Course Unit	Approximation Methods in Engineering			Field of study	Mathematics
Master in	Construction Engineering			School	School of Technology and Management
Academic Year	2023/2024	Year of study	1	Level	2-1	ECTS credits	6.0
Type	Semestral	Semester	1	Code	5024-419-1103-00-23

Workload (hours)	162	Contact hours	T	TP	PL	TC	S	E	OT	O
			-	45	15	-	-	-	-	-

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 problems of applied mathematics construction engineering.
2. Choose the appropriate numerical method to solve the proposed problem on the basis of their properties (stability, convergence, accuracy, …).
3. Solve numerically problems involving ordinary differential equations and partial differential equations.
4. Compute numerically eigenvalues and eigenvectors.
5. Determine numerically the minimum or the maximum of non-linear functions multivariable.

Prerequisites

Before the course unit the learner is expected to be able to:
1. Elementary knowledge of a programming language.
2. Derive and integrate real functions of a real variable.
3. Matrix calculation knowledge.
4. Knowledge of resolution methods of systems of linear equations.

Course contents

Introduction to programming with Octave software. Numerical resolution, using Octave software, of problems involving eigenvalues and eigenvectors, ordinary differential equations and partial derivatives, and to find the minimum or maximum of multivariable functions.

Course contents (extended version)

1. Introduction to the use and programming of software Octave .
2. Numerical resolution of initial value problems for ordinary differential equations (ODEs).
3. Resolution of boundary value problems with EDOs.
4. Numerical solution of partial Differential Equations (PDE's)
   - Numerical resolution of EDPs independent of time by the finite difference method.
   - Resolution of time-dependent EDPs through explicit and implicit schemes.
   - Solution of sparse systems resulting from the discretization of PDE's in boundary values problems.
5. Eigenvalues problems with iterative methods as the power and QR iteration.
6. Solving optimization of non-linear constrained and unconstrained problems.

Recommended reading

1. Michael T. Heath. “Scientific Computing an Introductory Survey”. McGraw-Hill, New York.
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. "Métodos de Aproximação em Engenharia da Construção - Estudo de Casos". ESTiG-IPB, Bragança, 2019.
5. D. J. Hatter. "Matrix Computer Methods of Vibration Analysis". Butterworth & Co (Publishers) Ltd, 1973.

Teaching and learning methods

Presentation of the main concepts in theoretical-practical classes. Practical case study. Targeted practical work. Laboratory work in computer rooms.

Assessment methods

1. Alternative 1 - (Regular, Student Worker) (Final, Supplementary)
   - Final Written Exam - 60%
   - Practical Work - 40% (Practical work around at least three case studies.)
2. Alternative 2 - (Student Worker) (Final, Supplementary, Special)
   - Final Written Exam - 100% (Only for student workers.)
3. Alternative 3 - (Regular, Student Worker) (Special)
   - Final Written Exam - 100% (For all students in special times.)

Language of instruction

Portuguese, with additional English support for foreign students.

Electronic validation

Carlos Jorge da Rocha Balsa	Florbela Alexandra Pires Fernandes	Manuel Teixeira Brás César	José Carlos Rufino Amaro
09-10-2023	11-10-2023	11-10-2023	20-10-2023