Instituto Politécnico de Bragança

Course Unit	Numerical Methods			Field of study	Mathematics								
Bachelor in	Civil Engineering			School	School of Technology and Management								
Academic Year	2025/2026	Year of study	2	Level	1-2	ECTS credits	6.0						
Type	Semestral	Semester	2	Code	9089-849-2205-00-25								
Workload (hours)	162	Contact hours	T -	TP 30	PL 30	TC -	S -	E -	OT -	O -			

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): Ana Ester Veiga Rodrigues, João Paulo Pais de Almeida

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. Atkinson, K. , “An Introduction to Numerical Analysis”, J. Wiley, 1978.
2. Burden, R. e Faires, J. , “Numerical Analysis”, 7th ed. , Brooks/Cole, 2000
3. Conte, S. e Boor, C. , “Elementary Numerical Analysis”, McGraw-Hill, 1980
4. Gerald, C. e Wheatley, P. , “Applied Numerical Analysis”, 6th ed. , Addison-Wesley, 1984
5. Pereira, A. , "Guia de Estudo de Métodos Numéricos", ESTiG-IPB, 2015

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)
   - Intermediate Written Test - 50% (The midterm exam will be held during the classes. (min. 7.0 in 20))
   - Final Written Exam - 50% (The Final exam will be held at the final exam's day.)
2. Alternative 2 - (Regular, Student Worker) (Supplementary, Special)
   - Final Written Exam - 100% (Final Exam)

Language of instruction

Portuguese, with additional English support for foreign students.

Electronic validation

Ana Ester Veiga Rodrigues, João Paulo Pais de Almeida	Paula Maria Pereira de Barros	Flora Cristina Meireles Silva	Maria Olga de Amorim Sá Ferreira
07-03-2026	08-03-2026	08-03-2026	09-03-2026