Last update: 04-09-2019

820009 - CNED - Numerical Calculus. Differential Equations

Coordinating unit: 295 - EEBE - Barcelona East School of Engineering

Teaching unit: 749 - MAT - Department of Mathematics

Academic year: 2019

Degree: BACHELOR'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN MECHANICAL 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 ENERGY ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN ELECTRICAL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN BIOMEDICAL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN MATERIALS ENGINEERING (Syllabus 2010). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN INDUSTRIAL ELECTRONICS AND AUTOMATIC CONTROL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN ENERGY ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN BIOMEDICAL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN MECHANICAL 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: JOSE JAVIER MUÑOZ ROMERO - M. JOSÉ JIMÉNEZ JIMÉNEZ

Others: Primer quadrimestre:
RAIMON ELGUETA MONTO - T11, T12, T21, T22
JOSE JAVIER MUÑOZ ROMERO - M11, M12, M21, M22
NURIA PARES MARINE - M11, M21, M31
YOLANDA VIDAL SEGUI - M12, M22, M31, M32

Opening hours

Timetable: To be determined by the faculty at the beginning of the semester. The students will be attended in the Mathematics Department at EEBE.

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.

Last update: 04-09-2019

820009 - CNED - Numerical Calculus. Differential Equations

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

Total learning time: 150h	Hours large group:	45h	30.00%
	Hours medium group:	0h	0.00%
	Hours small group:	15h	10.00%
	Guided activities:	0h	0.00%
	Self study:	90h	60.00%

Last update: 04-09-2019

820009 - CNED - Numerical Calculus. Differential Equations

Content

Unit 1: Basics of numerical calculus

Learning time: 67h 15m

Theory classes: 18h
Laboratory classes: 9h 30m
Self study : 39h 45m

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.

Unit 2: Ordinary differential equations

Learning time: 36h 15m

Theory classes: 12h
Laboratory classes: 2h 30m
Self study : 21h 45m

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.

Unit 3: Integral transforms and solution of ordinary differential equations

Learning time: 27h 45m

Theory classes: 9h
Laboratory classes: 1h 30m
Self study : 17h 15m

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.

Last update: 04-09-2019

820009 - CNED - Numerical Calculus. Differential Equations

Unit 4: Partial differential equations	Learning time: 18h 45m Theory classes: 6h Laboratory classes: 1h 30m Self study : 11h 15m

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

Qualification 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 <= N < 5,0 (https://eebe.upc.edu/ca/estudis/normatives-academiques/documents/eebe-normativa-avaluacio-i-permanencia-18-19-aprovat-je-2018-06-13.pdf).

Regulations for carrying out activities

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

Last update: 04-09-2019

820009 - CNED - Numerical Calculus. Differential Equations

Bibliography

Basic:

Vázquez, Luís [et al.]. Métodos numéricos para la física y la ingenieria. Madrid: McGraw Hill, cop. 2009. ISBN 9788448166021.

Huerta, Antonio; Sarrate, Josep; Rodríguez-Ferran, Antonio. Métodos numéricos : introducción, aplicaciones y programación. Barcelona: Edicions UPC, Universitat Politècnica de Catalunya, 2001. ISBN 8483015226.

Arias, I. [et al.]. Cálculo avanzado para ingeniería : teoría, problemas resueltos y aplicaciones. Barcelona: Edicions UPC, 2008. 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.

Complementary:

Burden, Richard L.; Faires, J. Douglas. Análisis numérico. 6a ed. México [etc.]: International Thomson, cop. 1998. ISBN 9687529466.

Chapra, Steven C.; Canale, Raymond P. Métodos numéricos para ingenieros. 5ª ed. México [etc.]: McGraw-Hill, cop. 2007. ISBN 9789701061145.

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. ISBN 9789708300551.

Çengel, Yunus A.; Palm, William J. Ecuaciones diferenciales : para ingeniería y ciencias. México [etc.]: McGraw-Hill, 2014. ISBN 9786071509895.