Course guide
300242 - AM2 - Further Mathematics 2

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: 2022  ECTS Credits: 7.5  Languages: Catalan, Spanish

LECTURER

Coordinating lecturer: Definit a la infoweb de l’assignatura.
Others: Definit a la infoweb de l’assignatura.

PRIOR SKILLS


REQUIREMENTS

Have passed or be enrolled in 1A: Algebra and Geometry and Calculus and 1B Further Mathematics

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; algoritmicça numèrica; estadística y optimización. (CIN/308/2009, BOE 18.2.2009)

General:
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 tráfico y del transporte aéreo.

Transversal:
CT6. SELF-DIRECTED LEARNING - Level 2: Completing set tasks based on the guidelines set by lecturers. Devoting the time needed to complete each task, including personal contributions and expanding on the recommended information sources.
CT3. EFFICIENT ORAL AND WRITTEN COMMUNICATION - Level 2. Using strategies for preparing and giving oral presentations. Writing texts and documents whose content is coherent, well structured and free of spelling and grammatical errors.
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 implica 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.
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
There are four 1-hour theory sessions per week. In theory sessions, theoretical concepts are worked out and illustrative exercises are solved. These sessions combine the expository model with the participatory one.
In problem sessions, exercises from the list of problems are solved encouraging problem solving by the students through a more personalized attention.
In the lab sessions, specific software is used to solve problems that require a computer. Students work in a small group on some problems (AD or supervised activities) that may require the use of a computer and which will be delivered at the end.
Frequent and personalized feedback is given to each student, through marking and comments on laboratory work, supervised activities, controls and exams and the publication of grades on the Digital Campus.

LEARNING OBJECTIVES OF THE SUBJECT
The student must be able to:
Distinguish between random and deterministic experiences.
Apply counting techniques.
Distinguish between continuous random variables and discrete random variables. Distinguish the different random variables introduced in the syllabus. Calculate probabilities for each of the random variables.
Determine confidence intervals for the mean and standard deviation of a population. Perform linear regressions from data.
Introduce the theory of graphs and networks and study basic algorithms.
Basic study of stochastic processes and queuing theory.
Manipulate a statistical data package to simulate simple random experiences.
Determine the error made in approximating a function by the Taylor polynomial.
Calculate and manipulate series of powers of elementary functions.
Derive numerically by the proposed methods. Solve ordinary differential equations and partial derivatives using the proposed numerical methods.
Calculate basic properties of graphs. Know and apply some basic algorithms on graphs and networks (PageRank, Kruskal, Prim, Dijkstra, Christofides).

STUDY LOAD

<table>
<thead>
<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours large group</td>
<td>52,0</td>
<td>27.73</td>
</tr>
<tr>
<td>Self study</td>
<td>105,0</td>
<td>56.00</td>
</tr>
<tr>
<td>Guided activities</td>
<td>30,5</td>
<td>16.27</td>
</tr>
</tbody>
</table>

Total learning time: 187.5 h
## CONTENTS

### Ordered, unordered samples, with and without replacement. Combinatorial numbers and properties.

**Description:**
Ordered, unordered samples, with and without replacement. Combinatorial numbers and properties.

**Specific objectives:**
Mathematical formulation and ability to calculate how many different combinations or options are obtained with different methods of selecting elements from a given set.

**Related activities:**
Supervised activity 1. Control 1

**Full-or-part-time:** 20h
- Theory classes: 6h
- Laboratory classes: 2h
- Guided activities: 2h
- Self study: 10h

### Probability

**Description:**

**Specific objectives:**
Mathematical meaning of probability and ability to determine the probability that a given event occurs, when random experiments are performed.

**Related activities:**
Supervised activity 1. Control 1

**Full-or-part-time:** 20h
- Theory classes: 6h
- Laboratory classes: 2h
- Guided activities: 2h
- Self study: 10h

### Probability distributions

**Description:**
Random variables. Expected value and variance.

**Specific objectives:**
Knowledge of the most relevant probability distributions. Application to specific problems.

**Related activities:**
Supervised activity 2. Minitab lab session. Control 1

**Full-or-part-time:** 20h
- Theory classes: 6h
- Laboratory classes: 2h
- Guided activities: 2h
- Self study: 10h
### Random samples. Estimators.

**Description:**
Random samples. Estimators.
Confidence intervals for the mean and standard deviation of a population.

**Specific objectives:**
Knowledge and application of sampling techniques and estimators. Determination of confidence intervals.

**Related activities:**
Supervised activity 2. Minitab lab session. Control 1

**Full-or-part-time:** 10h
- Theory classes: 3h
- Laboratory classes: 1h
- Guided activities: 1h
- Self study: 5h

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### Linear regression.

**Description:**
Simple linear model. Estimation by least squares. Correlation

**Specific objectives:**
Determine correlations in linear models.

**Related activities:**

**Full-or-part-time:** 9h 30m
- Theory classes: 2h 30m
- Laboratory classes: 1h
- Guided activities: 1h
- Self study: 5h

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### Queueing theory

**Description:**
Introduction to Poisson stochastic processes. Exponential queues M/M/ with finite and infinite population. Mean time in the system, in the queue and service time. Mean number of users in the system, in the queue and being serviced. Equations of the queue in stationary regime. Probabilities of the states in stationary regime.

**Specific objectives:**
Knowledge and applications of stochastic processes and queueing theory.

**Related activities:**
Supervised activity 2. Mid term exam.

**Full-or-part-time:** 16h
- Theory classes: 4h
- Laboratory classes: 1h 30m
- Guided activities: 1h 30m
- Self study: 9h
**Taylor formula. Power series.**

**Description:**

**Specific objectives:**
Study the convergence of a power series and its sum. Control the error when truncating a power series.

**Related activities:**
Supervised activity 3. Control 2

**Full-or-part-time:** 16h
- Theory classes: 4h
- Laboratory classes: 1h
- Guided activities: 1h
- Self study: 10h

**Numerical methods for differential equations.**

**Description:**

**Specific objectives:**
Numerical methods to solve ordinary differential equations and partial differential equations.

**Related activities:**

**Full-or-part-time:** 54h 30m
- Theory classes: 14h
- Laboratory classes: 3h
- Guided activities: 3h 30m
- Self study: 34h

**Graph theory and algorithms**

**Description:**

**Specific objectives:**
Basic knowledge on graph theory, networks and algorithms.

**Related activities:**
Supervised activity 4. Final exam.

**Full-or-part-time:** 21h 30m
- Theory classes: 6h 30m
- Laboratory classes: 1h 30m
- Guided activities: 1h 30m
- Self study: 12h
# ACTIVITIES

## Control 1

**Description:**
Control on counting techniques and probability. Solving exercises similar to those in the lists worked in class.

**Specific objectives:**
Verify learning process

**Delivery:**
15% in final mark

**Full-or-part-time:** 1h
Theory classes: 1h

## Control 2

**Description:**
Control on numerical methods. Resolution of exercises similar to those worked in class.

**Specific objectives:**
Verify

**Delivery:**
15% of final mark.

**Full-or-part-time:** 1h
Theory classes: 1h

## Minitab lab session.

**Description:**
Minitab lab session. Simulations of random experiences. Most usual probability distributions. Simulations of random experiments: Samples and Estimation.

**Specific objectives:**
Learn Minitab instructions needed to work out the results seen in problem classes. Simulation of random experiments with software.

**Full-or-part-time:** 3h
Laboratory classes: 1h 30m
Self study: 1h 30m
Supervised activities 1,2,3,4.

**Description:**
Solve in a small group one or more problems previously worked individually and following the script of the corresponding AD.

**Specific objectives:**
Solve in a small group one or more problems previously worked individually and following the script of the corresponding AD.

**Material:**
List of solved exercises, Guide for the AD.

**Delivery:**
A report on each directed activity. Total weight in the final grade 10%

**Full-or-part-time:** 10h
Laboratory classes: 5h
Self study: 5h

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**Midterm exam**

**Description:**
Assessment of the first part of the course. (25% of the overall grade)

**Specific objectives:**
Verify the level of achievement of the subjects studied.

**Delivery:**
Written exam.

**Full-or-part-time:** 1h 30m
Theory classes: 1h 30m

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**Final exam**

**Description:**
Assessment of the first part of the course. (25% of the overall grade)

**Specific objectives:**
Verify the level of achievement of the subjects studied.

**Delivery:**
Written exam.

**Full-or-part-time:** 1h 30m
Theory classes: 1h 30m

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**GRADING SYSTEM**

Evaluation criteria is defined elsewhere.

**EXAMINATION RULES.**

All activities are mandatory. Exams and controls will be carried out individually.
BIBLIOGRAPHY

Basic:

Complementary:
- Lipschutz, Seymour; Schiller, John J.; Cortiñas Vázquez, Pedro; Santos Peña, Julián; Muñoz Alamillas, Ángel; Guzmán Justicia, Luis. Introducción a la probabilidad y estadística. Madrid [etc.]: McGraw-Hill/Interamericana de España, 2001. ISBN 8448125045.