Course guide
330222 - MAE - Advanced Engineering Mathematics

Last modified: 04/05/2023

Unit in charge: Manresa School of Engineering
Teaching unit: 749 - MAT - Department of Mathematics.

Degree: BACHELOR'S DEGREE IN ICT SYSTEMS ENGINEERING (Syllabus 2010). (Compulsory subject).

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

LECTURER

Coordinating lecturer: Domenech Blazquez, Margarita

Others: Alsina Aubach, Montserrat
Cors Iglesias, Josep M.
Freixas Bosch, Josep
Gimenez Pradales, Jose Miguel
Puente Del Campo, Maria Albina
Rossell Garriga, Josep Maria
Rubió Massegú, Josep
Ventura Capell, Enric
Samaniego Vidal, Daniel

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
1. Ability to solve mathematical problems that may arise in engineering. Ability to apply the knowledge of: linear algebra, differential and integral calculus, differential equations, numerical methods, numerical algorithms and optimization

Transversal:
2. 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.
3. TEAMWORK - Level 2. Contributing to the consolidation of a team by planning targets and working efficiently to favor communication, task assignment and cohesion.
4. 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.

TEACHING METHODOLOGY

In the lectures, the professor introduces the theory, concepts, methods and results pertaining to the subject and illustrates them with examples that aid comprehension.
Students are required to work independently to assimilate the concepts and do the exercises proposed, by hand or with the help of a computer.
Face-to-face sessions take place in small groups. The professor answers students' queries after their independent study and/or students carry out practicals.
Activities 1, 2 and 3 are part of the face-to-face sessions in a small group and Activity 4 is part of the face-to-face sessions in a large group.

LEARNING OBJECTIVES OF THE SUBJECT

On completion of the subject Mathematics III, students must be able to:
- Solve differential equations and Fourier analysis problems with the help of Maple software without difficulties.
- Think in increasingly abstract terms.
- Understand and apply deductive reasoning.
- Organise and apply theoretical knowledge to solve concrete problems.
- Interpret the results obtained with the help of computer tools.

STUDY LOAD

Type	Hours	Percentage
Hours large group	30,0	20.00
Hours small group	30,0	20.00
Self study	90,0	60.00

Total learning time: 150 h

CONTENTS

1. ORDINARY DIFFERENTIAL EQUATIONS

Description:
- First-order ODEs. Euler method.
- Second-order linear ODEs with constant coefficients. Applications.
- Nth-order homogeneous linear ODEs with constant coefficients.

Related activities:
Test E1 and Activities A1 and A2

Full-or-part-time: 31h
Theory classes: 4h
Laboratory classes: 5h
Self study : 22h

2. LAPLACE TRANSFORM

Description:
- Definition and properties.
- Inverse transform. Properties.
- Application to solving linear ODEs with constant coefficients and initial conditions.

Related activities:
Test E1 and Activity A2

Full-or-part-time: 30h
Theory classes: 6h
Laboratory classes: 6h
Self study : 18h

3. NUMERICAL SERIES AND FOURIER SERIES

Description:
- Numerical series. Criteria of convergence.
- Fourier series. Dirichlet's theorem.
- Exponential form of the Fourier series. Parseval's identity.

Related activities:
Test E2 and Activity A3

Full-or-part-time: 40h
Theory classes: 9h
Laboratory classes: 9h
Self study : 22h

4. FOURIER TRANSFORM

Description:
- Definition and properties.
- Inverse transform and properties.
- Convolution.
- Application to the study of linear systems.

Related activities:
Test E2 and Activity A3

Full-or-part-time: 40h
Theory classes: 9h
Laboratory classes: 9h
Self study : 22h

5. PARTIAL DIFFERENTIAL EQUATIONS

Description:
- Definition and examples.
- Separation of variables and Fourier series to solve PDEs.

Related activities:
Activity A3.

Full-or-part-time: 9h
Theory classes: 2h
Laboratory classes: 1h
Self study : 6h

ACTIVITIES

ACTIVITY A1: SECOND-ORDER LINEAR ODE'S WITH CONSTANT COEFFICIENTS. APPLICATIONS.

Description:
Two-part activity: group work and individual assessment.

Specific objectives:
At the end of the activity the student should be able to:
1. Solve given LRC-series electrical circuit problems using undetermined Coefficients—Annihilator Approach.
2. Solve given LRC-series electrical circuit problems using numerical procedures.

Material:
Software that is available in the computer room and student license.
Guidelines for practicals, lists of problems, bibliography and a variety of materials available on ATENEA.

Delivery:
The assignment must be handed in to the professor.
It must be completed to pass the subject by continuous assessment.
It is a part of continuous theoretical assessment and laboratory teaching.

Full-or-part-time: 3h
Self study: 3h

Activity 2: A2: Differential Equations and Laplace Transform

Description:
An activity that must be carried out individually in the computer room.

Specific objectives:
On completion of the activity, students must be able to:
1. Solve an ordinary differential equation.
2. Calculate the Laplace transform of a function.
3. Apply the Laplace transform to solve a linear ODE.

Material:
Software that is available in the computer room.
Guidelines for practicals, lists of problems and a variety of materials available on ATENEA.

Delivery:
The assignment must be handed in to the professor.
It must be completed to pass the subject by continuous assessment.
It forms part of continuous assessment and laboratory teaching.

Full-or-part-time: 4h
Laboratory classes: 1h
Self study: 3h

ACTIVITY A3: FOURIER SERIES AND TRANSFORM. PARTIAL DIFFERENTIAL EQUATIONS.

Description:
An activity that must be carried out individually in the computer room.

Specific objectives:
On completion of the activity, students must be able to:
On completion of the activity, students must be able to:
1. Identify whether a numerical series is convergent or divergent.
2. Calculate the trigonometric Fourier series of a periodic function.
3. Calculate the exponential Fourier series of a periodic function.
4. Calculate the Fourier transform of a function.
5. Apply the Fourier transform to the study of linear systems.

Material:
Software that is available in the computer room.
Guidelines for practicals, lists of problems and a variety of materials available on ATENEA.

Delivery:
The assignment must be handed in to the professor.
It must be completed to pass the subject by continuous assessment.
It forms part of continuous assessment and laboratory teaching.

Full-or-part-time: 4h
Laboratory classes: 1h
Self study: 3h

ACTIVITY 4: WRITTEN TESTS E1 AND E2

Description:
Individual tests in the classroom related to the learning objectives for the subject.

Specific objectives:
To assess the general attainment of the objectives of topics 1, 2, 3 and 4.

Material:
Test statements (delivered at the time of the test).

Delivery:
The answers to the test must be handed in to the professor.
It forms part of continuous assessment.

Full-or-part-time: 16h
Theory classes: 4h
Self study: 12h

GRADING SYSTEM

The mark is calculated from the NE mark corresponding to Activity 4 and the NA mark corresponding to activities 1, 2 and 3, up to a maximum value of 10 for each one.
The learning objectives are considered to have been met if the final mark for continuous assessment NC=0.7*NE+0.3*NA is greater than or equal to 5.
Students with a mark for the subject (NC) of less than 5 may take a final examination (mark: NG).
The student's final mark will be NF=maximum (NC, NG)

EXAMINATION RULES.

All the activities are compulsory.
If students do not carry out one of the activities for the subject, they will be given a mark of 0.

BIBLIOGRAPHY

Basic:
- Zill, Dennis G. Ecuaciones diferenciales con problemas con valores en la frontera. 9a ed.. Cuajimalpa: Cengage Learning, 2018. ISBN 9786075266305.
- Blanchard, Paul; Devaney, R. L.; Hall, Glen R. Differential equations. 4th ed., International ed. S.l: Brooks/Cole, 2011. ISBN 9781133110590.
- Harris K.; Lopez, Robert J. Discovering calculus with Maple. 2nd ed. New York: John Wiley & Sons, 1995. ISBN 0471009733.
- Hsu, Hwei P. Análisis de Fourier [on line]. Argentina: Addison-Wesley Iberoamericana, 1987 [Consultation: 03/04/2024]. Available on : https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=6118465. ISBN 9684443560.

Complementary:
- Gabel, Robert A. Señales y sistemas lineales. México: Limusa, 1975.