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Nota di contenuto	Partial Differential Equations and the Finite Element Method; CONTENTS; List of Figures; LIST OF FIGURES; List of Tables; LIST OF TABLES; Preface; Acknowledgments; 1 Partial Differential Equations; 1.1 Selected general properties; 1.1.1 Classification and examples; 1.1.2 Hadamard's well-posedness; 1.1 Jacques Salomon Hadamard ( 1865-1963).; 1.2 Isolines of the solution $u(x, t)$ of Burger's equation.; 1.1.3 General existence and uniqueness results; 1.1.4 Exercises; 1.2 Second-order elliptic problems; 1.2.1 Weak formulation of a model problem 1.3 Johann Peter Gustav Lejeune Dirichlet (1805-1859).1.2.2 Bilinear forms, energy norm, and energetic inner product; 1.2.3 The Lax-Milgram lemma; 1.2.4 Unique solvability of the model problem; 1.2.5 Nonhomogeneous Dirichlet boundary conditions; 1.2.6 Neumann boundary conditions; 1.2.7 Newton (Robin) boundary conditions; 1.2.8 Combining essential and natural boundary conditions; 1.2.9 Energy of elliptic problems; 1.2.10 Maximum principles and well-posedness; 1.4 Maximum principle for the Poisson equation in 2D.; 1.2.11 Exercises; 1.3 Second-order parabolic problems

1.3.1 Initial and boundary conditions; 1.3.2 Weak formulation; 1.3.3 Existence and uniqueness of solution; 1.3.4 Exercises; 1.4 Second-order hyperbolic problems; 1.4.1 Initial and boundary conditions; 1.4.2 Weak formulation and unique solvability; 1.4.3 The wave equation; 1.4.4 Exercises; 1.5 First-order hyperbolic problems; 1.5.1 Conservation laws; 1.5.2 Characteristics; 1.5.3 Exact solution to linear first-order systems; 1.5.4 Riemann problem; 1.5 Georg Friedrich Bernhard Riemann (1826-1866).; 1.6 Propagation of discontinuity in the solution of the Riemann problem.  
 1.5.5 Nonlinear flux and shock formation; 1.5.6 Exercises; 1.7 Formation of shock in the solution  $u(x, t)$  of Burger's equation.; 2 Continuous Elements for 1D Problems; 2.1 The general framework; 2.1.1 The Galerkin method; 2.1 Boris Grigorievich Galerkin (1871-1945).; 2.1.2 Orthogonality of error and Cea's lemma; 2.1.3 Convergence of the Galerkin method; 2.1.4 Ritz method for symmetric problems; 2.1.5 Exercises; 2.2 Lowest-order elements; 2.2.1 Model problem; 2.2.2 Finite-dimensional subspace  $V_n \subset V$ ; 2.2.3 Piecewise-affine basis functions; 2.2.4 The system of linear algebraic equations  
 2.2 Example of a basis function  $v_i$  of the space  $V_n$ ; 2.2.5 Element-by-element assembling procedure; 2.3 Tridiagonal stiffness matrix  $S_n$ .; 2.2.6 Refinement and convergence; 2.2.7 Exercises; 2.3 Higher-order numerical quadrature; 2.3.1 Gaussian quadrature rules; 2.4 Carl Friedrich Gauss (1777-1855).; 2.3.2 Selected quadrature constants; 2.1 Gaussian quadrature on  $K_k$ , order  $2k - 1 = 3$ .; 2.2 Gaussian quadrature on  $K_k$ , order  $2k - 1 = 5$ .; 2.3 Gaussian quadrature on  $K_k$ , order  $2k - 1 = 7$ .; 2.4 Gaussian quadrature on  $K_k$ , order  $2k - 1 = 9$ .; 2.5 Gaussian quadrature on  $K_k$ , order  $2k - 1 = 11$ .  
 2.3.3 Adaptive quadrature

## Sommario/riassunto

A systematic introduction to partial differential equations and modern finite element methods for their efficient numerical solution. Partial Differential Equations and the Finite Element Method provides a much-needed, clear, and systematic introduction to modern theory of partial differential equations (PDEs) and finite element methods (FEM). Both nodal and hierarchical concepts of the FEM are examined. Reflecting the growing complexity and multiscale nature of current engineering and scientific problems, the author emphasizes higher-order finite element methods such as the spectral