UNIVERSITÀ DI PAVIA

Anno Accademico 2015/2016

NUMERICAL ANALYSIS

Enrollment year	2014/2015
Academic year	2015/2016
Regulations	DM270
Academic discipline	MAT/08 (NUMERICAL ANALYSIS)
Department	DEPARTMENT OF MATHEMATICS "FELICE CASORATI"
Course	MATHEMATICS
Curriculum	PERCORSO COMUNE
Year of study	2°
Period	2nd semester (01/03/2016 - 10/06/2016)
ECTS	9
Lesson hours	84 lesson hours
Language	ITALIAN
Activity type	ORAL TEST
Teacher	BOFFI DANIELE (titolare) - 6 ECTS GARDINI FRANCESCA - 3 ECTS
Prerequisites	First year Calculus courses and the contents of the course "Algebra lineare".
Learning outcomes	The aim of the course is to introduce the basics of Numerical Analysis and Scientific Computing so that the students can classify problems and the numerical algorithms suitable for their approximation. The course has a theoretical part as well as some Lab classes which take place at the Computer Lab of the Math Department.
Course contents	Error analysis. Linear systems: direct and iterative methods. Eingenvalue/eigenvector computation. Approximation of functions and data. Non linear equations and optimization. Numerical integration. Extended summary

1) Error analysis.
Classification of computational problems. Floating point numbers and arithmetics. Error propagation. Conditioning of a problem.

2) Direct methods for the solution of linear systems.
Triangular systems. Gauss elimination. LU factorization. Pivoting. Other factorizations, Choleski factorization. Banded, block and sparse matrices. Condition number. Forward and backward a priori analysis. Stability of LU factorization. Over-constrained systems; QR factorization; modified Gram-Schmidt algorithm and Householder matrices.

3) Iterative methods for the solution of linear systems.
Splitting methods: Jacobi and Gauss-Seidel methods. Iteration matrix and spectral radius. JOR and SOR methods. Convergence study and stopping criteria. Richardson-like methods; analysis of stationary Richardson method. Gradient method (steepest descent). Conjugate gradient method; preconditioned conjugate gradient method. Preconditioners.

4) Eigenvalues and eigenvectors approximation.
Conditioning of eigenproblems and eigenvalue localization. Power method. Inverse power method. Shifting. Deflation. Similarity methods; QR method.

5) Approximation of functions and data.
Lagrange interpolation. Error analysis in polynomial interpolation; Lebesgue constant and error estimate. Runge phenomenon and Chebychev nodes. Newton method and divided differences. Stability analysis of the interpolation. Abstract interpolation: unisolvence. Splines: linear and third order splines. Piecewise polynomial interpolation in three dimensions. General problem of linear interpolation. Linear least squares. Orthogonal polynomials (Legendre, Chebyshev). Best approximation.

6) Non linear equations and optimization.
Bisection method. Regula Falsi and Illinois methods. Newton method. Analysis of Newton method. Chord and secant methods. Fixed point iterations. Convergence of fixed point and error propagation. Newton method as fixed point iteration: multiple zeros. Deflation method in polynomial root finding.

7) Numerical integration.
Midpoint rule. Newton-Cotes integration (trapezoidal rule and Cavalieri-Simpson rule). Error estimate for Newton-Cotes formulae. Composite rules. Gauss integration, Jacobi theorem. Gauss-Legendre, Gauss-Chebyshev, Gauss-Lobatto rules. Adaptive Cavalieri-Simpson rule.

Teaching methods	Lectures. Exercises. Labs.
Reccomended or required readings	A. Quarteroni, R. Sacco, F. Saleri, P. Gervasio. Matematica numerica, ed. Springer (collana UNITEXT)

Assessment methods

Written and oral exam. Lab report.

Further information

Written and oral exam. Lab report.

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