Further topics in numerical methods

Academic Year: (2021 / 2022) **Review date: 29-06-2021**

Department assigned to the subject: Mathematics Department

Coordinating teacher: BAYONA REVILLA, VICTOR

Type: Compulsory ECTS Credits : 6.0

Year : 3 Semester : 2

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Linear Algebra (Course 1 - Semester 1); Differential Calculus (Course 1 - Semester 1); Programming (Course 1 - Semester 1); Integral Calculus (Course 1 - Semester 2); Programming Techniques (Course 1 - Semester 2); Numerical Methods (Course 2 - Semester 1); Ordinary Differential Equations (Course 3 - Semester 1).

DESCRIPTION OF CONTENTS: PROGRAMME

1. Approximation theory
1.1 The Weierstrass Theorem and Taylor's Theorem
1.2 The minimax approximation problem
1.3 The least squares approximation problem
1.4 Orthogonal polynomials
1.5 Gaussian quadrature
1.6 Trigonometric approximation
1.7 The Fast Fourier Transform (FFT)

2. Computation of eigenvalues and eigenvectors of dense matrices
2.1 The power method
2.2 Reduction to Hessenberg and tridiagonal forms
2.3 The QR method
2.4 Computing eigenvectors
2.5 Computing the Singular Value Decomposition of a matrix

3. Ordinary differential equations
3.1 Existence, uniqueness, and stability theory
3.2 One-step methods
3.3 Multistep methods
3.4 Predictor-corrector methods
3.5 Runge-kutta methods
3.6 System of ordinary differential equations
3.7 Stiff problems

LEARNING ACTIVITIES AND METHODOLOGY

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THEORETICAL-PRACTICAL CLASSES. [44 hours with 100% classroom instruction, 1.67 ECTS]
Knowledge and concepts students must acquire. Student receive course notes and will have basic reference texts to facilitate following the classes and carrying out follow up work. Students partake in exercises to resolve practical problems and participate in workshops and evaluation tests, all geared towards acquiring the necessary capabilities.

TUTORING SESSIONS. [4 hours of tutoring with 100% on-site attendance, 0.15 ECTS]
Individualized attendance (individual tutoring) or in-group (group tutoring) for students with a teacher.

STUDENT INDIVIDUAL WORK OR GROUP WORK [98 hours with 0 % on-site, 3.72 ECTS]

WORKSHOPS AND LABORATORY SESSIONS [8 hours with 100% on site, 0.3 ECTS]

FINAL EXAM. [4 hours with 100% on site, 0.15 ECTS]
Global assessment of knowledge, skills and capacities acquired throughout the course.

METHODOLOGIES

THEORY CLASS. Classroom presentations by the teacher with IT and audiovisual support in which the subject's main concepts are developed, while providing material and bibliography to complement student learning.

PRACTICAL CLASS. Resolution of practical cases and problem, posed by the teacher, and carried out individually or in a group.

TUTORING SESSIONS. Individualized attendance (individual tutoring sessions) or in-group (group tutoring sessions) for students with a teacher as tutor.

LABORATORY PRACTICAL SESSIONS. Applied/experimental learning/teaching in workshops and laboratories under the tutor's supervision.

ASSESSMENT SYSTEM

SE1 - FINAL EXAM. [40 %]
Global assessment of knowledge, skills and capacities acquired throughout the course.

SE2 - CONTINUOUS EVALUATION. [60 %]
Assesses papers, projects, class presentations, debates, exercises, internships and workshops throughout the course.

In particular, given the high practical content of this subject, the continuous assessment will consist on:
60% continuous assessment: 3 labs (12% each one) + 1 midterm (24%)
40% final exam

% end-of-term-examination:	40
% of continuous assessment (assigments, laboratory, practicals…):	60

BASIC BIBLIOGRAPHY

- K. Atkinson Elementary Numerical Analysis, Wiley, 2003
- R. L. Burden, J. D. Faires Numerical Analysis, Brooks/Cole, 2010
- S. D. Conte, Carl de Boor Elementary Numerical Analysis: An Algorithmic Approach, McGraw-Hill, 1980
- Timothy Sauer Numerical Analysis, Pearson, 2012

ADDITIONAL BIBLIOGRAPHY

- A Iserles A First Course in the Numerical Analysis of Differential Equations, Cambridge University Press, 2009
- Butcher, J. C. Numerical Methods for Ordinary Differential Equations, Wiley, 2008
- Endre Süli and David F. Mayers An Introduction to Numerical Analysis, Cambridge, 2003
- Lloyd N. Trefethen Finite Difference and Spectral Methods for Ordinary and Partial Differential Equations, Cornell, 1996
- Moler, C. B. Numerical Computing with Matlab, SIAM, 2004
- Quarteroni, A., Sacco, R., y Saleri, F. Numerical Mathematics, Springer, 2007
- Shen W. An Introduction to Numerical Computation, World Scientific, 2016
- Trefethen, L. N. Approximation Theory and Approximation Practice, SIAM, 2012
- Trefethen, L. N., y Bau, D., III Numerical Linear Algebra, SIAM, 1997
- Uri M. Ascher, Chen Greif A First Course on Numerical Methods, SIAM, 2011