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320008 - M3 - Mathematical Methods III

Coordinating unit: 205 - ESEIAAT - Terrassa School of Industrial, Aerospace and Audiovisual Engineering

Teaching unit: 749 - MAT - Department of Mathematics

Academic year: 2019

Degree: BACHELOR'S DEGREE IN MECHANICAL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN TEXTILE TECHNOLOGY AND DESIGN ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN INDUSTRIAL ELECTRONICS AND AUTOMATIC CONTROL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN ELECTRICAL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)

ECTS credits: 6 Teaching languages: Catalan, Spanish

Teaching staff

Coordinator: Teresa Navarro Gonzalo

Others: Víctor Mañosa Fernández i Julian Pfeifle

Prior skills

As a general rule, students will be expected to have passed Mathematics in the first year to be able to take this subject. Specifically, a basic knowledge of integral calculus is considered essential.

Degree competences to which the subject contributes

Specific:

2. (ENG) Capacitat per a la resolució dels problemes matemàtics que puguin platenjar-se a l'enginyeria. Aptitud per aplicar els coneixements sobre: àlgebra lineal; geometria, geometria diferencial; càlcul diferencial i integral; equacions diferencials i amb derivades parcials; mètodes numèrics; algorítmica numèrica; estadística i optimització.

Transversal:

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

3. 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.

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Teaching methodology

- Face-to-face lecture sessions.
- Face-to-face practical work sessions.
- Independent learning and exercises.
- Preparation and completion of individual and/or group activities subject to assessment.

In the face-to-face lecture sessions, the lecturer will introduce the basic theory, concepts, methods and results for the subject and use examples to facilitate students' understanding.

Students will be expected to study in their own time so that they are familiar with concepts and are able to solve the exercises set, either manually or with the help of a computer.

The use of IT support tools will be encouraged: students will learn how to use a mathematical software package as a tool for performing numerical, symbolic and graphic calculations.

Learning objectives of the subject

Familiarise students with the techniques inherent to Fourier Analysis and with the interpretation of signals in the frequency range.
Familiarise students with some of the techniques used in Differential Equations, both Ordinary Equations and Partial Differential Equations. They will be expected to use the deterministic modelling tool and interpret its answers.
Teach students how to apply these techniques properly for solving common practical problems encountered by engineers. Use it software tools for approaching and solving problems. Develop the specific and transversal competencies associated with the academic work.

Study load

Total learning time: 150h	Hours large group:	30h	20.00%
	Hours medium group:	30h	20.00%
	Hours small group:	0h	0.00%
	Guided activities:	0h	0.00%
	Self study:	90h	60.00%

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Content

TOPIC 1: FOURIER SERIES

Learning time: 39h

Theory classes: 8h
Practical classes: 8h
Self study : 23h

Description:
1.1. Numerical series.
1.2. Sequences and function series.
1.3. Fourier series.
1.4. Signal reconstruction. Spectrum.
1.5. Dirichlet's theorem. Uniform and pointwise convergence. Gibbs phenomenon.
1.6. Complex expression. Parseval's identity.

Specific objectives:
For students to:
- Understand the concept of convergence of a numerical series, a sequence of functions and a series of functions.
- Understand the concept of Fourier series representation of a periodic signal and calculate it in real and exponential form.
- Understand the concepts of pointwise convergence vs. uniform convergence, Dirichlet's theorem and Gibbs phenomenon.
- Understand the concepts of spectrum and average signal strength.
- Understand and apply Parseval's theorem.
- Be able to calculate Fourier series and obtain the graphs of the partial sums and the spectra with the help of symbolic computation software.

TOPIC 2: FOURIER TRANSFORM

Learning time: 25h

Theory classes: 4h 30m
Practical classes: 4h 30m
Self study : 16h

Description:
2.1. Deduction and spectrum. Parseval's identity.
2.2. Properties of Fourier transform.
2.3. Frequency description of LTI systems and filters

Specific objectives:
For students to:
- Understand the Fourier transform concept of a non-periodic signal and know how to calculate it.
- Understand the concepts of spectral energy density and Parseval's theorem.
- Understand the main properties of the Fourier transform: linearity, shifts, time scales and convolution.
- Understand the frequency description of LTI systems, in particular for describing filters.
- Calculate Fourier transforms and inverse Fourier transforms and use symbolic computation software to produce graphs of the corresponding spectra.

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TOPIC 3: ORDINARY DIFFERENTIAL EQUATION

Learning time: 38h

Theory classes: 7h
Practical classes: 7h
Self study : 24h

Description:
3.1. General introduction to Ordinary Differential Equations (ODEs).
3.2. First-order linear ODEs.
3.3. Linear ODEs with constant coefficients.
3.4. Interpretation of results.

Specific objectives:
For students to:
- Understand the concept of ordinary differential equation and its solution. Understand the conditions for the existence and uniqueness of a solution to an initial value problem.
- Understand the concept of ODE problem modelling.
- Understand the techniques for the integration of simple ODEs, first-order linear ODEs (in particular the method of variation of parameters), and ODEs with constant coefficients.
- Use a linear ODE with constant coefficients to model the time description of an LTI system.
- Understand the concepts of resonance and stability.
- Solve ODEs and use symbolic computation software to obtain the corresponding graphs.

TOPIC 4: LAPLACE TRANSFORM

Learning time: 22h

Theory classes: 4h
Practical classes: 4h
Self study : 14h

Description:
4.1. Definition of the Laplace Transform (LT).
4.2. Derivative theorem. Initial value problems.
4.3. Properties of LT.
4.4. The inverse LT.

TOPIC 5: ORDINARY DIFFERENTIAL EQUATIONS.

Learning time: 13h

Theory classes: 3h
Practical classes: 3h
Self study : 7h

Description:
5.1. Definition and examples. Solving and phase portrait.
5.2. Homogeneous linear systems. Plane case.

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TOPIC 6: PARTIAL DIFFERENTIAL EQUATIONS	Learning time: 13h Theory classes: 3h 30m Practical classes: 3h 30m Self study : 6h

Description:
6.1. Definition and examples. Wave equation.
6.2. Separation of variables and use of Fourier Series for solving Partial Differential Equations.

Planning of activities

WRITTEN TESTS	Hours: 4h Self study: 4h

Description:
Face-to-face individual events in the timetable set by the School.

Specific objectives:
The student must have successfully achieved the objectives outlined in the contents that have been part of the corresponding test.

OTHER ACTIVITIES	Hours: 10h Self study: 10h

Description:
Tasks related to the subject contents.

Specific objectives:
The student must have successfully achieved the objectives outlined in the contents that have been part of the corresponding task.

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Qualification system

It is evaluated by partial assessments with the following weights:
- 1st exam: 45%
- 2nd exam: 45%
- Tasks: 10%

The note of the 1st exam may be renewed with a second change examination, which will be done on the same date as the day set for the 2nd exam. Any matriculated student may be submitted. The final qualification of the 1st exam will be the highest mark between the 1st exam and the mark of the second change examination.

For those students who meet the requirements and submit to the re-evaluation examination, the grade of the re-evaluation exam will replace the grades of all the evaluation acts during the course.
If the final grade after re-evaluation is lower than 5, it will replace the initial one only if it is higher. If the final grade after re-evaluation is greater or equal to 5, the final grade of the subject will be pass 5.0.

To access the re-evaluation, students must have a final grade higher or iqual to 2.0 but lower than 5.0 during the teaching period.

Regulations for carrying out activities

The assessment consists of the following acts of classroom assessment and/or other activities assessed as part of continuous assessment. If not done any of the events or activities will be considered qualified to zero.

Bibliography

Basic:

Antonijuan, J.; Batlle, C.; Boza, S.; Prat, J. Matemàtiques de la telecomunicació [on line]. Barcelona: UPC, 2001 [Consultation: 11/01/2016]. Available on: <http://hdl.handle.net/2099.3/36249>. ISBN 8483015757.

Zill, D.G. Ecuaciones diferenciales con aplicaciones de modelado. México D.F: International Thomson, 1997. ISBN 968-7529-21-0.

James, Glyn [et al.]. Matemáticas avanzadas para ingeniería. 2ª ed. México: Pearson Educación, 2002. ISBN 9702602092.

Complementary:

Haberman, R. Ecuaciones en derivadas parciales: con series de Fourier y problemas de contorno. Madrid: Prentice Hall, 2003. ISBN 8420535346.

Oppenheim, A.V.; Wilsky, A.S. Señales y sistemas. 2ª ed. México: Prentice Hall, 1997. ISBN 970170116X.

Zill, D.G.; Cullen, M.R. Ecuaciones diferenciales con problemas de valores en la frontera. 5ª ed. Méxic D.F: Thomson, 2002. ISBN 970-686-133-5.

Braun, M. Ecuaciones diferenciales y sus aplicaciones. México D.F: Grupo Editorial Iberoamérica, 1990. ISBN 968-7270-58-6.

Almira, J.M. Matemáticas para la recuperación de señales: una introducción. Jaén: Grupo Editorial Universitario, 2005. ISBN 84-8491-519-0.

Others resources:

- List of exercises of the course.
- Scripts for using MAPLE Software to solve problems.