Numerical Analysis Of Spectral Methods Theory And Applications Cbms Nsf Regional Conference Series In Applied Mathematics

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Spectral Methods in Fluid Dynamics Courier Corporation
Handbook of Numerical Methods for Hyperbolic Problems explores the changes that have taken place in the past few decades regarding literature in the design, analysis and application of various numerical algorithms for solving hyperbolic equations. This volume provides concise summaries from experts in different types of algorithms, so that readers can find a variety of algorithms under different situations and readily understand their relative advantages and limitations. Provides detailed, cutting-edge background explanations of existing algorithms and their analysis Ideal for readers working on the theoretical aspects of algorithm development and its numerical analysis Presents a method of different algorithms for specific applications and the relative advantages and limitations of different algorithms for engineers or readers involved in applications Written by leading subject experts in each field who provide breadth and depth of content coverage
Numerical Analysis of Spectral Methods Springer Science & Business Media
A balanced guide to the essential techniques for solving elliptic partial differential equations Numerical Analysis of Partial Differential Equations provides a comprehensive, self-contained treatment of the quantitative methods used to solve elliptic partial differential equations (PDEs), with a focus on the efficiency as well as the error of the presented methods. The author utilizes coverage of theoretical PDEs, along with the nu merical solution of linear systems and various examples and exercises, to supply readers with an introduction to the essential concepts in the numerical analysis of PDEs. The book presents the three main discretization methods of elliptic PDEs: finite difference, finite elements, and spectral methods. Each topic has its own devoted chapters and is discussed alongside additional key topics, including: The mathematical theory of elliptic PDEs Numerical linear algebra Time-dependent PDEs Multigrid and domain decomposition PDEs posed on infinite domains The book concludes with a discussion of the methods for nonlinear problems, such as Newton's method, and addresses the importance of hands-on work to facilitate learning. Each chapter concludes with a set of exercises, including theoretical and programming problems, that allows readers to test their understanding of the presented theories and techniques. In addition, the book discusses important nonlinear problems in many fields of science and engineering, providing information as to how they can serve as computing projects across various disciplines. Requiring only a preliminary understanding of analysis, Numerical Analysis of Partial Differential Equations is suitable for courses on numerical PDEs at the upper-undergraduate and graduate levels. The book is also appropriate for students majoring in the mathematical sciences and engineering.
Spectral/hp Element Methods for Computational Fluid Dynamics Springer Science & Business Media
In the wake of the computer revolution, a large number of apparently uncon nected computational techniques have emerged. Also, particular methods have assumed prominent positions in certain areas of application. Finite element methods, for example, are used almost exclusively for solving

structural problems; spectral methods are becoming the preferred approach to global atmospheric modelling and weather prediction; and the use of finite difference methods is nearly universal in predicting the flow around aircraft wings and fuselages. These apparently unrelated techniques are firmly entrenched in computer codes used every day by practicing scientists and engineers. Many of these scientists and engineers have been drawn into the computational area without the benefit offormal computational training. Often the formal computational training we do provide reinforces the arbitrary divisions between the various computational methods available. One of the purposes of this monograph is to show that many computational techniques are, indeed, closely related. The Galerkin formulation, which is being used in many subject areas, provides the connection. Within the Galerkin frame-work we can generate finite element, finite difference, and spectral methods.
With Applications to Computational Fluid Dynamics Springer Science & Business Media
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
Fractional Order Analysis Springer
Spectral methods are well-suited to solve problems modeled by time-dependent partial differential equations: they are fast, efficient and accurate and widely used by mathematicians and practitioners. This class-tested 2007 introduction, the first on the subject, is ideal for graduate courses, or self-study. The authors describe the basic theory of spectral methods, allowing the reader to understand the techniques through numerous examples as well as more rigorous developments. They provide a detailed treatment of methods based on Fourier expansions and orthogonal polynomials (including discussions of stability, boundary conditions, filtering, and the extension from the linear to the nonlinear situation). Computational solution techniques for integration in time are dealt with by Runge-Kutta type methods. Several chapters are devoted to material not previously covered in book form, including stability theory for polynomial methods, techniques for problems with discontinuous solutions, round-off errors and the formulation of spectral methods on general grids. These will be especially helpful for practitioners.
Nonlinear Physical Systems Cambridge Scholars Publishing
Spectral Methods Using Multivariate Polynomials on the Unit Ball is a research level text on a numerical method for the solution of partial differential equations. The authors introduce, illustrate with examples, and analyze 'spectral methods' that are based on multivariate polynomial approximations. The method presented is an alternative to finite element and difference methods for regions that are diffeomorphic to the unit disk, in two dimensions, and the unit ball, in three dimensions. The speed of convergence of spectral methods is usually much higher than that of finite element or finite difference methods. Features Introduces the use of multivariate polynomials for the construction and analysis of spectral methods for linear and nonlinear boundary value problems Suitable for researchers and students in numerical analysis of PDEs, along with anyone interested in applying this method to a particular physical problem One of the few texts to address this area using multivariate orthogonal polynomials, rather than tensor products of univariate polynomials.
Spectral Methods in Geodesy and Geophysics SIAM
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.
Introduction to Finite and Spectral Element Methods Using MATLAB Cambridge University Press
A unified discussion of the formulation and analysis of special methods of mixed initial boundary-value problems. The focus is on the development of a new mathematical theory that explains why and how well spectral methods work. Included are interesting extensions of the classical numerical analysis.
Spectral Methods for Incompressible Viscous Flow Now Publishers Inc
This paper reviews some operators that are used in the numerical analysis of spectral and spectral element methods. We motivate the introduction of these different operators and sketch their approximation properties. Finally we apply them to derive optimal error estimates for spectral type approximations of the solution of elliptic partial differential equations.
Spectral and High-order Methods with Applications Elsevier
This is a book about spectral methods for partial differential equations: when to use them, how to implement them, and what can be learned from their of spectral methods has evolved rigorous theory. The computational side vigorously since the early 1970s, especially in computationally intensive of the more spectacular applications are applications in fluid dynamics. Some of the power of these discussed here, first in general terms as examples of the methods have been methods and later in great detail after the specifics covered. This book pays special attention to those algorithmic details which are essential to successful implementation of spectral methods. The focus is on algorithms for fluid dynamical problems in transition, turbulence, and aero dynamics. This book does not address specific applications in meteorology, partly because of the lack of experience of the authors in this field and partly because of the coverage provided by Haltiner and Williams (1980). The success of spectral methods in practical computations has led to an increasing interest in their theoretical aspects, especially since the mid-1970s. Although the theory does not yet cover the complete spectrum of applications, the analytical techniques which have been developed in recent years have facilitated the examination of an increasing number of problems of practical interest. In this book we present a unified theory of the mathematical analysis of spectral methods and apply it to many of the algorithms in current use.
Numerical Methods that Work Oxford University Press
This collection of essays explores the ancient affinity between the mathematical and the aesthetic, focusing on fundamental connections between these two modes of reasoning and communicating. From historical, philosophical and psychological perspectives, with particular attention to certain mathematical areas such as geometry and analysis, the authors examine ways in which the aesthetic is ever-present in mathematical thinking and contributes to the growth and value of mathematical knowledge.
Spectral Methods for Partial Differential Equations SIAM
Following up the seminal Spectral Methods in Fluid Dynamics, Spectral Methods: Evolution to Complex Geometries and Applications to Fluid Dynamics contains an extensive survey of the essential algorithmic and theoretical aspects of spectral methods for complex geometries. These types of spectral methods were only just emerging at the time the earlier book was published. The discussion of spectral algorithms for linear and nonlinear fluid dynamics stability analyses is greatly expanded. The chapter on spectral algorithms for incompressible flow focuses on algorithms that have proven most useful in practice, has much greater coverage of algorithms for two or more non-periodic directions, and shows how to treat outflow boundaries. Material on spectral methods for compressible flow emphasizes boundary conditions for hyperbolic systems, algorithms for simulation of homogeneous turbulence, and improved methods for shock fitting. This book is a companion to Spectral Methods: Fundamentals in Single Domains.
Numerical Methods for Conservation Laws CRC Press
This book deals with the application of spectral methods to problems of uncertainty propagation and quanti?cation in model-based computations. It speci?cally focuses on computational and algorithmic features of these methods which are most useful in dealing with models based on partial differential equations, with special att- tion to models arising in simulations of ?uid ?ows. Implementations are illustrated through applications to elementary problems, as well as more elaborate examples selected from the authors' interests in incompressible vortex-dominated ?ows and compressible ?ows at low Mach numbers. Spectral stochastic methods are probabilistic in nature, and are consequently rooted in the rich mathematical foundation associated with probability and measure spaces. Despite the authors' fascination with this foundation, the discussion only - ludes to those theoretical aspects needed to set the stage for subsequent applications. The book is authored by practitioners, and is primarily intended for researchers or graduate students in computational mathematics, physics, or ?uid dynamics. The book assumes familiarity with elementary methods for the numerical solution of time-dependent, partial differential equations; prior experience with spectral me- ods is naturally helpful though not essential. Full appreciation of elaborate examples in computational ?uid dynamics (CFD) would require familiarity with key, and in some cases delicate, features of the associated numerical methods. Besides these shortcomings, our aim is to treat algorithmic and computational aspects of spectral stochastic methods with details suf?cient to address and reconstruct all but those highly elaborate examples.
Spectral Methods Using Multivariate Polynomials On The Unit Ball Springer Science & Business Media
Since the publication of "Spectral Methods in Fluid Dynamics" 1988, spectral methods have become firmly established as a mainstream tool for scientific and engineering computation. The authors of that book have incorporated into this new edition the many improvements in the algorithms and the theory of spectral methods that have been made since then. This latest book retains the tight integration between the theoretical and practical aspects of spectral methods, and the chapters are enhanced with material on the Galerkin with numerical integration version of spectral methods. The discussion of direct and iterative solution methods is also greatly expanded.
Second Edition CRC Press
This is a very lucid introduction to spectral methods emphasizing the mathematical aspects of the theory rather than the many applications in numerical analysis and the engineering sciences. The first part is a fairly complete introduction to Fourier series while the second emphasizes polynomial expansion methods like Chebyshev's. The author gives rigorous proofs of fundamental results related to one-dimensional advection and diffusions equations. The book addresses students as well as practitioners of numerical analysis.
New Approaches to an Ancient Affinity Springer
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Spectral Methods for Non-Standard Eigenvalue Problems American Mathematical Soc.
The@ first graduate-level textbook to focus on fundamental aspects of numerical methods for stochastic computations, this book describes the class of numerical methods based on generalized polynomial chaos (gPC). These fast, efficient, and accurate methods are an extension of the classical spectral methods of high-dimensional random spaces. Designed to simulate complex systems subject to random inputs, these methods are widely used in many areas of computer science and engineering. The book introduces polynomial approximation theory and probability theory; describes the basic theory of gPC methods through numerical examples and rigorous development; details the procedure for converting stochastic equations into deterministic ones; using both the Galerkin and collocation approaches; and discusses the distinct differences and challenges arising from high-dimensional problems. The last section is devoted to the application of gPC methods to critical areas such as inverse problems and data assimilation. Ideal for use by graduate students and researchers both in the classroom and for self-study, Numerical Methods for Stochastic Computations provides the required tools for in-depth research related to stochastic computations. The first graduate-level textbook to focus on the fundamentals of numerical methods for stochastic computations Ideal introduction for graduate courses or self-study Fast, efficient, and accurate numerical methods Polynomial approximation theory and probability theory included Basic gPC methods illustrated through examples
Implementing Spectral Methods for Partial Differential Equations Springer Science & Business Media
This book focuses on the constructive and practical aspects of spectral methods. It rigorously examines the most important qualities as well as drawbacks of spectral methods in the context of numerical methods devoted to solve non-standard eigenvalue problems. In addition, the book also considers some nonlinear singularly perturbed boundary value problems along with eigenproblems obtained by their linearization around constant solutions. The book is mathematical, poising

problems in their proper function spaces, but its emphasis is on algorithms and practical difficulties. The range of applications is quite large. High order eigenvalue problems are frequently beset with numerical ill conditioning problems. The book describes a wide variety of successful modifications to standard algorithms that greatly mitigate these problems. In addition, the book makes heavy use of the concept of pseudospectrum, which is highly relevant to understanding when disaster is imminent in solving eigenvalue problems. It also envisions two classes of applications, the stability of some elastic structures and the hydrodynamic stability of some parallel shear flows. This book is an ideal reference text for professionals (researchers) in applied mathematics, computational physics and engineering. It will be very useful to numerically sophisticated engineers, physicists and chemists. The book can also be used as a textbook in review courses such as numerical analysis, computational methods in various engineering branches or physics and computational methods in analysis.

Spectral Algorithms Springer Science & Business Media

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.

Spectral Analysis, Stability and Bifurcations CRC Press

In this monograph we apply scattering theory methods to calculations in quantum ?eld theory, with a particular focus on properties of the quantum vacuum. These methods will provide e?cient and reliable solutions to a - riety of problems in quantum ?eld theory. Our approach will also elucidate in a concrete context many of the subtleties of quantum ?eld theory, such as divergences, regularization, and renormalization, by connecting them to more familiar results in quantum mechanics. We will use tools of scattering theory to characterize the spectrum of energyeigenstatesinapotentialbackground,hencethetermspectralmethods. This mode spectrum comprises both discrete bound states and a continuum of scattering states. We develop a powerful formalism that parameterizes the e?ects of the continuum by the density of states, which we compute from scattering data. Summing the zero-point energies of these modes gives the energy of the quantum vacuum, which is one of the central quantities we study.Althoughthemostcommonlystudiedbackgroundpotentialsarisefrom static soliton solutions to the classical equations of motion, these methods are not limited to such cases.

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