UNIVERSIDAD DE MURCIA

FACULTY OF MATHEMATICS

Numerical Analysis in one variable

Syllabus

Course code:	1581
Number of ECTS credits:	6
Semester:	1st (September-January)
Prerequisites:	None
Recommended components:	(1572) Introduction to scientific software and programming, (1577) Object-Oriented Programming, (1575) Topology of metric spaces, (1568) Functions in one real variable 1 and (1573) Functions in one real variable 2.
Language of instruction:	Spanish (students are allowed to ask questions and write homeworks and exams in English)

Course description

This is an introductory course on Numerical Methods. This area is devoted to the practical and theoretical development of numerical algorithms for resolution, in a computer environment, of problems from scientific applications.

The course will focus on approximation of functions and to the solution of algebraic, differential and integral equations, with particular emphasis on stability, accuracy, efficiency and robustness of the algorithms designed. Therefore it has a special relevance in the Degree, being one of the main guarantors of students to acquire three of the eleven generic competences of the degree (CGM6, CGM7 and CGM9). These competences are particularly useful in view of the job placement of graduates in Mathematics.

More specifically, the course will focus on the numerical solution of nonlinear equations, with special attention to polynomials, interpolation and numerical differentiation and integration.

Learning outcomes and competences

After completion of this course you will:

1. know the basic techniques of numerical analysis and its translation to algorithms. Use mathematical formalism and rigor in the design, analysis and evaluation of the algorithms.
2. identify, find and check the errors in logical and numerical processes.
3. know the internal arithmetic of computers.
4. use the explicit formulas and the divided differences to obtain the Lagrange's and Hermite's interpolation polynomials.

5. know the numerical differentiation, integration and extrapolation thecniques.

6. solve nonlinear equations with basic iterative methods and analyze their convergence. Implement these methods in the computer and compare their effectiveness in the resolution of practical cases.

Course contents

I. Scientific Computation.

Numbers and its representation. Errors. Floating-Point numbers. Rounding. Stable and unstable algorithms. Ill-condicioned problems. Algorithms: type, evaluation and complexity Iterative Algorithms.

II. Interpolation.

Polynomial Interpolation. Divided Differences and Newton's Interpolation Formula. Hermite's Interpolation. Error estimation. Convergence of the interpolation polynomials. The Runge Phenomenon. Cubic splines and Bézier curves.

III. Numerical Differentiation and Integration.

Numerical Differentiation and Richardson Extrapolation. Numerical Integration using Interpolation: Quadrature Rules. Newton-Côtes' Quadrature Formulas: The Trapezoidal and Simpson's Rules. Orthogonal polynomials: Gaussian Quadrature. Multiple and Improper Integrals.

IV. Nonlinear Equations.

Elementary Iteratives Methods: Bisection Method, Regula Falsi Method, Newton's Method and Secand Method. Banach Fixed-Point Theorem. Convergence Rates of Iterative Methods. Aitken's delta-squared process. Steffensen's Method. Polynomials. Zeros of polynomials. Laguerre's Iterated Method and Sturm Method.

References

1. Aubanell, A., Benseny, A. and Delshams, A. *Útiles básicos de Cálculo Numérico (3rd edition)*; Labor, Barcelona, 1989

2. Burden R. L. and Faires J. D. *Numerical Analysis (9th. edition)*; Brooks/Cole Cengage Learning, 2010.

3. Garcia Merayo, F. and Nevot Luna, A. *Análisis Numérico. Más de 300 ejercicios resueltos y comentados*; Paraninfo, Madrid, 1993

4. Atkinson, K. E. *An introduction to Numerical Analysis*; John Willew & Sons, New York, 1989.

5. Kinkaid D. and Cheney W. *Numerical Mathematics and computing (6th edition)*; Monterrey, California : Thomson/Brooks-Cole, cop. 2008.

6. Hammeling, G. and Hoffmann, K. H., *Numerical Mathematics*, Springer-Verlag, Nueva York, 1991.