Course Unit	Numeric methods			Field of study	Mathematics		
Bachelor in	Mechanical 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	2	Code	9123-759-2203-00-22		

Workload (hours)	162	Contact hours	T	TP	PL	TC	S	E	OT	O
			-	60	-	-	-	-	-	-

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): Joao 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 mathematical tools to solve numeric problems.
2. Relate the convergence and stability notions.

Prerequisites

Before the course unit the learner is expected to be able to:
Have knowledge in the area of Linear Algebra and Mathematical Analysis.

Course contents

Error Analysis. Nonlinear Equations. Approximation Theory. Numerical Differentiation and Integration. Systems of Linear Equations. Systems of Nonlinear Equations. Ordinary Differential Equations.

Course contents (extended version)

1. Error Analysis
   - Basic definitions of error theory.
   - Error propagation formula.
   - Stability and conditioning. Algorithms and convergence.
2. Nonlinear Equations with one Variable
   - Bisection method.
   - Fixed-point method.
   - Newton method.
   - Secand method.
   - Roots of polynomials.
3. Approximation Theory.
   - Interpolation and the Lagrange polynomial. Newton´s interpolatory divided-difference formula.
   - Least-squares method. Orthogonal polynomials.
4. Numerical Differentiation and Integration
   - Numerical differentiation: Richardson extrapolation.
   - Numerical integration: trapezoidal rule; Simpson´s rule; Newton-Cotes formula.
5. Linear Systems.
   - Direct methods: Gaussian elimination with partial pivoting.
   - Direct methods: matrix factorization - LU and LDL^T.
   - Norms of vectors and matrices.
   - Iterative methods: Jacobi, Gauss-Seidel and SOR methods.
6. Nonlinear Systems Equations
   - Newton method.
7. Ordinary Differential Equations
   - Euler´s method. Runge-Kutta method.

Recommended reading

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

Teaching and learning methods

Topics will be presented and explored in class. There will be individual and group sessions outside class to accompany the student's work. All classes will be in informatics rooms using mathematical software (Matlab/Octave, Mathematica/Maple).

Assessment methods

1. Continuous Evaluation - (Regular, Student Worker) (Final, Supplementary)
   - Practical Work - 75% (2 reports and presentations. The presentation is mandatory. 15 % is associated to deliverables.)
   - Final Written Exam - 25%
2. Final Evaluation - (Regular, Student Worker) (Supplementary, Special)
   - Final Written Exam - 100%

Language of instruction

1. Portuguese
2. English

Electronic validation

Joao Paulo Pais de Almeida	Florbela Alexandra Pires Fernandes	João da Rocha e Silva	José Carlos Rufino Amaro
04-03-2023	06-03-2023	06-03-2023	10-03-2023