Classical Numerical Analysis

A Comprehensive Course

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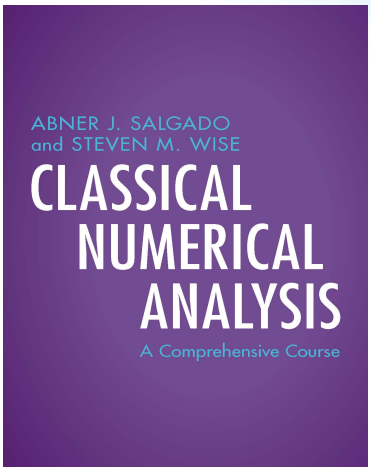

Numerical Analysis is a broad field, and coming to grips with all of it may seem like a daunting task. This text provides a thorough and comprehensive exposition of all the topics contained in a classical graduate sequence in numerical analysis. With an emphasis on theory and connections with linear algebra and analysis, the book shows all the rigor of numerical analysis. Its high level and exhaustive coverage will prepare students for research in the field and become a valuable reference as they continue their career. Students will appreciate the simple notation, clear assumptions and arguments, as well as the many examples and classroom-tested exercises ranging from simple verification to qualifying exam-level problems. In addition to the many examples with hand calculations, readers will also be able to translate theory into practical computational codes by running sample MATLAB codes as they try out new concepts.

Part I. Numerical Linear Algebra: 1. Linear operators and matrices; 2. The singular value decomposition; 3. Systems of linear equations; 4. Norms and matrix conditioning; 5. Linear least squares problem; 6. Linear iterative methods; 7. Variational and Krylov subspace methods; 8. Eigenvalue problems; Part II. Constructive Approximation Theory: 9. Polynomial interpolation; 10. Minimax polynomial approximation; 11. Polynomial least squares approximation; 12. Fourier series; 13. Trigonometric interpolation and the Fast Fourier Transform; 14. Numerical quadrature; Part III. Nonlinear Equations and Optimization: 15. Solution of nonlinear equations; 16. Convex optimization; Part IV. Initial Value Problems for Ordinary Differential Equations: 17. Initial value problems for ordinary differential equations; 18. Single-step methods; 19. Runge–Kutta methods; 20. Linear multi-step methods; 21. Sti ff systems of ordinary diff erential equations and linear stability; 22. Galerkin methods for initial value problems; Part V. Boundary and Initial Boundary Value Problems: 23. Boundary and initial boundary value problems for partial di fferential equations; 24. Finite diff erence methods for elliptic problems; 25. Finite element methods for elliptic problems; 26. Spectral and pseudo-spectral methods for periodic elliptic equations; 27. Collocation methods for elliptic equations; 28. Finite di fference methods for parabolic problems; 29. Finite diff erence methods for hyperbolic problems; Appendix A. Linear algebra review; Appendix B. Basic analysis review; Appendix C. Banach fixed point theorem; Appendix D. A (petting) zoo of function spaces; References; Index.

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'This impressive volume covers an unusually broad range of topics in the field of numerical analysis, including numerical linear algebra, polynomial and trigonometric interpolation, best approximation, numerical quadrature, the approximate solution of nonlinear equations and convex optimization, and the numerical solution of ordinary and partial differential equations by finite difference, spectral and finite element methods. A particularly appealing feature of the text is the way in which it integrates a mathematically rigorous exposition with a wealth of illustrative examples, including numerical simulations, sample codes, and exercises. I warmly recommend the book to students and lecturers as an advanced undergraduate or introductory graduate level text.'

Endre Süli,

University of Oxford