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### An Introduction to Numerical Analysis

**Cambridge University Press** Introduction to numerical analysis combining rigour with practical applications. Numerous exercises plus solutions.

### AN INTRODUCTION TO NUMERICAL ANALYSIS, 2ND ED

**John Wiley & Sons** Market\_Desc: · Mathematics Students · Instructors About The Book: This Second Edition of a standard numerical analysis text retains organization of the original edition, but all sections have been revised, some extensively, and bibliographies have been updated. New topics covered include optimization, trigonometric interpolation and the fast Fourier transform, numerical differentiation, the method of lines, boundary value problems, the conjugate gradient method, and the least squares solutions of systems of linear equations.

### An Introduction to Numerical Methods and Analysis

**John Wiley & Sons** Praise for the First Edition ". . . outstandingly appealing with regard to its style, contents, considerations of requirements of practice, choice of examples, and exercises." —Zentrablatt Math ". . . carefully structured with many detailed worked examples . . ." —The Mathematical Gazette ". . . an up-to-date and user-friendly account . . ." —Mathematika An Introduction to Numerical Methods and Analysis addresses the mathematics underlying approximation and scientific computing and successfully explains where approximation methods come from, why they sometimes work (or don't work), and when to use one of the many techniques that are available. Written in a style that emphasizes readability and usefulness for the numerical methods novice, the book begins with basic, elementary material and gradually builds up to more advanced topics. A selection of concepts required for the study of computational mathematics is introduced, and simple approximations using Taylor's Theorem are also treated in some depth. The text includes exercises that run the gamut from simple hand computations, to challenging derivations and minor proofs, to programming exercises. A greater emphasis on applied exercises as well as the cause and effect associated with numerical mathematics is featured throughout the book. An Introduction to Numerical Methods and Analysis is the ideal text for students in advanced undergraduate mathematics and engineering courses who are interested in gaining an understanding of numerical methods and numerical analysis.

### Numerical Analysis

**Cengage Learning** This well-respected text gives an introduction to the theory and application of modern numerical approximation techniques for students taking a one- or two-semester course in numerical analysis. With an accessible treatment that only requires a calculus prerequisite, Burden and Faires explain how, why, and when approximation techniques can be expected to work, and why, in some situations, they fail. A wealth of examples and exercises develop students' intuition, and demonstrate the subject's practical applications to important everyday problems in math, computing, engineering, and physical science disciplines. The first book of its kind built from the ground up to serve a diverse undergraduate audience, three decades later Burden and Faires remains the definitive introduction to a vital and practical subject. Important Notice: Media content referenced within the product description or the product text may not be available in the ebook version.

# Numerical Methods in Scientific Computing: Volume 1

**SIAM** This work addresses the increasingly important role of numerical methods in science and engineering. It combines traditional and well-developed topics with other material such as interval arithmetic, elementary functions, operator series, convergence acceleration, and continued fractions.

## Introduction to Numerical Analysis

**Cambridge University Press** This textbook provides an introduction to constructive methods that provide accurate approximations to the solution of numerical problems using MATLAB.

## Dynamical Systems and Numerical Analysis

**Cambridge University Press** The first three chapters contain the elements of the theory of dynamical systems and the numerical solution of initial-value problems. In the remaining chapters, numerical methods are formulated as dynamical systems and the convergence and stability properties of the methods are examined.

## Foundations of Computational Mathematics

**Cambridge University Press** Collection of papers by leading researchers in computational mathematics, suitable for graduate students and researchers.

## Guide to Scientific Computing in C++

**Springer Science & Business Media** This easy-to-read textbook/reference presents an essential guide to object-oriented C++ programming for scientific computing. With a practical focus on learning by example, the theory is supported by numerous exercises. Features: provides a specific focus on the application of C++ to scientific computing, including parallel computing using MPI; stresses the importance of a clear programming style to minimize the introduction of errors into code; presents a practical introduction to procedural programming in C++, covering variables, flow of control, input and output, pointers, functions, and reference variables; exhibits the efficacy of classes, highlighting the main features of object-orientation; examines more advanced C++ features, such as templates and exceptions; supplies useful tips and examples throughout the text, together with chapter-ending exercises, and code available to download from Springer.

## Numerical Solution of Ordinary Differential Equations

**John Wiley & Sons** A concise introduction to numerical methods and the mathematical framework needed to understand their performance. Numerical Solution of Ordinary Differential Equations presents a complete and easy-to-follow introduction to classical topics in the numerical solution of ordinary differential equations. The book's approach not only explains the presented mathematics, but also helps readers understand how these numerical methods are used to solve real-world problems. Unifying perspectives are provided throughout the text, bringing together and categorizing different types of problems in order to help readers comprehend the applications of ordinary differential equations. In addition, the authors' collective academic experience ensures a coherent and accessible discussion of key topics, including: Euler's method Taylor and Runge-Kutta methods General error analysis for multi-step methods Stiff differential equations Differential algebraic equations Two-point boundary value problems Volterra integral equations Each chapter features problem sets that enable readers to test and build their knowledge of the presented methods, and a related Web site features MATLAB® programs that facilitate the exploration of numerical methods in greater depth. Detailed references outline additional literature on both analytical and numerical aspects of ordinary differential equations for further exploration of individual topics. Numerical Solution of Ordinary Differential Equations is an excellent textbook for courses on the numerical solution of differential equations at the upper-undergraduate and beginning graduate levels. It also serves as a valuable reference for researchers in the fields of mathematics and engineering.

## A Friendly Introduction to Numerical Analysis

**Prentice Hall** This reader-friendly introduction to the fundamental concepts and techniques of numerical analysis/numerical methods develops concepts and techniques in a clear, concise, easy-to-read manner, followed by fully-worked examples. Application problems drawn from the literature of many different fields prepares readers to use the techniques covered to solve a wide variety of practical problems. Rootfinding. Systems of Equations. Eigenvalues and Eigenvectors. Interpolation and Curve Fitting. Numerical Differentiation and Integration. Numerical Methods for Initial Value Problems of Ordinary Differential Equations. Second-Order One-Dimensional Two-Point Boundary Value Problems. Finite Difference Method for Elliptic Partial Differential Equations. Finite Difference Method for Parabolic Partial Differential Equations. Finite Difference Method for Hyperbolic Partial Differential Equations and the Convection-Diffusion Equation. For anyone interested in numerical analysis/methods and their applications in many fields

## Approximation Theory and Approximation Practice, Extended Edition

**SIAM** This is a textbook on classical polynomial and rational approximation theory for the twenty-first century. Aimed at advanced undergraduates and graduate students across all of applied mathematics, it uses MATLAB to teach the field's most important ideas and results. Approximation Theory and Approximation Practice, Extended Edition differs fundamentally from other works on approximation theory in a number of ways: its emphasis is on topics close to numerical algorithms; concepts are illustrated with Chebfun; and each chapter is a PUBLISHable MATLAB M-file, available online. The book centers on theorems and methods for analytic functions, which appear so often in applications, rather than on functions at the edge of discontinuity with their seductive theoretical challenges. Original sources are cited rather than textbooks, and each item in the bibliography is accompanied by an editorial comment. In addition, each chapter has a collection of exercises, which span a wide range from mathematical theory to Chebfun-based numerical experimentation. This textbook is appropriate for advanced undergraduate or graduate students who have an understanding of numerical analysis and complex analysis. It is also appropriate for seasoned mathematicians who use MATLAB.

## Introduction to Scientific Computing and Data Analysis

**Springer** This textbook provides an introduction to numerical computing and its applications in science and engineering. The topics covered include those usually found in an introductory course, as well as those that arise in data analysis. This includes optimization and regression based methods using a singular value decomposition. The emphasis is on problem solving, and there are numerous exercises throughout the text concerning applications in engineering and science. The essential role of the mathematical theory underlying the methods is also considered, both for understanding how the method works, as well as how the error in the computation depends on the method being used. The MATLAB codes used to produce most of the figures and data tables in the text are available on the author's website and SpringerLink.

## Chebyshev and Fourier Spectral Methods

### Second Revised Edition

**Courier Corporation** Completely revised text applies spectral methods to boundary value, eigenvalue, and time-dependent problems, but also covers cardinal functions, matrix-solving methods, coordinate transformations, much more. Includes 7 appendices and over 160 text figures.

## Numerical Methods for Delay Differential Equations

**Oxford University Press** This unique book describes, analyses, and improves various approaches and techniques for the numerical solution of delay differential equations. It includes a list of available codes and also aids the reader in writing his or her own.

## Numerical Methods

### Design, Analysis, and Computer Implementation of Algorithms

**Princeton University Press** A rigorous and comprehensive introduction to numerical analysis Numerical Methods provides a clear and concise exploration of standard numerical analysis topics, as well as nontraditional ones, including mathematical modeling, Monte Carlo methods, Markov chains, and fractals. Filled with appealing examples that will motivate students, the textbook considers modern application areas, such as information retrieval and animation, and classical topics from physics and engineering. Exercises use MATLAB and promote understanding of computational results. The book gives instructors the flexibility to emphasize different aspects—design, analysis, or computer implementation—of numerical algorithms, depending on the background and interests of students. Designed for upper-division undergraduates in mathematics or computer science classes, the textbook assumes that students have prior knowledge of linear algebra and calculus, although these topics are reviewed in the text. Short discussions of the history of numerical methods are interspersed throughout the chapters. The book also includes polynomial interpolation at Chebyshev points, use of the MATLAB package Chebfun, and a section on the fast Fourier transform. Supplementary materials are available online. Clear and concise exposition of standard numerical analysis topics Explores nontraditional topics, such as mathematical modeling and Monte Carlo methods Covers modern applications, including information retrieval and animation, and classical applications from physics and engineering Promotes understanding of computational results through MATLAB exercises Provides flexibility so instructors can emphasize mathematical or applied/computational aspects of numerical methods or a combination Includes recent results on polynomial interpolation at Chebyshev points and use of the MATLAB package Chebfun Short discussions of the history of numerical methods interspersed throughout Supplementary materials available online

## Numerical Analysis

### Mathematics of Scientific Computing

**American Mathematical Soc.** This book introduces students with diverse backgrounds to various types of mathematical analysis that are commonly needed in scientific computing. The subject of numerical analysis is treated from a mathematical point of view, offering a complete analysis of methods for scientific computing with appropriate motivations and careful proofs. In an engaging and informal style, the authors demonstrate that many computational procedures and intriguing questions of computer science arise from theorems and proofs. Algorithms are presented in pseudocode, so that students can immediately write computer programs in standard languages or use interactive mathematical software packages. This book occasionally touches upon more advanced topics that are not usually contained in standard textbooks at this level.

## Computational Differential Equations

**Cambridge University Press** Textbook for teaching computational mathematics.

## Essentials of Stochastic Processes

**Springer** Building upon the previous editions, this textbook is a first course in stochastic processes taken by undergraduate and graduate students (MS and PhD students from math, statistics, economics, computer science, engineering, and finance departments) who have had a course in probability theory. It covers Markov chains in discrete and continuous time, Poisson processes, renewal processes, martingales, and option pricing. One can only learn a subject by seeing it in action, so there are a large number of examples and more than 300 carefully chosen exercises to deepen the reader's understanding. Drawing from teaching experience and student feedback, there are many new examples and problems with solutions that use TI-83 to eliminate the tedious details of solving linear equations by hand, and the collection of exercises is much improved, with many more biological examples. Originally included in previous editions, material too advanced for this first course in stochastic processes has been eliminated while treatment of other topics useful for applications has been expanded. In addition, the ordering of topics has been improved; for example, the difficult subject of martingales is delayed until its usefulness can be applied in the treatment of mathematical finance.

# Error Estimation and Adaptive Discretization Methods in Computational Fluid Dynamics

**Springer Science & Business Media** As computational fluid dynamics (CFD) is applied to ever more demanding fluid flow problems, the ability to compute numerical fluid flow solutions to a user specified tolerance as well as the ability to quantify the accuracy of an existing numerical solution are seen as essential ingredients in robust numerical simulation. Although the task of accurate error estimation for the nonlinear equations of CFD seems a daunting problem, considerable effort has centered on this challenge in recent years with notable progress being made by the use of advanced error estimation techniques and adaptive discretization methods. To address this important topic, a special course was jointly organized by the NATO Research and Technology Office (RTO), the von Karman Institute for Fluid Dynamics, and the NASA Ames Research Center. The NATO RTO sponsored course entitled "Error Estimation and Solution Adaptive Discretization in CFD" was held September 10-14, 2002 at the NASA Ames Research Center and October 15-19, 2002 at the von Karman Institute in Belgium. During the special course, a series of comprehensive lectures by leading experts discussed recent advances and technical progress in the area of numerical error estimation and adaptive discretization methods with specific emphasis on computational fluid dynamics. The lecture notes provided in this volume are derived from the special course material. The volume consists of 6 articles prepared by the special course lecturers.

# Functional Analysis, Sobolev Spaces and Partial Differential Equations

**Springer Science & Business Media** This textbook is a completely revised, updated, and expanded English edition of the important *Analyse fonctionnelle* (1983). In addition, it contains a wealth of problems and exercises (with solutions) to guide the reader. Uniquely, this book presents in a coherent, concise and unified way the main results from functional analysis together with the main results from the theory of partial differential equations (PDEs). Although there are many books on functional analysis and many on PDEs, this is the first to cover both of these closely connected topics. Since the French book was first published, it has been translated into Spanish, Italian, Japanese, Korean, Romanian, Greek and Chinese. The English edition makes a welcome addition to this list.

# Automated Solution of Differential Equations by the Finite Element Method

## The FEniCS Book

**Springer Science & Business Media** This book is a tutorial written by researchers and developers behind the FEniCS Project and explores an advanced, expressive approach to the development of mathematical software. The presentation spans mathematical background, software design and the use of FEniCS in applications. Theoretical aspects are complemented with computer code which is available as free/open source software. The book begins with a special introductory tutorial for beginners. Following are chapters in Part I addressing fundamental aspects of the approach to automating the creation of finite element solvers. Chapters in Part II address the design and implementation of the FEniCS software. Chapters in Part III present the application of FEniCS to a wide range of applications, including fluid flow, solid mechanics, electromagnetics and geophysics.

## Calculus on Manifolds

# A Modern Approach to Classical Theorems of Advanced Calculus

**Westview Press** This book uses elementary versions of modern methods found in sophisticated mathematics to discuss portions of "advanced calculus" in which the subtlety of the concepts and methods makes rigor difficult to attain at an elementary level.

## Fundamental Mathematical Analysis

**Springer Nature** This textbook offers a comprehensive undergraduate course in real analysis in one variable. Taking the view that analysis can only be properly appreciated as a rigorous theory, the book recognises the difficulties that students experience when encountering this theory for the first time, carefully addressing them throughout. Historically, it was the precise description of real numbers and the correct definition of limit that placed analysis on a solid foundation. The book therefore begins with these crucial ideas and the fundamental notion of sequence. Infinite series are then introduced, followed by the key concept of continuity. These lay the groundwork for differential and integral calculus, which are carefully covered in the following chapters. Pointers for further study are included throughout the book, and for the more adventurous there is a selection of "nuggets", exciting topics not commonly discussed at this level. Examples of nuggets include Newton's method, the irrationality of  $\pi$ , Bernoulli numbers, and the Gamma function. Based on decades of teaching experience, this book is written with the undergraduate student in mind. A large number of exercises, many with hints, provide the practice necessary for learning, while the included "nuggets" provide opportunities to deepen understanding and broaden horizons.

## Essential Partial Differential Equations

### Analytical and Computational Aspects

**Springer** This volume provides an introduction to the analytical and numerical aspects of partial differential equations (PDEs). It unifies an analytical and computational approach for these; the qualitative behaviour of solutions being established using classical concepts: maximum principles and energy methods. Notable inclusions are the treatment of irregularly shaped boundaries, polar coordinates and the use of flux-limiters when approximating hyperbolic conservation laws. The numerical analysis of difference schemes is rigorously developed using discrete maximum principles and discrete Fourier analysis. A novel feature is the inclusion of a chapter containing projects, intended for either individual or group study, that cover a range of topics such as parabolic smoothing, travelling waves, isospectral matrices, and the approximation of multidimensional advection-diffusion problems. The underlying theory is illustrated by numerous examples and there are around 300 exercises, designed to promote and test understanding. They are starred according to level of difficulty. Solutions to odd-numbered exercises are available to all readers while even-numbered solutions are available to authorised instructors. Written in an informal yet rigorous style, Essential Partial Differential Equations is designed for mathematics undergraduates in their final or penultimate year of university study, but will be equally useful for students following other scientific and engineering disciplines in which PDEs are of practical importance. The only prerequisite is a familiarity with the basic concepts of calculus and linear algebra.

## Handbook of Numerical Analysis

**Gulf Professional Publishing**

### Exploring ODEs

**SIAM** Exploring ODEs is a textbook of ordinary differential equations for advanced undergraduates, graduate students, scientists, and engineers. It is unlike other books in this field in that each concept is illustrated numerically via a few lines of Chebfun code. There are about 400 computer-generated figures in all, and Appendix B presents 100 more examples as templates for further exploration.?

## Discontinuous Galerkin Methods

### Theory, Computation and Applications

**Springer Science & Business Media** A class of finite element methods, the Discontinuous Galerkin Methods (DGM), has been under rapid development recently and has found its use very quickly in such diverse applications as aeroacoustics, semi-conductor device simulation, turbomachinery, turbulent flows, materials processing, MHD and plasma simulations, and image processing. While there has

been a lot of interest from mathematicians, physicists and engineers in DGM, only scattered information is available and there has been no prior effort in organizing and publishing the existing volume of knowledge on this subject. In May 24-26, 1999 we organized in Newport (Rhode Island, USA), the first international symposium on DGM with equal emphasis on the theory, numerical implementation, and applications. Eighteen invited speakers, leaders in the field, and thirty-two contributors presented various aspects and addressed open issues on DGM. In this volume we include forty-nine papers presented in the Symposium as well as a survey paper written by the organizers. All papers were peer-reviewed. A summary of these papers is included in the survey paper, which also provides a historical perspective of the evolution of DGM and its relation to other numerical methods. We hope this volume will become a major reference in this topic. It is intended for students and researchers who work in theory and application of numerical solution of convection dominated partial differential equations. The papers were written with the assumption that the reader has some knowledge of classical finite elements and finite volume methods.

## Number Theory

### An Introduction to Mathematics

**Springer Science & Business Media** Number Theory is more than a comprehensive treatment of the subject. It is an introduction to topics in higher level mathematics, and unique in its scope; topics from analysis, modern algebra, and discrete mathematics are all included. The book is divided into two parts. Part A covers key concepts of number theory and could serve as a first course on the subject. Part B delves into more advanced topics and an exploration of related mathematics. The prerequisites for this self-contained text are elements from linear algebra. Valuable references for the reader are collected at the end of each chapter. It is suitable as an introduction to higher level mathematics for undergraduates, or for self-study.

### An Introduction to Manifolds

**Springer Science & Business Media** Manifolds, the higher-dimensional analogs of smooth curves and surfaces, are fundamental objects in modern mathematics. Combining aspects of algebra, topology, and analysis, manifolds have also been applied to classical mechanics, general relativity, and quantum field theory. In this streamlined introduction to the subject, the theory of manifolds is presented with the aim of helping the reader achieve a rapid mastery of the essential topics. By the end of the book the reader should be able to compute, at least for simple spaces, one of the most basic topological invariants of a manifold, its de Rham cohomology. Along the way, the reader acquires the knowledge and skills necessary for further study of geometry and topology. The requisite point-set topology is included in an appendix of twenty pages; other appendices review facts from real analysis and linear algebra. Hints and solutions are provided to many of the exercises and problems. This work may be used as the text for a one-semester graduate or advanced undergraduate course, as well as by students engaged in self-study. Requiring only minimal undergraduate prerequisites, 'Introduction to Manifolds' is also an excellent foundation for Springer's GTM 82, 'Differential Forms in Algebraic Topology'.

### Mathematical Modelling of Zombies

**University of Ottawa Press** You're outnumbered, in fear for your life, surrounded by flesh-eating zombies. What can save you now? Mathematics, of course. Mathematical Modelling of Zombies engages the imagination to illustrate the power of mathematical modelling. Using zombies as a "hook," you'll learn how mathematics can predict the unpredictable. In order to be prepared for the apocalypse, you'll need mathematical models, differential equations, statistical estimations, discrete-time models, and adaptive strategies for zombie attacks—as well as baseball bats and Dire Straits records (latter two items not included). In Mathematical Modelling of Zombies, Robert Smith? brings together a highly skilled team of contributors to fend off a zombie uprising. You'll also learn how modelling can advise government policy, how theoretical results can be communicated to a nonmathematical audience and how models can be formulated with only limited information. A forward by Andrew Cartmel—former script editor of Doctor Who, author, zombie fan and all-round famous person in science-fiction circles—even provides a genealogy of the undead. By understanding how to combat zombies, readers will be introduced to a wide variety of modelling techniques that are applicable to other real-world issues (biology, epidemiology, medicine, public health, etc.). So if the zombies turn up, reach for this book. The future of the human race may depend on it.

## Principles of Numerical Analysis

**Courier Corporation** Computer science rests upon the building blocks of numerical analysis. This concise treatment by an expert covers the essentials of the solution of finite systems of linear and nonlinear equations as well as the approximate representation of functions. A final section provides 54 problems, subdivided according to chapter. 1953 edition.

## A First Course in the Numerical Analysis of Differential Equations

**Cambridge University Press** lead the reader to a theoretical understanding of the subject without neglecting its practical aspects. The outcome is a textbook that is mathematically honest and rigorous and provides its target audience with a wide range of skills in both ordinary and partial differential equations." --Book Jacket.

## Numerical Computing with MATLAB

### Revised Reprint

**SIAM** A revised textbook for introductory courses in numerical methods, MATLAB and technical computing, which emphasises the use of mathematical software.

## Verification and Validation in Scientific Computing

**Cambridge University Press** Advances in scientific computing have made modelling and simulation an important part of the decision-making process in engineering, science, and public policy. This book provides a comprehensive and systematic development of the basic concepts, principles, and procedures for verification and validation of models and simulations. The emphasis is placed on models that are described by partial differential and integral equations and the simulations that result from their numerical solution. The methods described can be applied to a wide range of technical fields, from the physical sciences, engineering and technology and industry, through to environmental regulations and safety, product and plant safety, financial investing, and governmental regulations. This book will be genuinely welcomed by researchers, practitioners, and decision makers in a broad range of fields, who seek to improve the credibility and reliability of simulation results. It will also be appropriate either for university courses or for independent study.

## Higher Mathematics for Science, Technology and Engineering

**Bentham Science Publishers** Higher Mathematics for Science, Technology and Engineering is a textbook for undergraduate and postgraduate students undertaking science, technology, engineering and mathematics (STEM) courses. The book begins with an introduction to one variable functions, followed by chapters covering functional derivatives, partial differentiation, integrals, matrices and determinant theory, partial fractions and much more. Key features of this textbook include: -simple, easy-to-understand explanations of relevant concepts -a wide range of simple and complex examples - several figures where appropriate

## Numerical Analysis and Optimization

## An Introduction to Mathematical Modelling and Numerical Simulation

**OUP Oxford** This text, based on the author's teaching at École Polytechnique, introduces the reader to the world of mathematical modelling and numerical simulation. Covering the finite difference method; variational formulation of elliptic problems; Sobolev spaces; elliptical problems; the finite element method; Eigenvalue problems; evolution problems; optimality conditions and algorithms and methods of operational research, and including a several exercises throughout, this is an ideal text for advanced undergraduate students and graduates in applied mathematics, engineering, computer science, and the physical sciences.

# Student Solutions Manual and Study Guide for Numerical Analysis

**Cengage Learning** The Student Solutions Manual contains worked-out solutions to many of the problems. It also illustrates the calls required for the programs using the algorithms in the text, which is especially useful for those with limited programming experience.

## Basic Linear Algebra

**Springer Science & Business Media** Basic Linear Algebra is a text for first year students leading from concrete examples to abstract theorems, via tutorial-type exercises. More exercises (of the kind a student may expect in examination papers) are grouped at the end of each section. The book covers the most important basics of any first course on linear algebra, explaining the algebra of matrices with applications to analytic geometry, systems of linear equations, difference equations and complex numbers. Linear equations are treated via Hermite normal forms which provides a successful and concrete explanation of the notion of linear independence. Another important highlight is the connection between linear mappings and matrices leading to the change of basis theorem which opens the door to the notion of similarity. This new and revised edition features additional exercises and coverage of Cramer's rule (omitted from the first edition). However, it is the new, extra chapter on computer assistance that will be of particular interest to readers: this will take the form of a tutorial on the use of the "LinearAlgebra" package in MAPLE 7 and will deal with all the aspects of linear algebra developed within the book.

## Numerical Analysis in Modern Scientific Computing

### An Introduction

**Springer Science & Business Media** This book introduces the main topics of modern numerical analysis: sequence of linear equations, error analysis, least squares, nonlinear systems, symmetric eigenvalue problems, three-term recursions, interpolation and approximation, large systems and numerical integrations. The presentation draws on geometrical intuition wherever appropriate and is supported by a large number of illustrations, exercises, and examples.