UNIVERSITAT POLITÈCNICA DE CATALUNYA BARCELONATECH

Course guides
200221 - MNEDOS - Numerical Methods for Odes

Last modified: 06/06/2017

Unit in charge: School of Mathematics and Statistics
Teaching unit: 749 - MAT - Department of Mathematics.
751 - DECA - Department of Civil and Environmental Engineering.

Degree: BACHELOR'S DEGREE IN MATHEMATICS (Syllabus 2009). (Optional subject).

Academic year: 2017 **ECTS Credits:** 6.0 **Languages:** English

LECTURER

Coordinating lecturer: JAUME SOLER VILLANUEVA

Others: Primer quadrimestre:
SONIA FERNANDEZ MENDEZ - A
JAUME SOLER VILLANUEVA - A

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
3. CE-1. Propose, analyze, validate and interpret simple models of real situations, using the mathematical tools most appropriate to the goals to be achieved.
4. CE-2. Solve problems in Mathematics, through basic calculation skills, taking in account tools availability and the constraints of time and resources.
5. CE-3. Have the knowledge of specific programming languages and software.
6. CE-4. Have the ability to use computational tools as an aid to mathematical processes.
7. Ability to solve problems from academic, technical, financial and social fields through mathematical methods.

Generical:
1. CB-4. Have the ability to communicate their conclusions, and the knowledge and rationale underpinning these to specialist and non-specialist audiences clearly and unambiguously.
2. To have developed those learning skills necessary to undertake further interdisciplinary studies with a high degree of autonomy in scientific disciplines in which Mathematics have a significant role.
8. CG-1. Show knowledge and proficiency in the use of mathematical language.
9. CG-2. Construct rigorous proofs of some classical theorems in a variety of fields of Mathematics.
10. CG-3. Have the ability to define new mathematical objects in terms of others already know and ability to use these objects in different contexts.
11. CG-4. Translate into mathematical terms problems stated in non-mathematical language, and take advantage of this translation to solve them.
12. CG-6 Detect deficiencies in their own knowledge and pass them through critical reflection and choice of the best action to extend this knowledge.

Transversal:
13. ENTREPRENEURSHIP AND INNOVATION: Knowing about and understanding how businesses are run and the sciences that govern their activity. Having the ability to understand labor laws and how planning, industrial and marketing strategies, quality and profits relate to each other.
14. SUSTAINABILITY AND SOCIAL COMMITMENT. Being aware of and understanding the complexity of social and economic phenomena that characterize the welfare society. Having the ability to relate welfare to globalization and sustainability. Being able to make a balanced use of techniques, technology, the economy and sustainability.
15. EFFICIENT ORAL AND WRITTEN COMMUNICATION. Communicating verbally and in writing about learning outcomes, thought-building and decision-making. Taking part in debates about issues related to the own field of specialization.
16. TEAMWORK. Being able to work as a team player, either as a member or as a leader. Contributing to projects pragmatically and responsibly, by reaching commitments in accordance to the resources that are available.
17. SELF-DIRECTED LEARNING. Detecting gaps in one's knowledge and overcoming them through critical self-appraisal. Choosing the best path for broadening one's knowledge.

TEACHING METHODOLOGY

(Section not available)

LEARNING OBJECTIVES OF THE SUBJECT

(Section not available)

STUDY LOAD

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

Total learning time: 150 h

CONTENTS

1. Introduction. Initial and boundary value problems. Discretization. Finite difference equations.

Full-or-part-time: 13h
Theory classes: 5h
Laboratory classes: 2h
Guided activities: 1h
Self study : 5h

2. Euler's method and its generalizations. Local discretization error. Order of a method. Consistent, convergent and stable methods.

Full-or-part-time: 29h
Theory classes: 7h
Laboratory classes: 2h
Guided activities: 5h
Self study : 15h

3. Runge-Kutta methods. Order conditions and Butcher's theory. Embedded methods and control of local error. Implicit methods. Stability. Numerical exemples.

Full-or-part-time: 29h
Theory classes: 7h
Laboratory classes: 2h
Guided activities: 5h
Self study : 15h

4. Linear multistep methods. Local error and order of the method. Stability. Implicit methods and Predictor-Corrector methods. Error estimation.

Full-or-part-time: 29h
Theory classes: 7h
Laboratory classes: 2h
Guided activities: 5h
Self study : 15h

5. Stiff problems. Numerical exemples. Implicit Runge-Kutta implementation. Convergence and stability.

Full-or-part-time: 29h
Theory classes: 7h
Laboratory classes: 2h
Guided activities: 5h
Self study : 15h

6. Introduction to oundary value problems. The shooting method. Other methods.

Full-or-part-time: 19h
Theory classes: 7h
Laboratory classes: 2h
Guided activities: 3h
Self study : 7h

GRADING SYSTEM

The final mark is given as a number from 0 to 10 (less than 5: fail; 5 or higher: pass; 8 to 10: excellent) obtained as the sum of three marks:
1) Coursework and public presentation of part of it: up to 3 points.
2) Two short presentations given in class during the course: up to 1 point.
3) Written exams: up to 6 points.

EXAMINATION RULES.

Attendance at a minimum of lessons is compulsory. Coursework and its public is compulsory as well as giving a short talk in class during the course.

BIBLIOGRAPHY

Basic:
- Lambert, J.D. Numerical methods for ordinary differential systems : the initial value problem. Chichester [etc.]: John Wiley, cop. 1991. ISBN 0471929905.
- Hairer, E.; Norsett, S.P.; Wanner, G. Solving ordinary differential equations I. 3rd. Springer, 2008. ISBN 978-3-540-56670-0.
- Dekker, K.; Verwer, J.G. Stability of Runge-Kutta methods for stiff nonlinear differential equations. 1a. Elsevier, 1984.

Complementary:
- García Merayo, Félix. Fortran 90 Lenguaje de programación. Madrid: Paraninfo, 1999. ISBN 8428325278.
- Kernighan, B.W.; Ritchie, D.M. The C programming language. 2nd ed. New Jersey: Prentice Hall, 1988.
- Isaacson, E.; Keller, H.B. Analysis of numerical methods. New York: Dover, 1994. ISBN 0486680290.
- Ortega, James M. Numerical analysis : a second course. Philadelphia: Society for Industrial and Applied Mathematics, cop. 1990.

ISBN 0898712505.
- Butcher, J. The Numerical analysis of ordinary differential equations : runge-kutta and general linear methods. Chichester [etc.]: John Wiley & Sons, 1987. ISBN 0471910465.