SUBJECT TEACHING GUIDE

G1972 - Numerical Methods

Degree in Civil Engineering
First Degree in Civil Engineering

Academic year 2024-2025

1. IDENTIFYING DATA					
Degree	Degree in Civil Engineering First Degree in Civil Engineering			Type and Year	Core. Year 2 Core. Year 2
Faculty	School of civil Engineering				
Discipline	BASIC MATHEMATICS FOR ENGINEERING				
Course unit title and code	G1972 - Numerical Methods				
Number of ECTS credits allocated	6	Term	Semester based (2)		
Web	http://personales.unican.es/gila/docencia.pdf				
Language of instruction	Spanish	English Friendly	No	Mode of delivery	Face-to-face

Department	DPTO. MATEMATICA APLICADA Y CIENCIAS DE LA COMPUTACION
Name of lecturer	AMPARO GIL GOMEZ
E-mail	amparo.gil@unican.es
Office	E.T.S. de Ingenieros de Caminos, Canales y Puertos. Planta: + 1. DESPACHO PROFESORES (1028)
Other lecturers	DIEGO RUIZ ANTOLIN

3.1 LEARNING OUTCOMES

- Solving linear systems of equations, understanding the suitability of the methods. Solving nonlinear equations. Interpolating and approximating functions and numerical data. Performing numerical calculations of integrals and derivatives of functions. Modeling and mathematically solving basic scientific-technical problems. Becoming familiar with the use of software for problem-solving in engineering. Adequately modeling simple optimization problems in engineering. Identifying the most appropriate techniques for solving linear programming problems.

4. OBJECTIVES
To complete the mathematical education of the Civil Engineering student based on their previous knowledge of Algebra , Geometry, Calculus, and Differential Equations.
Identify and understand the errors in approximate methods. Identify and understand the limitations regarding accuracy that arise in the implementation of algorithms in a computational environment
Introduce and reinforce the student in the numerical approximation of derivatives, function approximation, integrals in one and several variables, scalar equations, and linear and nonlinear systems. Reinforce the student in the numerical solution of differential equations that appear in various Civil Engineering problems . Introduce and reinforce the student in the methods of least squares regression. Introduce and reinforce the student in linear programming.

6. SUBJECT PROGRAM	
CONTENTS	
1	PART I: INTRODUCTION TO NUMERICAL ANALYSIS. NUMERICAL SOLUTION OF LINEAR AND NONLINEAR EQUATIONS. LEAST SQUARES REGRESSION MODELS
1.1	Topic 1. INTRODUCTION TO NUMERICAL ANALYSIS Computational arithmetic. Floating-point arithmetic standard. Conditioning of a problem. Stability of numerical methods. Examples. Computational cost and efficiency. Examples.
1.2	Topic 2. NUMERICAL SOLUTION OF NONLINEAR EQUATIONS. Introduction. Bisection method. Newton-Raphson method. Secant method. Fixed-point methods. Polynomial roots. Newton method for solving systems of nonlinear equations.
1.3	Topic 3. NUMERICAL METHODS FOR SOLVING SYSTEMS OF LINEAR EQUATIONS AND CALCULATING EIGENVALUES OF A MATRIX Direct methods: triangular systems, Gaussian elimination, LU, Cholesky, and QR factorizations. Related problems: matrix inversion and determinant calculation. Vector and matrix norms. Conditioning of a system of linear equations. QR method for calculating the eigenvalues of a matrix. Topic 4. LEAST SQUARES REGRESSION MODELS. Fitting models to data. Normal equations. Transformations. Measuring the quality of the fit.
2	PART II: APPROXIMATION OF FUNCTIONS, NUMERICAL INTEGRATION AND NUMERICAL METHODS FOR DIFFERENTIAL EQUATIONS.
2.1	Topic 5. NUMERICAL METHODS FOR DIFFERENTIAL EQUATIONS. Single-step methods for solving initial value problems described by EDOs. Methods for solving boundary problems described by differential equations .
2.2	Topic 6. INTERPOLATION AND APPROXIMATION OF FUNCTIONS. Lagrange's interpolation. Interpolation by Newton's divided differences. Hermite interpolation.
2.3	Topic 7. NUMERICAL INTEGRATION Interpolatory formulas of quadrature. Simple and compound Newton-Cotes formulas. Introduction to Gaussian quadrature.
3	Topic 8. INTRODUCTION TO MATHEMATICAL PROGRAMMING. Basics of the Simplex method. Applications of linear programming.

7. ASSESSMENT METHODS AND CRITERIA

Description	Type	Final Eval.	Reassessn	%
Two exams (70% of the final grade). Computer exercises (25% of the final grade). Exercise in teams (5% of the final grade).	Work	No	Yes	25,00
Exercises corresponding to the topics covered in Part I. 30% of the final grade.	Written exam	No	Yes	30,00
Exercises corresponding to the topics covered in Part II. 40% of the final grade.	Written exam	No	Yes	40,00
Exercise in teams.	Work	No	No	5,00
TOTAL				100,00

Observations

Only for justified reasons (e.g. health restrictions) may the assessment tests be organised remotely, with prior authorisation from the Management of the Centre.

Observations for part-time students

Attendance is not compulsory and the contents of the subject can be followed from the Moodle page of the subject. Students enrolled part-time (and only these) will be able to take the written tests and the practical tests simultaneously in the period established for the exams if they request it. The work proposed throughout the course will be carried out individually and may be submitted in electronic format.

8. BIBLIOGRAPHY AND TEACHING MATERIALS

BASIC

Quarteroni, A., Saleri, F., Gervasio, P. (2014). "Scientific Computing with MATLAB and Octave". Fourth edition. Springer.

Chapra S. y Canale R. (2005) "Numerical Methods for Engineers". McGraw-Hill Science/Engineering/Math.