A Practical To Pseudospectral Methods

In recent years, an unprecedented interest in novel and revolutionary space missions has risen out of the advanced NASA and ESA programs. Astrophysicists, astronomers, space systems engineers, mathematicians and scientists have been cooperating to implement novel and ground-breaking space missions. Recent progress in mathematical dynamics has enabled development of specialised spacecraft orbits and propulsion systems. Recently, the concept of flying spacecraft in formation has gained a lot of interest within the community. These progresses constitute the background to a significant renaissance of research dealing with astrodynamics and its applications. Modern Astrodynamics is designed as a stepping stone for the exposition of modern astrodynamics to students, researchers, engineers and scientists. This volume will present the main constituents of the astrodynamical science in an elaborate, comprehensive and rigorous manner. Although the volume will contain a few distinct chapters, it will render a coherent portrayal of astrodynamics. Encompasses the main constituents of the astrodynamical sciences in an elaborate, comprehensive and rigorous manner Presents recent astrodynamical advances and describes the challenges ahead The first volume of a series designed to give scientists and engineers worldwide an opportunity to publish their works in this multi-disciplinary field

This volume is the fifth in a series of proceedings which started in 1999. The contributions include the latest results on the theory of wave propagation, extended thermodynamics, and the stability of the solutions to partial differential equations.

Revision of: Spectral/hp element methods for CFD. 1999.

Gaussian quadrature is a powerful technique for numerical integration that falls under the broad category of spectral methods. The purpose of this work is to provide an introduction to the theory and practice of Gaussian quadrature. We study the approximation theory of trigonometric and orthogonal polynomials and related functions, and examine the analytical framework of Gaussian quadrature. We discuss Gaussian quadrature for bandlimited functions, a topic inspired by some recent developments in the analysis of prolate spheroidal wave functions. Algorithms for the computation of the quadrature nodes and weights are described. Several applications of Gaussian quadrature are given, ranging from the evaluation of special functions to pseudospectral methods for solving differential equations. Software realization of select algorithms is provided.

Musical Performance covers many aspects like Musical Acoustics, Music Psychology, or motor and prosodic actions. It deals with basic concepts of the origin or music and its evolution, ranges over neurocognitive foundations, and covers computational, technological, or simulation solutions. This volume gives an overview about current research in the foundation of musical performance studies on all these levels. Recent concepts of synchronized systems, evolutionary concepts, basic understanding of performance as Gestalt patterns, theories of chill as performance goals or historical aspects are covered. The neurocognitive basis of motor action in terms of music, musical syntax, as well as therapeutic aspects are discussed. State-of-the-art applications in performance realizations, like virtual room acoustics, virtual musicians, new concepts of real-time physical modeling using complex performance data as input or sensor and gesture studies with soft- and hardware solutions are presented. So although the field is still much larger, this volume presents current trends in terms of understanding, implementing, and perceiving performance.

This book explains how, when and why the pseudospectral approach works.

This edited volume consists of twelve contributions related to the EU Marie Curie Transfer of Knowledge Project Cooperation of Estonian and Norwegian Scienti c Centres within Mathematics and its Applications, CENS-CMA (2005-2009), - der contract MTKD-CT-2004-013909, which ?nanced exchange visits to and from CENS, the Centre for Nonlinear Studies at the Institute of Cybernetics of Tallinn University of Technology in Estonia. Seven contributions describe research highlights of CENS members, two the work of members of CMA, the Centre of Mathematics for Applications,Univ- sity of Oslo, Norway, as the partner institution of CENS in the Marie Curie project, and three the ?eld of work of foreign research fellows, who visited CENS as part of theproject. Thestructureofthebookre?ectsthedistributionofthetopicsaddressed: Part I Waves in Solids Part II Mesoscopic Theory Part III Exploiting the Dissipation Inequality Part IV Waves in Fluids Part V Mathematical Methods The papers are written in a tutorial style, intended for non-specialist researchers and students, where the authors communicate their own experiences in tackling a problem that is currently of interest in the scienti?c community. The goal was to produce a book, which highlights the importance of applied mathematics and which can be used for educational purposes, such as material for a course or a seminar. To ensure the scienti?c quality of the contributions, each paper was carefully - viewed by two international experts. Special thanks go to all authors and referees, without whom making this book would not have been possible.

These ten detailed and authoritative survey articles on numerical methods for direct and inverse wave propagation problems are written by leading experts. Researchers and practitioners in computational wave propagation, from postgraduate level onwards, will find the breadth and depth of coverage of recent developments a valuable resource. The articles describe a wide range of topics on the application and analysis of methods for time and frequency domain PDE and boundary integral formulations of wave propagation problems. Electromagnetic, seismic and acoustic equations are considered. Recent developments in methods and analysis ranging from finite differences to hp-adaptive finite elements, including high-accuracy and fast methods are described with extensive references.

Publisher Description

Numerical analysis is the subject of applied mathematics concerned mainly with using computers in evaluating or approximating mathematical models. As such, it is crucial to all applications of mathematics in science and engineering, as well as being an important discipline on its own. Acta Numerica surveys annually the most important developments in numerical analysis and scientific computing. The subjects and authors of the substantive survey articles are chosen by a distinguished international editorial board so as to report the most important developments in the subject in a manner accessible to the wider community of professionals with an interest in scientific computing.

The book describes how sparse optimization methods can be combined with discretization techniques for differential-algebraic equations and used to solve optimal control and estimation problems. The interaction between optimization and integration is emphasized throughout the book.

Develops, analyses, and applies numerical methods for evolutionary, or time-dependent, differential problems.

This book presents the latest researches on hypersonic steady glide dynamics and guidance, including the concept of steady glide reentry trajectory and the stability of its regular perturbation solutions, trajectory damping control technique for hypersonic glide reentry, singular perturbation guidance of hypersonic glide reentry, trajectory optimization based on steady glide, linear pseudospectral generalized nominal effort miss distance guidance, analytical entry guidance and trajectory-shaping guidance with final speed and load factor constraints. They can be used to solve many new difficult problems in entry guidance. And many practical engineering cases are provided for the readers for better understanding. Researchers and students in the fields of flight vehicle design or flight dynamics, guidance and control could use the book as valuable reference.

This book is the second edition of Numerical methods for diffusion phenomena in building physics: a practical introduction originally published by PUCPRESS (2016). It intends to stimulate research in simulation of diffusion problems in building physics, by providing an overview of mathematical models and numerical techniques such as the finite difference and finite-element methods traditionally used in building simulation tools. Nonconventional methods such as reduced order models, boundary integral approaches and spectral methods are presented, which might be considered in the next generation of building-energy-simulation tools. In this reviewed edition, an innovative way to simulate energy and hydrothermal performance are presented, bringing some light on innovative approaches in the field.

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.

Mathematics of Computing -- Numerical Analysis.

A Practical Guide to Pseudospectral MethodsCambridge University Press

This book and CD-ROM compile the most widely applicable methods for solving and approximating differential equations. The CD-ROM provides convenient access to these methods through electronic search capabilities, andtogether the book and CD-ROM contain numerous examples showing the methods use. Topics include ordinary differential equations, symplectic integration of differential equations, and the use of wavelets when numerically solving differential equations. * For nearly every technique, the book and CD-ROM provide: * The types of equations to which the method is applicable * The idea behind the method * The procedure for carrying out the method * At least one simple example of the method * Any cautions that should be exercised * Notes for more advanced users * References to the literature for more discussion or more examples, including pointers to electronic resources, such as URLs

Pure and applied mathematicians, physicists, scientists, and engineers use matrices and operators and their eigenvalues in quantum mechanics, fluid mechanics, structural analysis, acoustics, ecology, numerical analysis, and many other areas. However, in some applications the usual analysis based on eigenvalues fails. For example, eigenvalues are often ineffective for analyzing dynamical systems such as fluid flow, Markov chains, ecological models, and matrix iterations. That's where this book comes in. This is the authoritative work on nonnormal matrices and operators, written by the authorities who made them famous. Each of the sixty sections is written as a self-contained essay. Each document is a lavishly illustrated introductory survey of its topic, complete with beautiful numerical experiments and all the right references. The breadth of included topics and the numerous applications that provide links between fields will make this an essential reference in mathematics and related sciences.

Advances in photonics and nanotechnology have the potential to revolutionize humanity's ability to communicate and compute. To pursue these advances, it is mandatory to understand and properly model interactions of light with materials such as silicon and gold at the nanoscale, i.e., the span of a few tens of atoms laid side by side. These interactions are governed by the fundamental Maxwell's equations of classical electrodynamics, supplemented by quantum electrodynamics. This book presents the current state-of-the-art in formulating and implementing computational models of these interactions. Maxwell's equations are solved using the finite-difference time-domain (FDTD) technique, pioneered by the senior editor, whose prior Artech House books in this area are among the top ten most-cited in the history of engineering. This cutting-edge resource helps readers understand the latest developments in computational modeling of nanoscale optical microscopy and microchip lithography, as well as nanoscale plasmonics and biophotonics.

This volume is designed to give the practicing geophysicist an understanding of the principles of prestack migration, presented with intuitive reasoning that avoids difficult math. Modeling with common-shot record and a constant-offset section are used to introduce prestack migration. New material in this revised edition of the original 1998 book includes algorithms that lead to and include Claerbout's inversion method.

This brief presents numerical methods for describing and calculating invariant phase space structures, as well as solving the classical and quantum equations of motion for polyatomic molecules. Examples covered include simple model systems to realistic cases of molecules spectroscopically studied. Vibrationally excited and reacting molecules are nonlinear dynamical systems, and thus, nonlinear mechanics is the proper theory to elucidate molecular dynamics by investigating invariant structures in phase space. Intramolecular energy transfer, and the breaking and forming of a chemical bond have now found a rigorous explanation by studying phase space structures.

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.

This volume is designed to give the practicing geophysicist an understanding of the principles of poststack migration, presented with intuitive reasoning rather than laborious math. Modeling is introduced as a natural process that starts with a geologic model and then builds seismic data. Migration is then described as the reverse process that uses seismic data to find the geologic model. Many other topics are covered relating to the quality of the migrated section, such as aliasing, rugged topography, or use of the correct velocity. Significant new material has been added in this revised edition of the original 1997 book, especially algorithms based on the phase-shift method, such as PSPI and the omegaX method.

The International Conference on Computational Science (ICCS 2004) held in Krak ? ow, Poland, June 6–9, 2004, was a follow-up to the highly successful ICCS 2003 held at two locations, in Melbourne, Australia and St. Petersburg, Russia; ICCS 2002 in Amsterdam, The Netherlands; and ICCS 2001 in San Francisco, USA. As computational science is still evolving in its quest for subjects of inves- gation and e?cient methods, ICCS 2004 was devised as a forum for scientists from mathematics and computer science, as the basic computing disciplines and application areas, interested in advanced computational methods for physics, chemistry, life sciences, engineering, arts and humanities, as well as computer system vendors and software developers. The main objective of this conference was to discuss problems and solutions in all areas, to identify new issues, to shape future directions of research, and to help users apply various advanced computational techniques. The event harvested recent developments in com-tationalgridsandnextgenerationcomputingsystems,tools,advancednumerical methods, data-driven systems, and novel application ?elds, such as complex - stems, ?nance, econo-physics and population evolution.

This book explains recent results in the theory of moving frames that concern the symbolic manipulation of invariants of Lie group actions. In particular, theorems concerning the calculation of generators of algebras of differential invariants, and the relations they satisfy, are discussed in detail. The author demonstrates how new ideas lead to significant progress in two main applications: the solution of invariant ordinary differential equations and the structure of Euler-Lagrange equations and conservation laws of variational problems. The expository language used here is primarily that of undergraduate calculus rather than differential geometry, making the topic more accessible to a student audience. More sophisticated ideas from differential topology and Lie theory are explained from scratch using illustrative examples and exercises. This book is ideal for graduate students and researchers working in differential equations, symbolic computation, applications of Lie groups and, to a lesser extent, differential geometry.

This book features a selection of high-quality papers chosen from the best presentations at the International Conference on Spectral and High-Order Methods (2016), offering an overview of the depth and breadth of the activities within this important research area. The carefully reviewed papers provide a snapshot of the state of the art, while the extensive bibliography helps initiate new research directions.

Adapted from a series of lectures given by the authors, this monograph focuses on radial basis functions (RBFs), a powerful numerical methodology for solving PDEs to high accuracy in any number of dimensions. This method applies to problems across a wide range of PDEs arising in fluid mechanics, wave motions, astro- and geosciences, mathematical biology, and other areas and has lately been shown to compete successfully against the very best previous approaches on some large benchmark problems. Using examples and heuristic explanations to create a practical and intuitive perspective, the authors address how, when, and why RBF-based methods work. The authors trace the algorithmic evolution of RBFs, starting with brief introductions to finite difference (FD) and pseudospectral (PS) methods and following a logical progression to global RBFs and then to RBF-generated FD (RBF-FD) methods. The RBF-FD method, conceived in 2000, has proven to be a leading candidate for numerical simulations in an increasingly wide range of applications, including seismic exploration for oil and gas, weather and climate modeling, and electromagnetics, among others. This is the first survey in book format of the RBF-FD methodology and is suitable as the text for a one-semester first-year graduate class.

Table of contents

This book is an introductory text to a range of numerical methods used today to simulate time-dependent processes in Earth science, physics, engineering, and many other fields. The physical problem of elastic wave propagation in 1D serves as a model system with which the various numerical methods are introduced and compared. The theoretical background is presented with substantial graphical material supporting the concepts. The results can be reproduced with the supplementary electronic material provided as python codes embedded in Jupyter notebooks. The book starts with a primer on the physics of elastic wave propagation, and a chapter on the fundamentals of parallel programming, computational grids, mesh generation, and hardware models. The core of the book is the presentation of numerical solutions of the wave equation with six different methods: 1) the finite-difference method; 2) the pseudospectral method (Fourier and Chebyshev); 3) the linear finite-element method; 4) the spectral-element method; 5) the finite-volume method; and 6) the discontinuous Galerkin method. Each chapter contains comprehension questions, theoretical, and programming exercises. The book closes with a discussion of domains of application and criteria for the choice of a specific numerical method, and the presentation of current challenges. Readers are welcome to visit the author's website www.geophysik.lmu.de/Members/igel for more information on his research, projects, publications, and other activities.

The origin ofthe International Acoustical Imaging Symposium series can be traced to 1967, when a meeting on acoustical holography was held in C alifornia. In those days, acoustical holography was at the leading edge of research but, as the importance of this subject waned, so the title of the series was changed from Acoustical Holography to Acoustical Imaging in 1978. The early Symposia were held at various venues in the United States. In 1980. the series became international, with the Symposium that year taking place in Cannes in France. The pattern now is to try to met alternately in the USA and in another part of the world so that active researchers everywhere can conveniently attend at a reasonably high frequency. It was a great privilege for us in Bristol in the United Kingdom to be chosen to host the 25th Symposium, which convened on 19 March 2000 and spread over four days. We were blessed not only by good weather, but also by the attendance ofnearly 100 pa rticipants who came from 17 c ountries. A large number of papers were accepted for presentation, either orally or as posters. Whether an oral presentation or a poster, all were considered to have equal merit, and no distinction is made between them in the published proceedings. There were no parallel sessions, so every participant could attend every presentation. The re sultant disciplinary cross fertilisation maintained the t radition of past Symposia.

Offers students a practical knowledge of modern techniques in scientific computing.

This volume contains contributions from international experts in the fields of constructive approximation. This area has reached out to encompass the computational and approximation-theoretical aspects of various interesting fields in applied mathematics.

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.

The book focuses on symplectic pseudospectral methods for nonlinear optimal control problems and their applications. Both the fundamental principles and engineering practice are addressed. Symplectic pseudospectral methods for nonlinear optimal control problems with complicated factors (i.e., inequality constraints, state-delay, unspecific terminal time, etc.) are solved under the framework of indirect methods. The methods developed here offer a high degree of computational efficiency and accuracy when compared with popular direct pseudospectral methods. The methods are applied to solve optimal control problems arising in various engineering fields, particularly in path planning problems for autonomous vehicles. Given its scope, the book will benefit researchers, engineers and graduate students in the fields of automatic control, path planning, ordinary differential equations, etc.

In the last few years there has been a growing interest in the development of numerical techniques appropriate for the approximation of differential model problems presenting multiscale solutions. This is the case, for instance, with functions displaying a smooth behavior, except in certain regions where sudden and sharp variations are localized. Typical examples are internal or boundary layers. When the number of degrees of freedom in the discretization process is not sufficient to ensure a fine resolution of the layers, some stabilization procedures are needed to avoid unpleasant oscillatory effects, without adding too much artificial viscosity to the scheme. In the field of finite elements, the streamline diffusion method, the Galerkin least-squares method, the bub ble function approach, and other recent similar techniques provide excellent treatments of transport equations of elliptic type with small diffusive terms, referred to in fluid dynamics as advection-diffusion (or convection-diffusion) equations. Goals This book is an attempt to guide the reader in the construction of a computa tional code based on the spectral collocation method, using algebraic polyno mials. The main topic is the approximation of elliptic type boundary-value par tial differential equations in 2-D, with special attention to transport-diffusion equations, where the second-order diffusive terms are strongly dominated by the first-order advective terms. Applications will be considered especially in the case where nonlinear systems of partial differential equations can be re duced to a sequence of transport-diffusion equations.

This book is an essential reference for anyone interested in the use of spectral/hp element methods in fluid dynamics. It provides a comprehensive introduction to the field together with detailed examples of the methods to the incompressible and compressible Navier-Stokes equations.

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.