Numerical methods

Academic Year: (2023 / 2024)   **Review date: 29-01-2024**

Department assigned to the subject: Mathematics Department

Coordinating teacher: TERAN VERGARA, FERNANDO DE

Type: Compulsory ECTS Credits : 6.0

Year : 2 Semester : 2

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)
Lineal Algebra, Programming, Calculus I, Calculus II

OBJECTIVES
Using NUMERICAL METHODS (NM) to calculate approximate solutions of mathematical models

Study the stability and accuracy of NM.

Calculate numerical solution of systems of nonlinear equations.

Approximate the minimum of a function of several variables.

Developing, analyzing, and implementing finite difference methods.

Solving ordinary differential equations and systems by numerical integration methods.

Using the software environments to discuss the efficiency, pros and cons of different NM.

DESCRIPTION OF CONTENTS: PROGRAMME
1. Fundamentals (floating point, errors, stability, algorithms...).
2. Solution of linear systems of equations.
3. Numerical solution of equations and systems of nonlinear equations.
4. Interpolation and approximation of functions.
5. Least squares problems.
6. Numerical optimization.
7. Numerical integration.
8. Numerical differentiation.
9. Fast Fourier Transform.

LEARNING ACTIVITIES AND METHODOLOGY
This is a "hands on" course. In the large-group lectures the theoretical contents will be introduced, and they will be delivered in a blackboard standard room. However, the small-group lectures will take place in the computer Lab, and students are supposed to follow the explanations of the instructor performing in real time the exercises, examples and other proposed activities. Students must become acquainted with MATLAB.

The course will start learning how to program MATLAB. After and introduction to the course, every two weeks (as a general rule), one of the topics of the course will be discussed in the classroom and practices related to these topics will be proposed to the students. Usually the practices involve to solve a simple problem by writing the appropriate code.

ASSESSMENT SYSTEM
The final grade will come from: 50% final exam + 50% resolution of lab practices throughout the quarter.
In order to pass the subject, it will be mandatory to get a grade of, at least, 4/10 (or equivalent) in the final exam.

| **% end-of-term-examination:** | 50 |
| **% of continuous assessment (assigments, laboratory, practicals…):** | 50 |

BASIC BIBLIOGRAPHY

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 - [BF] R. L. Burden, J. D. Faires Numerical Methods, Brooks/Cole, Cengage Learning, 2003

 - [QSG] A. Quarteroni, F. Saleri, P. Gervasio Scientific computing with MATLAB and Octave, Springer, 2010

 - [QSS] A. Quarteroni, R. Sacco, F. Saleri Numerical Mathematics, Springer, 2007

ADDITIONAL BIBLIOGRAPHY

 - [BC] A. Belegundu, T. Chandrupatla Optimization Concepts and Applications in Engineering, Cambridge University Press, 2011

 - [BV] S. Boyd, L. Vanderberghe Convex Optimization, Cambridge University Press, 2004

 - [DCM] S. Dunn, A. Constantinides, P. Moghe Numerical Methods in Biomedical Engineering, Elsevier Academic Press, 2010

 - [DH] P. Deuflhard, A. Hohmann Numerical Analysis in Modern Scientific Computing. An Introduction, Springer, 2003

 - [FJNT] P.E. Frandsen, K. Jonasson, H.B. Nielsen, O. Tingleff Unconstrained Optimization, IMM, DTU, 1999

 - [HH] D. Higham, N. J. Higham Matlab Guide, SIAM, 2017

 - [HJ] R. A. Horn, C. R. Johnson Matrix Analysis, 2nd ed., Cambridge University Press, 2013

 - [H] N. J. Higham Accuracy and stability of Numerical Methods, SIAM, 1998

 - [II] Ilse Ipsen Numerical Matrix Analysis, SIAM, 2009

 - [K] C. Kelley Iterative Methods for Optimization, SIAM (available online), 1999

 - [NW] J. Nocedal, S. J. Wright Numerical Optimization, Springer, 2006

 - [S] G. Strang Linear Algebra and Learning from Data, Wellesley-Cambridge, 2019

 - [TB] L. N. Trefethen, D. Bau Numerical Linear Algebra, SIAM, 1997

BASIC ELECTRONIC RESOURCES

 - Cleve Moler . Numerical Computing with MATLAB: https://es.mathworks.com/moler/chapters.html