Course guide
300205 - AM - Further Mathematics

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

The students must have achieved skill in the calculation of the integrals proposed in the asignaturas of the 1A.
It is advisable to have passed or studied simultaneously Calculus, Algebra and Geometry.

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)

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:
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.

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 large group sessions (theory) theoretical concepts are worked on and illustrative problems are solved. These sessions combine the exhibition model with participatory. There are two theory sessions of 1.5 hours a week.

In the classes of problems priority prioritizes the resolution of problems by part of the students, with a more personalized attention by part of the profesorado of the difficulties of the alumnado. There are one hour of problems a week, where exercises are solved from the list of problems of the subject.

The directed activities include the preparation of previous material autonomously for the following week, and sessions of realization of problems individually or in groups.

Frequent and personalized feedback is given to each student, through the corrections and comments of the works, controls and exams and the publication of qualifications in the Digital Campus.

On the other hand, the working groups are monitored (attendance control, operation, conflict resolution and eventual reallocation of groups).

LEARNING OBJECTIVES OF THE SUBJECT

At the end of the subject Further Mathematics, the student must be able to:

· Calculate double and triple integrals and apply change of variables.
· Define the concepts: scalar field and vector field, length of a curve, area of a surface, volume of a body.
· Determine, from the concepts, the length of a curve, the area of a surface and the volume of a body.
· Identify: gradient, rotational, divergence (using the nabla operator) the different types of integrals according to the dimension of the variety and depending on the field, scalar or vector.
· Use the nabla operator to differentiate between gradient, rotational and divergence.
· Explain the meaning of the conservative field and apply vector theorems.
· Develop fourier serial functions (trigonometric and exponential) regular periodic functions and represent the discrete frequency spectrum.
· Apply Parseval's identity and Dirichlet's theorem to the calculation of sums of numerical series.
· Define and use the Fourier transform and its main properties.
· Obtain and interpret the frequency spectrum of common non-recurring functions.
· Apply the convolution theorem and Parseval theorem. Use some widespread functions (distributions).

STUDY LOAD

Type	Hours	Percentage
Hours large group	39,0	26.00
Self study	84,0	56.00
Hours medium group	13,0	8.67
Guided activities	14,0	9.33

Total learning time: 150 h

CONTENTS

Integration into two and three dimensions.

Description:
Double integrals. Changes in variables (Cartesian and polar coordinates). Triple integrals. Changes in variables (Cartesian, spherical and cylindrical coordinates).

Related activities:
Activities 1 and 9.

Full-or-part-time: 22h 30m
Theory classes: 6h
Practical classes: 2h
Guided activities: 2h
Self study : 12h 30m

(ENG) 2 Integració sobre una corba

Description:
Description of curves using different types of ccordinates. Scalar fields and vector fields. Line integrals.

Related activities:
Activities 2 and 9.

Full-or-part-time: 11h
Theory classes: 3h
Practical classes: 1h
Guided activities: 1h
Self study : 6h

(ENG) 3 Integració sobre una superfície

Description:
Expression of some surfaces in Cartesian coordinates. Surface parameterization. Area of a surface. Integral on a surface of a scalar function. Integral on a surface of a vector function.

Related activities:
Activities 3 and 10.

Full-or-part-time: 22h 30m
Theory classes: 6h
Practical classes: 2h
Guided activities: 2h
Self study : 12h 30m

(ENG) 4 Teoremes vectorials

Description:
Nabla operator. Gradient, rotational and divergence. Green's theorem: application to area calculation. Stokes' theorem. Gauss's theorem. Conservative vector fields.

Related activities:
Activities 4 and 10.

Full-or-part-time: 24h
Theory classes: 6h
Practical classes: 2h
Guided activities: 3h
Self study : 13h

Numerical series and Fourier series

Description:
Introduction to sequences and numerical series. Harmonic and geometrical series.
Fourier series associated to a periodic function. Fourier series of even and odd functions . Sine and cosine series. Convergence and Gibbs phenomenon, convergence in quadratic average. Bessel's inequality and Parseval's identity. Complex Fourier series. Frequency spectrum. Complex shape of the series of Fourier. Spectrum of frequency.

Related activities:
Activities 5, 6 and 11.

Full-or-part-time: 34h
Theory classes: 9h
Practical classes: 3h
Guided activities: 3h
Self study : 19h

Fourier Transform

Description:
The Fourier Transform: definition, properties and calculation. Properties of the transform of a real function. Parseval's identity and the energy spectrum. The convolution theorem. Generalised functions: transformed of the heaviside function and the delta comb, convoluting with a delta. Relation between the Fourier and the Laplace transforms.

Related activities:
Activities 7, 8 and 12.

Full-or-part-time: 36h
Theory classes: 9h
Practical classes: 3h
Guided activities: 3h
Self study : 21h

ACTIVITIES

INTEGRATION SESSION

Description:
Students must solve some basic exercises and more elaborate problems, previously commissioned and that can be carried out and delivered individually or shared in small groups in the classroom.

Specific objectives:
Calculate double and triple integrals.

Material:
Integration Material (Available on the Digital Campus).

Delivery:
Deliverable1: IDT1 Problems

Full-or-part-time: 4h
Guided activities: 2h
Self study: 2h

VECTOR ANALYSIS 1

Description:
Students must solve some basic exercises and more elaborate problems, previously commissioned and that can be carried out and delivered individually or shared in small groups in the classroom.

Specific objectives:
Calculate line integrals and curve lengths.

Material:
Material Vector Analysis 1 (Available on the Digital Campus).

Delivery:
Deliverable 2: Vector Analysis 1

Full-or-part-time: 4h
Guided activities: 2h
Self study: 2h

VECTOR ANALYSIS SESSION

Description:
Students must solve some basic exercises and more elaborate problems, previously commissioned and that can be carried out and delivered individually or shared in small groups in the classroom.

Specific objectives:
Calculate surface integrals and surface areas.

Material:
Material Vector Analysis 2 (Available on the Digital Campus).

Delivery:
Deliverable 3: Vector Analysis Problems 2.

Full-or-part-time: 4h
Guided activities: 2h
Self study: 2h

VECTOR ANALYSIS 3

Description:
Students must solve some basic exercises and more elaborate problems, previously commissioned and that can be carried out and delivered individually or shared in small groups in the classroom.

Specific objectives:
Application of vector theorems.

Material:
Material Vector Analysis 3 (Available on the Digital Campus).

Delivery:
Deliverable 4: Vector Analysis Problems 3.
Link with the evaluation: Section deliverable in group.

Full-or-part-time: 4h
Guided activities: 2h
Self study: 2h

NUMERICAL SERIES

Description:
Students must solve some basic exercises and more elaborate problems, previously commissioned and that can be carried out and delivered individually or shared in small groups in the classroom.

Specific objectives:
To calculate the sum of certain numerical series (geometric, or using Parseval's identity and Dirichlet's theorem).

Material:
SN material (Available on the Digital Campus).

Delivery:
Deliverable 5: Application problems solved in the classroom.
Link with the evaluation: Section deliverable in group .

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

FOURIER SERIES

Description:
Students must solve some basic exercises and more elaborate problems, previously commissioned and that can be carried out and delivered individually or shared in small groups in the classroom.

Specific objectives:
To know the basic characteristics of the periodic functions and values of the integrals of sine and cosine products in the range [-p,p]. Knowing the basic characteristics of even functions and odd functions and the decomposition of a function are in addition to a couple function plus an odd function. Observe the graphic representation of a square wave and other signals and the first terms of its Fourier series, as well as the behavior at discontinuity points.

Material:
SF material (Available on the Digital Campus).

Delivery:
This activity has no deliverable associated because the objective is that after this activity the student must have the necessary prior knowledge to understand the serial development of Fourier of a periodic signal.

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

FOURIER TRANSFORM 1

Description:
Students must solve some basic exercises and more elaborate problems, previously commissioned and that can be carried out and delivered individually or shared in small groups in the classroom.

Specific objectives:
Know and apply the basic properties of the Fourier transform.

Material:
MATERIAL OF FOURIER TRANSFORM (Available on the Digital Campus).

Delivery:
Deliverable 6: Application problems solved in the classroom.
Link with the evaluation: Section deliverable in group.

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

FOURIER TRANSFORM 2

Description:
Students must solve some basic exercises and more elaborate problems, previously commissioned and that can be carried out and delivered individually or shared in small groups in the classroom.

Specific objectives:
Know and apply the basic properties of the Fourier transform of a real function. Know the sine and cosine transform and their relationship with the Fourier transform in the case of even and odd functions. To know and apply Parseval's identity.

Material:
Material of FOURIER TRANSFORM 2 (Available on the Digital Campus).

Delivery:
Deliverable 7: Application problems solved in the classroom.
Link with the evaluation: Section deliverable in group.

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

(ENG) TÍTOL ACTIVITAT 10: CONTROL 1

Description:
Individual control. Resolution of exercises similar to those that include lists of problems worked in class.

Specific objectives:
Calculate double and triple integrals and integral line and curve lengths.

Material:
Notes of the subject and lists of problems available on the Digital Campus.

Delivery:
Solved Control
Link with the evaluation: Controls section

Full-or-part-time: 10h 50m
Theory classes: 0h 50m
Self study: 10h

(ENG) TÍTOL ACTIVITAT 12: CONTROL 3

Description:
Individual control. Resolution of exercises similar to those that include lists of problems worked in class.

Specific objectives:
Calculate the series development of trigonometric and complex Fourier of a periodic function. Application of Dirichlet's theorem and Parseval's relationship.

Material:
Notes of the subject and lists of problems available on the Digital Campus.

Delivery:
Control resolved.
Link with the evaluation: Controls section

Full-or-part-time: 10h 50m
Theory classes: 0h 50m
Self study: 10h

GRADING SYSTEM

The evaluation criteria defined in the infoweb of the subject will be applied.

EXAMINATION RULES.

The controls are done during theory or problem class hours.

The first exam is done in the middle of the semester (week without classes).
The second exam takes place the week after the end of the semester classes.

BIBLIOGRAPHY

Basic:
- Hsu, Hwei P.; Mehra, Raj. Análisis de Fourier. Argentina [etc.]: Addison-Wesley Iberoamericana, 1987. ISBN 9684443560.
- Marsden, Jerrold E.; Tromba, Anthony. Cálculo vectorial [on line]. 5ª. Madrid [etc.]: Addison Wesley, 2004 [Consultation: 26/07/2022]. Available on: https://www-ingebook-com.recursos.biblioteca.upc.edu/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=7634. ISBN 8478290699.

Complementary:
- Lathi, B. P. (Bhagwandas Pannalal). Introducción a la teoría y sistemas de comunicación. México, [etc.]: Limusa : Noriega, 1974. ISBN 9681805550.
- Larson, Ron; Hostetler, Robert P.; Edwards, Bruce H. Cálculo. Vol. 2, Cálculo 2 de varias variables. 8a. Madrid [etc.]: McGraw-Hill, 2006. ISBN 9701052757.
- Marsden, Jerrold E.; Tromba, Anthony; Pao, Karen; Soon, Frederick H. Cálculo vectorial : problemas resueltos. 3ª ed. Argentina [etc.]: Addison-Wesley Iberoamericana, 1993. ISBN 0201625644.
- Morrison, Norman. Introduction to Fourier Analysis : Instructor's Manual. New York: John Wiley & Sons, 1995. ISBN 0471128481.
- Bradley, Gerald L.; Smith, Karl J. Cálculo. Madrid [etc.]: Prentice Hall, 1998. ISBN 8483220415.

RESOURCES

Other resources:
Material available on the Digital Campus (Atenea):

1) Specific material for cooperative learning sessions
2) Notes of the subject
3) Problem Lists