UNIVERSITÀ DI PAVIA

Anno Accademico 2019/2020

NUMERICAL METHODS IN ENGINEERING SCIENCES

Anno immatricolazione	2019/2020
Anno offerta	2019/2020
Normativa	DM270
SSD	MAT/08 (ANALISI NUMERICA)
Dipartimento	DIPARTIMENTO DI INGEGNERIA INDUSTRIALE E DELL'INFORMAZIONE
Corso di studio	COMPUTER ENGINEERING
Curriculum	PERCORSO COMUNE
Anno di corso	1°
Periodo didattico	Primo Semestre (30/09/2019 - 20/01/2020)
Crediti	6
Ore	56 ore di attività frontale
Lingua insegnamento	English
Tipo esame	SCRITTO
Docente	SANGALLI GIANCARLO (titolare) - 6 CFU
Prerequisiti	Differential and integral calculus for real functions; complex numbers; linear algebra; computer programming experience.
Obiettivi formativi	The aim of the course is to enable students to classify real-life problems and choose the best suited algorithms for solving them, in terms of costs/benefits and convergence properties. At the same time, the course is meant to make students well acquainted with the use of Matlab software and with the practical implementation of some algorithms.
Programma e contenuti	NUMERICAL SOLUTION OF BOUNDARY VALUE PROBLEMS FOR PARTIAL DIFFERENTIAL EQUATIONS (PDE): * Finite Difference method on a model problem in 1D. Consistency and Stability - Lax's Theorem for convergence of a numerical scheme.

*Finite Element method on a model problem in 1D: Variational formulation, continuous piecewise linear finite element approximation, stability and convergence; construction of the final system and comparison with finite differences.
*Finite Element method on a model problem in 2D: Variational Formulation, Continuous piecewise linear finite element discretization on triangular meshes; Explicit computation of the elementary stiffness matrix and right-hand side; Assembling and solution of the final system.
*Various examples of boundary value problems in 2D.

NUMERICAL SOLUTION OF INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS (ODE):

*One-step methods: Euler backward and forward, Crank-Nicolson, Heun; Stability and A-stability, consistency, convergence and order of convergence.
*Multistep Methods: general structure, consistency and stability conditions; Explicit and Implicit Adams methods.
*Runge-Kutta methods: consistency and stability conditions; example of construction of an explicit RK-method (Hints on predictor-corrector methods).
*Systems of Ordinary Differential Equations: stiff problems.

COMMON TOOLS:

*Solution of linear systems of equations: direct and iterative methods.
*Nonlinear equations: bisection and Newton's methods. Convergence, order of convergence, stopping criteria.
*Lagrange interpolation: interpolation error, piecewise Lagrange interpolation, order of approximation.
*Least squares method for data fitting: linear regression and various examples.
*Interpolatory quadrature formulas in 1D: midpoint, trapezoidal, Simpson and error analysis. Gaussian formulae.Extension to dimension 2 on rectangular domains. Quadrature formulas on triangular domains: barycenter, vertex, and midpoint of the edges.

Metodi didattici	Lectures (hours/year in lecture theatre): 45 Practical class (hours/year in lecture theatre): 0 Practicals / Workshops (hours/year in lecture theatre): 0
Testi di riferimento	A. Quarteroni, R. Sacco, F. Saleri . Numerical Mathematics-2nd edition. Springer Series: Texts in Applied Mathematics, Vol. 37 (2007).
Modalità verifica apprendimento	The exam will be written. Each student will be offered a couple of questions on subjects developed in the classes and has one hour to answer.
Altre informazioni	Additional information can be found on the web page: http://www-dimat.unipv.it/sangalli
Obiettivi Agenda 2030 per lo	

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