Course guide
820009 - CNED - Numerical Calculus. Differential Equations

Last modified: 27/10/2022

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

Degree: BACHELOR'S DEGREE IN BIOMEDICAL ENGINEERING (Syllabus 2009). (Compulsory subject).
BACHELOR'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2009). (Compulsory subject).
BACHELOR'S DEGREE IN ELECTRICAL ENGINEERING (Syllabus 2009). (Compulsory subject).
BACHELOR'S DEGREE IN ENERGY ENGINEERING (Syllabus 2009). (Compulsory subject).
BACHELOR'S DEGREE IN INDUSTRIAL ELECTRONICS AND AUTOMATIC CONTROL ENGINEERING (Syllabus 2009). (Compulsory subject).
BACHELOR'S DEGREE IN MECHANICAL ENGINEERING (Syllabus 2009). (Compulsory subject).
BACHELOR'S DEGREE IN MATERIALS ENGINEERING (Syllabus 2010). (Compulsory subject).

Academic year: 2022 **ECTS Credits:** 6.0 **Languages:** Catalan, Spanish

LECTURER

Coordinating lecturer: M. JOSÉ JIMÉNEZ JIMÉNEZ - JOSE JAVIER MUÑOZ ROMERO

Others: Primer quadrimestre:
ENRIC AMADO VICENTE - Grup: T11, Grup: T12
ADRIÀ DOMINGO GIMENEZ - Grup: T31, Grup: T32
RAIMON ELGUETA MONTO - Grup: T31, Grup: T32
ALFONSO ESCOBOSA FERNANDEZ - Grup: T31, Grup: T32
M. JOSÉ JIMÉNEZ JIMÉNEZ - Grup: M11, Grup: M12, Grup: M21, Grup: M22
ALVARO MARTIN LLOPIS - Grup: T11, Grup: T12, Grup: T21, Grup: T22
NURIA PARES MARINE - Grup: M11, Grup: M12, Grup: M21, Grup: M22
MARGARITA TORRE ALCOCEBA - Grup: T21, Grup: T22, Grup: T31, Grup: T32

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
2. Solve mathematical problems that may arise in engineering. Apply knowledge of linear algebra; geometry; differential geometry; differential and integral calculus; differential equations and partial differential equations; numerical methods; numerical algorithms; statistics and optimisation.

Transversal:
1. 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

Apart from the 6 houres per week in the classroom, self-study must las and average of 9 hours per week (40% of the total work at class and 60% of individual work).

LEARNING OBJECTIVES OF THE SUBJECT

Unit 1: Introduce the students to computer simulation explaining its capabilities, potential and limitations. Programming of basic numerical algorithms. Correct and judgeful use of basic numerical methods. Ability to chose the appropriate method for different enginnering applications.
Unit 2: State, analize and numerically and analytically solve ordinary differential equations. Physical interpretation of ode's.
Unit 3: Use of integral transforms in enginneering applications.
Unit 4: State, analize and numerically and analitically solve partial differential equations. Physical interpretation of pde's.

STUDY LOAD

Type	Hours	Percentage
Hours large group	45,0	30.00
Self study	90,0	60.00
Hours small group	15,0	10.00

Total learning time: 150 h

CONTENTS

Unit 1: Basics of numerical calculus

Description:
1.1. Numbers and errors. Finite arithmetic storage. Absolute error, relative error, truncation error. Correct significant digits.
1.2. Roots of functions. Bisection, Newton and secant methods. Convergence criteria. Convergence rates.
1.3. Interpolation and approximation. Pure interpolation. Least squares interpolation. Linear spline.
1.4. Numerical integration. Simple and composite rectangle approximation. Simple and composite trapezoidal rule. Simple and composite Simpson rule. Deduction of the error term and order of convergence of the different methods.

Full-or-part-time: 67h 15m
Theory classes: 18h
Laboratory classes: 9h 30m
Self study : 39h 45m

Unit 2: Ordinary differential equations

Description:
2.1. Ordinary differential equation of first order. Separable ordinary differential equations. Linear first order differential equations.
2.2. Numerical methods for ode's: Euler and Runge-Kutta 4.
2.3. Linear differential equations of order 2 with constant coefficients. Undetermined coefficients method. Variation of constants method.

Full-or-part-time: 36h 15m
Theory classes: 12h
Laboratory classes: 2h 30m
Self study : 21h 45m

Unit 3: Integral transforms and solution of ordinary differential equations

Description:
3.1. Laplace transform and its properties. Invers Laplace transform. Solution of ordinary differential equations and systems of ordinary differential equations.
3.2. Fourier series.

Full-or-part-time: 27h 45m
Theory classes: 9h
Laboratory classes: 1h 30m
Self study : 17h 15m

Unit 4: Partial differential equations

Description:
4.1. Introduction to partial differential equations. Motivation.
4.2. Equations of mathematical fisics. Boundary conditions.

Full-or-part-time: 18h 45m
Theory classes: 6h
Laboratory classes: 1h 30m
Self study : 11h 15m

GRADING SYSTEM

First exam: 30%
Second exam: 40%
Matlab Laboratory: 25%
Generic competence: 5%

Students can pass the course through the continuous assessment based on two exams (a first mid course exam and a second exam during the period fixed in the academic calendar of the school devoted to the final exams) and the delivery of laboratory assessments.

Finally, as detailed in the academic normative of the EEBE, a reevaluation exam will take place (excluding the Matlab Laboratory exam and the Generic Competence). To be able to do the reevaluation exam, the student has to attend to all the evaluation exams of the subject and its mark, N, for the part which can be reevaluated has to be such that 3.0 https://eebe.upc.edu/ca/estudis/normatives-academiques/documents/eebe-normativa-avaluacio-i-permanencia-18-19-aprovat-je-2018-06-13.pdf

EXAMINATION RULES.

In the two exams it will be allowed to use scientific calculators, but NEITHER PROGRAMMABLE NOR GRAPHING calculators .

BIBLIOGRAPHY

Basic:
- Huerta, Antonio; Sarrate, Josep; Rodríguez-Ferran, Antonio. Métodos numéricos : introducción, aplicaciones y programación [on line]. Barcelona: Edicions UPC, Universitat Politècnica de Catalunya, 1998 [Consultation: 21/04/2020]. Available on: http://hdl.handle.net/2099.3/36258. ISBN 8483012650.
- Arias, I. [et al.]. Cálculo avanzado para ingeniería : teoría, problemas resueltos y aplicaciones [on line]. Barcelona: Edicions UPC, 2008 [Consultation: 21/04/2020]. Available on: http://hdl.handle.net/2099.3/36849. ISBN 9788483017609.
- Zill, Dennis G.; Cullen, Michael R. Ecuaciones diferenciales con problemas de valores en la frontera. 7ª ed. México, D.F. [etc.]: Cengage Learning, 2009. ISBN 9789708300384.
- Vázquez, Luís [et al.]. Métodos numéricos para la física y la ingenieria. Madrid: McGraw Hill, cop. 2009. ISBN 9788448166021.

Complementary:
- Çengel, Yunus A.; Palm, William J. Ecuaciones diferenciales : para ingeniería y ciencias. México [etc.]: McGraw-Hill, 2014. ISBN 9786071509895.
- Burden, Richard L.; Faires, J. Douglas. Análisis numérico. 7ª ed. México [etc.]: International Thomson, cop. 2002. ISBN 9706861343.
- Chapra, Steven C.; Canale, Raymond P. Métodos numéricos para ingenieros. 6ª ed. México [etc.]: McGraw-Hill, cop. 2011. ISBN 9786071504999.
- Hoffman, Joe D. Numerical methods for engineers and scientists. 2nd ed. New York [etc.]: Marcel Dekker, cop. 2001. ISBN 0824704436.
- Recktenwald, Gerald W. Numerical methods with MATLAB : implementations and applications. Upper Saddle River: Prentice Hall, cop. 2000. ISBN 0201308606.
- Zill, Dennis G. Ecuaciones diferenciales con aplicaciones de modelado. 9ª ed. México, D.F. [etc.]: International Thomson, cop. 2009.

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