Course Unit	Numerical Methods		Field of study	Mathematics	
Bachelor in	Renewable Energy Engineering		School	School of Technology and Management	
Academic Year	2022/2023	Year of study 2	Level	1-2	ECTS credits 6.0
Type	Semestral	Semester 1	Code	9910-743-2103-00-22	

Workload (hours)	162	Contact hours	T	TP	PL	TC	S	E	OT	O
			30	-	30	-	-	-	-	-

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, Cholesky) 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 Integrating 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, 2020.
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%
   - Practical Work - 40% (Group and individual work around practical exercises and problems.)
2. Alternative 2 - (Student Worker) (Final, Supplementary)
   - Final Written Exam - 100%
3. Alternative 3 - (Regular, Student Worker) (Special)
   - Final Written Exam - 100%

Language of instruction

Portuguese, with additional English support for foreign students.

Electronic validation

Carlos Jorge da Rocha Balsa	Carla Sofia Veiga Fernandes	Ana Maria Alves Queiroz da Silva	Paulo Alexandre Vara Alves
05-10-2022	10-10-2022	18-10-2022	04-11-2022