vehículos aeroespaciales, los sistemas de propulsión aeroespacial, los materiales aeroespaciales, las infraestructuras aeroportuarias, las infraestructuras de aeronavegación y cualquier sistema de gestión del espacio, del trafico y del transporte aéreo.
CG2. (ENG) CG2 - Planificación, redacción, dirección y gestión de proyectos, cálculo y fabricación en el ámbito de la ingeniería aeronáutica que tengan por objeto, de acuerdo con los conocimientos adquiridos, los vehículos aeroespaciales, los sistemas de propulsión aeroespacial, los materiales aeroespaciales, las infraestructuras aeroportuarias, las infraestructuras de aeronavegación y cualquier sistema de gestión del espacio, del trafico y del transporte aéreo.

**Transversal:**
CT6. SELF-DIRECTED LEARNING - Level 1. Completing set tasks within established deadlines. Working with recommended information sources according to the guidelines set by lecturers.

**Basic:**
CB1. (ENG) CB1 - Que los estudiantes hayan demostrado poseer y comprender conocimientos en un área de estudio que parte de la base de la
educación secundaria general, y se suele encontrar a un nivel que, si bien se apoya en libros de texto avanzados, incluye también algunos aspectos que implican conocimientos procedentes de la vanguardia de su campo de estudio
CB2. (ENG) CB2 - Que los estudiantes sepan aplicar sus conocimientos a su trabajo o vocación de una forma profesional y posean las competencias que suelen demostrarse por medio de la elaboración y defensa de argumentos y la resolución de problemas dentro de su área de estudio
CB3. (ENG) CB3 - Que los estudiantes tengan la capacidad de reunir e interpretar datos relevantes (normalmente dentro de su área de estudio)
para emitir juicios que incluyan una reflexión sobre temas relevantes de índole social, científica o ética
CB4. (ENG) CB4 - Que los estudiantes puedan transmitir información, ideas, problemas y soluciones a un público tanto especializado como no especializado
CB5. (ENG) CB5 - Que los estudiantes hayan desarrollado aquellas habilidades de aprendizaje necesarias para emprender estudios posteriores con un alto grado de autonomíA

## TEACHING METHODOLOGY

In the theory sessions, fundamental concepts of the subject will be introduced and the basic techniques will be presented for the solution of exercises and problems.

In the problem-solving sessions, problems proposed a priori by the faculty and prepared by the students autonomously will be discussed and solved.

## 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;
- 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

| Type | Hours | Percentage |
|---|---|---|
| Self study | 84,0 | 56.00 |
| Hours large group | 39,0 | 26.00 |
| Guided activities | 15,0 | 10.00 |
| Hours medium group | 12,0 | 8.00 |

**Total learning time:** 150 h

## CONTENTS

### Content 1: Complex Numbers

**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 C1, Mid term exam and Final term exam.

**Full-or-part-time:** 14h 10m
Theory classes: 3h 30m
Practical classes: 1h
Guided activities: 1h 20m
Self study : 8h 20m

### Content 2: Linear Systems, Matrices and Determinants

**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.

**Related activities:**
Test C1, Mid term exam and Final term exam.

**Full-or-part-time:** 15h 30m
Theory classes: 3h 20m
Practical classes: 1h
Guided activities: 1h 20m
Self study : 9h 50m

### Content 3: Linear spaces

**Description:**
3.1 Vector spaces and subspaces; Subspace generated by a set: Linear combinations; Linear dependence and independence; Generator systems.
3.2 Bases; Dimension; Coordinates of a vector basis; Change of basis.
3.3 Operations with subspaces. Direct sum.

**Related activities:**
Test C1, Mid term exam and Final term exam.

**Full-or-part-time:** 17h 05m
Theory classes: 4h 55m
Practical classes: 1h
Guided activities: 1h 20m
Self study : 9h 50m

**Content 4: Linear mappings. Diagonalisation.**

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

**Related activities:**
Mid term exam and Final exam.

**Full-or-part-time:** 36h 15m
Theory classes: 8h 15m
Practical classes: 3h
Guided activities: 4h
Self study : 21h

**Content 5: Differential Equations**

**Description:**
5.1 First-order differential equations; Definition; Separable, linear and homogeneous equations.
5.2 Higher-order linear differential equations with constant coefficients; Test method for obtaining a specific solution in the inhomogeneous case.
5.3 Sistems of linear differential equations with constant coefficients.

**Related activities:**
Test C2 and Finalexam.

**Full-or-part-time:** 24h 20m
Theory classes: 6h 20m
Practical classes: 2h
Guided activities: 2h
Self study : 14h

**Content 6: Laplace Transform**

**Description:**
6.1 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.
6.2 Use of the Laplace Transform to solve linear differential systems of equations with constant coefficients.

**Related activities:**
Final exam.

**Full-or-part-time:** 42h 40m
Theory classes: 12h 40m
Practical classes: 4h
Guided activities: 5h
Self study : 21h

## ACTIVITIES

### Activity 1: Test C1

**Description:**
Test on contents 1, 2 and 3.

**Full-or-part-time:** 10h 45m
Theory classes: 0h 45m
Self study: 10h

### Activity 2: Test C2

**Description:**
Test on content 5.

**Full-or-part-time:** 10h 45m
Theory classes: 0h 45m
Self study: 10h

### Activity 3: Mid term exam

**Description:**
Exam on contents 1,2,3 and 4.

**Full-or-part-time:** 3h
Guided activities: 1h 30m
Self study: 1h 30m

### Activity 4: Final exam

**Description:**
Examen on contents 1, 2, 3, 4, 5 and 6.

**Delivery:**

**Full-or-part-time:** 8h
Guided activities: 2h
Self study: 6h

## GRADING SYSTEM

Available in the subject's infoweb.

The end-of-term exam allows you to recover the grade of the mid-term exam. In the event that it is effectively recovered, the mark of the mid-term exam will be replaced by the mark of the end-of-term exam, which will weigh 65% of the final mark. However, in order to guarantee a real continuous assessment, only students who have taken all the exams and tests (passed or failed) will be able to recover the mark of the mid-term exam.

## EXAMINATION RULES.

Tests are done in class hours and on dates announced in advance in ATENEA. Mid term and final examins are done on the dates scheduled by the EETAC.

Exams and tests are done individually. Books, notes, calculators, computer equipment and mobile phones are not allowed.

## BIBLIOGRAPHY

**Basic:**

- Lay, David C.; Murrieta Murrieta, Jesús Elmer; Alfaro Pastor, Javier. Álgebra lineal y sus aplicaciones [on line]. 3a. México [etc.]: 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.
- Pelayo Melero, Ignacio M.; Rubio Montaner, Francisco. Álgebra lineal básica para ingeniería civil. Barcelona: Edicions UPC, 2008. ISBN 9788483019610.
- 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.

**Complementary:**

- Anton, Howard; Rorres, Chris. Elementary linear algebra with supplemental applications : international student version. 10th. Hoboken, New Jersey: Wiley, 2011. ISBN 9780470561577.
- Marcellán, Francisco; Casasus, Luis; Zarzo, Alejandro. Ecuaciones diferenciales : problemas lineales y aplicaciones. Madrid, [etc.]: McGraw-Hill, 1990. ISBN 8476155115.
- Williams, Gareth; Hano Roa, Ma. del Carmen. Álgebra lineal con aplicaciones. 4a ed. México [etc.]: McGraw-Hill, cop. 2002. ISBN 970103838X.

## RESOURCES

**Other 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