

Course Unit	Numerical Methods	Field of study	Mathematics
Bachelor in	Civil Engineering	School	School of Technology and Management
Academic Year	2023/2024	Year of study	2
Type	Semestral	Semester	2
Workload (hours)	162	Contact hours	T - TP 30 PL 30 TC - S - E - OT - O -
		Level	1-2
		Code	9089-322-2205-00-23
		ECTS credits	6.0

T - Lectures; TP - Lectures and problem-solving; PL - Problem-solving, project or laboratory; TC - Fieldwork; S - Seminar; E - Placement; OT - Tutorial; O - Other

Name(s) of lecturer(s) Carlos Jorge da Rocha Balsa

Learning outcomes and competences

At the end of the course unit the learner is expected to be able to:

1. Use the computer with Octave software to solve mathematical problems.
2. Know the origin of errors implicit in a numerical solution to be able to assess the quality of approximation.
3. Choose the appropriate numerical method to solve the proposed problem on the basis of their properties (stability, convergence, accuracy, ...).
4. Approach discrete data through continuous functions.
5. Numerically integrate first-order ordinary differential functions and equations.
6. Solve numerically equations and systems of linear and non-linear equations.

Prerequisites

Before the course unit the learner is expected to be able to:

1. Basic knowledge of programming and use of computers.
2. Analyse the behaviour of univariables functions.
3. Handle matrices and vectors.
4. Solving systems of linear equations by Gauss method.

Course contents

Introduction to Octave programming language. Study of errors associated with a numerical solution. Numerical solution, using the Octave software, of problems involving equations and systems of linear and non-linear equations, approximation of data using linear least squares method, discrete interpolation of data, numerical integration of functions and first order ordinary differential equations.

Course contents (extended version)

1. Introduction to the use and programming of software Octave.
2. Errors associated with solutions, origins and propagation.
3. Solution of linear systems through direct (LU fact.) and iterative (Jacobi and Gauss-Seidel).
4. Approximation of discrete data by the linear least squares method, using the normal equation.
5. Polynomial interpolation by monomial basis and Lagrange methods.
6. Solving non-linear equations by bisection and Newton-Raphson.
7. Solving systems of non-linear equations by Newton's method.
8. Numerical Integration of functions by the of trapezoids and Simpson methods.
9. Initial value problems by means of the methods of Euler, simple and modified, and Runge-Kutta.

Recommended reading

1. Michael T. Heath. "Scientific Computing an Introductory Survey". McGraw-Hill, New York, 2002.
2. A. Quarteroni e F. Saleri. "Scientific Computing with MATLAB and Octave". Springer, 2006.
3. S. C. Chapra e R. P. Canale. "Métodos Numéricos para Engenharia". McGraw-Hill, São Paulo, 2008.
4. C. Balsa. "Introdução aos Métodos Numéricos com Octave". ESTIG-IPB, Bragança, 2023
5. Loyd Trefethen e David Bau III. "Numerical Linear Algebra". SIAM, Philadelphia. 1997.

Teaching and learning methods

Laboratory work with the computer. Exposure of major theoretical concepts followed by practical exercises resolution. Solution of practical case studies. Practical work involving individual research.

Assessment methods

1. Alternative 1 - (Regular, Student Worker) (Final, Supplementary)
 - Final Written Exam - 60% (Global exam on all content taught)
 - Practical Work - 40% (Group and individual work around practical exercises and problems.)
2. Alternative 2 - (Student Worker) (Final, Supplementary)
 - Final Written Exam - 100% (Global exam on all content taught)
3. Alternative 3 - (Regular, Student Worker) (Special)
 - Final Written Exam - 100% (Global exam on all content taught)

Language of instruction

Portuguese, with additional English support for foreign students.

Electronic validation

Carlos Jorge da Rocha Balsa	Florbela Alexandra Pires Fernandes	António Miguel Verdelho Paula	José Carlos Rufino Amaro
12-02-2024	26-02-2024	02-03-2024	09-03-2024