Finite Difference Methods For Ordinary And Partial Differential Equations Steady State And Time Dependent Problems Classics In Applied Mathematics

Numerical Solution of Differential EquationsNumerical Methods for Fractional CalculusAnalysis of Discretization Methods for Ordinary Differential EquationsNumerical Methods for Engineers and Scientists, Second Edition,Finite Difference Methods for Ordinary and Partial Differential EquationsFundamental Numerical Methods for Electrical EngineeringAnalytic Methods for Partial Differential EquationsFinite Difference Methods for Ordinary and Partial Differential EquationsFinite Difference Computing with PDEsNumerical Solution of Ordinary and Partial Differential EquationsNumerical Solution of Partial Differential EquationsTopics in Numerical Analysis IINumerical Solution of Boundary Value Problems for Ordinary Differential EquationsFinite Difference Schemes and Partial Differential EquationsIntroductory Finite Difference Methods for PDEsSpectral Methods in MATLABNumerical Methods for Partial Differential EquationsFinite Difference Methods for Partial Differential EquationsNumerical Methods in Biomedical EngineeringNumerical Methods and Modeling for Chemical EngineersAdvanced Numerical Methods with Matlab 2The Numerical Solution of Ordinary and Partial Differential EquationsFinite Difference EquationsNonstandard Finite Difference Models of Differential EquationsFinite Volume Methods for Hyperbolic ProblemsSpectra and PseudospectraTime-Dependent Problems and Difference MethodsFinite Difference and Spectral Methods for Ordinary and Partial Differential EquationsThe Numerical Solution of Ordinary and Partial Differential EquationsFinite Difference Computing with Exponential Decay ModelsFinite Difference Methods for Ordinary and Partial Differential EquationsNumerical Solution of Partial Differential Equations by the Finite Element MethodNumerical Methods for Conservation LawsFinite Difference Methods in Heat TransferThe Finite Difference Method in Partial Differential EquationsApplications of Nonstandard Finite Difference SchemesNumerical Partial Differential Equations: Finite Difference MethodsFinite Difference Methods in Financial EngineeringPartial Differential Equations with Numerical MethodsFinite Difference Methods. Theory and Applications

Numerical Solution of Differential Equations

The main purpose of this book is to provide a concise introduction to the methods and philosophy of constructing nonstandard finite difference schemes and illustrate how such techniques can be applied to several important problems. Chapter I gives an overview of the subject and summarizes previous work. Chapters 2 and 3 consider in detail the construction and numerical implementation of schemes for physical problems involving convection-diffusion-reaction equations, that arise in groundwater pollution and scattering of electromagnetic waves using Maxwell's equations. Chapter 4 examines certain mathematical issues related to the nonstandard discretization of competitive and cooperative models for ecology. The application chapters illustrate well the power of nonstandard methods. In particular, for the same accuracy as obtained by standard techniques, larger step sizes can be used. This volume will satisfy the needs of scientists, engineers, and mathematicians who wish to know how to construct nonstandard schemes and see how these are applied to obtain numerical solutions of the differential equations which arise in the study of nonlinear dynamical systems modeling important physical phenomena.

Numerical Methods for Fractional Calculus

This book introduces finite difference methods for both ordinary differential equations (ODEs) and partial differential equations (PDEs) and discusses the similarities and differences between algorithm design and stability analysis for different types of equations. A unified view of stability theory for ODEs and PDEs is presented, and the interplay between ODE and PDE analysis is stressed. The text emphasizes standard classical methods, but several newer approaches also are introduced and are described in the context of simple motivating examples.

Analysis of Discretization Methods for Ordinary Differential Equations

This book constitutes the refereed conference proceedings of the 7th International Conference on Finite Difference Methods, FDM 2018, held in Lozenetz, Bulgaria, in June 2018.The 69 revised full papers presented together with 11 invited papers were carefully reviewed and selected from 94 submissions. They deal with many modern and new numerical techniques like splitting techniques, Green's function method, multigrid methods, and immersed interface method.

Numerical Methods for Engineers and Scientists, Second Edition,

A practical and concise guide to finite difference and finite element methods. Well-tested MATLAB® codes are available online.

Finite Difference Methods for Ordinary and Partial Differential Equations

This book is open access under a CC BY 4.0 license. This easy-to-read book introduces the basics of solving partial differential equations by means of finite difference methods. Unlike many of the traditional academic works on the topic, this book was written for practitioners. Accordingly, it especially addresses: the construction of finite difference schemes, formulation and implementation of algorithms, verification of implementations, analyses of physical behavior as implied by the numerical solutions, and how to apply the methods and software to solve problems in the fields of physics and biology.

Fundamental Numerical Methods for Electrical Engineering

Numerical Solution of Ordinary and Partial Differential Equations is based on a summer school held in Oxford in August-September 1961. The book is organized into four parts. The first three cover the numerical solution of ordinary differential equations, integral equations, and partial differential equations of quasi-linear form. Most of the techniques are evaluated from the standpoints of accuracy, convergence, and stability (in the various senses of these terms) as well as ease of coding and convenience of machine computation. The last part, on practical problems, uses and develops the techniques for the treatment of problems of the greatest difficulty and complexity, which tax not only the best machines but also the best brains. This book was written for scientists who have problems to solve, and who want to know what methods exist, why and in what circumstances some are better than others, and how to adapt and develop techniques for new problems. The budding numerical analyst should also benefit from this book, and should find some topics for valuable research. The first three parts, in fact, could be used not only by practical men but also by students, though a preliminary elementary course would assist the reading.

Analytic Methods for Partial Differential Equations

Substantially revised, this authoritative study covers the standard finite difference methods of parabolic, hyperbolic, and elliptic equations, and includes the concomitant theoretical work on consistency, stability, and convergence. The new edition includes revised and greatly expanded sections on stability based on the Lax-Richtmeyer definition, the application of Pade approximants to systems of ordinary differential equations for parabolic and hyperbolic equations, and a considerably improved presentation of iterative methods. A fast-paced introduction to numerical methods, this will be a useful volume for students of mathematics and engineering, and for postgraduates and professionals who need a clear, concise grounding in this discipline.

Finite Difference Methods for Ordinary and Partial Differential Equations

Topics in Numerical Analysis II contains in complete form, the papers given by the invited speakers to the Conference on Numerical Analysis held under the auspices of the National Committee for Mathematics of the Royal Irish Academy at University College, Dublin from 29th July to 2nd August, 1974. In addition, the titles of the contributed papers are listed together with the names and addresses of the authors who presented them at the conference. This book is divided into 20 chapters that present the papers in their entirety. They discuss such topics as applications of approximation theory to numerical analysis; interior regularity and local convergence of Galerkin finite element approximations for elliptic equations; and numerical estimates for the error of Gauss-Jacobi quadrature formulae. Some remarks on the unified treatment of elementary functions by microprogramming; application of finite difference methods to exploration seismology; and variable coefficient multistep methods for ordinary differential equations applied to parabolic partial differential equations are also presented. Other chapters cover realistic estimates for generic constants in multivariate pointwise approximation; matching of essential boundary conditions in the finite element method; and collocation, difference equations, and stitched function representations. This book will be of interest to practitioners in the fields of mathematics and computer science.

Finite Difference Computing with PDEs

What makes this book stand out from the competition is that it is more computational. Once done with both volumes, readers will have the tools to attack a wider variety of problems than those worked out in the competitors' books. The author stresses the use of technology throughout the text, allowing students to utilize it as much as possible.

Numerical Solution of Ordinary and Partial Differential Equations

Numerical Solution of Partial Differential Equations

Introductory textbook from which students can approach more advance topics relating to finite difference methods.

Topics in Numerical Analysis II

Comprehensive study focuses on use of calculus of finite differences as an approximation method for solving troublesome differential equations. Elementary difference operations; interpolation and extrapolation; modes of expansion of the solutions of nonlinear equations, applications of difference equations, difference equations associated with functions of two variables, more. Exercises with answers. 1961 edition.

Numerical Solution of Boundary Value Problems for Ordinary Differential Equations

Finite Difference Schemes and Partial Differential Equations

Finite Difference Methods in Heat Transfer presents a clear, step-by-step delineation of finite difference methods for solving engineering problems governed by ordinary and partial differential equations, with emphasis on heat transfer applications. The finite difference techniques presented apply to the numerical solution of problems governed by similar differential equations encountered in many other fields. Fundamental concepts are introduced in an easy-to-follow manner. Representative examples illustrate the application of a variety of powerful and widely used finite difference techniques. The physical situations considered include the steady state and transient heat conduction, phase-change involving melting and solidification, steady and transient forced convection inside ducts, free convection over a flat plate, hyperbolic heat conduction, nonlinear diffusion, numerical grid generation techniques, and hybrid numerical-analytic solutions.

Introductory Finite Difference Methods for PDEs

The main theme is the integration of the theory of linear PDE and the theory of finite difference and finite element methods. For each type of PDE, elliptic, parabolic, and hyperbolic, the text contains one chapter on the mathematical theory of the differential equation, followed by one chapter on finite difference methods and one on finite element methods. The chapters on elliptic equations are preceded by a chapter on the two-point boundary value problem for ordinary differential equations. Similarly, the chapters on time-dependent problems are preceded by a chapter on the initial-value problem for ordinary differential equations. There is also one chapter on the elliptic eigenvalue problem and eigenfunction expansion. The presentation does not presume a deep knowledge of mathematical and functional analysis. The required background on linear functional analysis and Sobolev spaces is reviewed in an appendix. The book is suitable for advanced undergraduate and beginning graduate students of applied mathematics and engineering.

Spectral Methods in MATLAB

This book, first published in 2002, contains an introduction to hyperbolic partial differential equations and a powerful class of numerical methods for approximating their solution, including both linear problems and nonlinear conservation laws. These equations describe a wide range of wave propagation and transport phenomena arising in nearly every scientific and engineering discipline. Several applications are described in a self-contained manner, along with much of the mathematical theory of hyperbolic problems. High-resolution versions of Godunov's method are developed, in which Riemann problems are solved to determine the local wave structure and limiters are then applied to eliminate numerical oscillations. These methods were originally designed to capture shock waves accurately, but are also useful tools for studying linear wave-propagation problems, particularly in heterogenous material. The methods studied are implemented in the CLAWPACK software package and source code for all the examples presented can be found on the web, along with animations of many of the simulations. This provides an excellent learning environment for understanding wave propagation phenomena and finite volume methods.

Numerical Methods for Partial Differential Equations

An accessible introduction to the finite element method for solving numeric problems, this volume offers the keys to an important technique in computational mathematics. Suitable for advanced undergraduate and graduate courses, it outlines clear connections with applications and considers numerous examples from a variety of science- and engineering-related specialties.This text encompasses all varieties of the basic linear partial differential equations, including elliptic, parabolic and hyperbolic problems, as well as stationary and time-dependent problems. Additional topics include finite element methods for integral equations, an introduction to nonlinear problems, and considerations of unique developments of finite element techniques related to parabolic problems, including methods for automatic time step control. The relevant mathematics are expressed in non-technical terms whenever possible, in the interests of keeping the treatment accessible to a majority of students.

Finite Difference Methods for Partial Differential Equations

Introductory textbook from which students can approach more advance topics relating to finite difference methods.

Numerical Methods in Biomedical Engineering

Numerical Methods and Modeling for Chemical Engineers

This book is the most comprehensive, up-to-date account of the popular numerical methods for solving boundary value problems in ordinary differential equations. It aims at a thorough understanding of the field by giving an in-depth analysis of the numerical methods by using decoupling principles. Numerous exercises and real-world examples are used throughout to demonstrate the methods and the theory. Although first published in 1988, this republication remains the most comprehensive theoretical coverage of the subject matter, not available elsewhere in one volume. Many problems, arising in a wide variety of application areas, give rise to mathematical models which form boundary value problems for ordinary differential equations. These problems rarely have a closed form solution, and computer simulation is typically used to obtain their approximate solution. This book discusses methods to carry out such computer simulations in a robust, efficient, and reliable manner.

Advanced Numerical Methods with Matlab 2

Numerical Modeling in Biomedical Engineering brings together the integrative set of computational problem solving tools important to biomedical engineers. Through the use of comprehensive homework exercises, relevant examples and extensive case studies, this book integrates principles and techniques of numerical analysis. Covering biomechanical phenomena and physiologic, cell and molecular systems, this is an essential tool for students and all those studying biomedical transport, biomedical thermodynamics & kinetics and biomechanics. Supported by Whitaker Foundation Teaching Materials Program; ABET-oriented pedagogical layout Extensive hands-on homework exercises

The Numerical Solution of Ordinary and Partial Differential Equations

This text provides a very simple, initial introduction to the complete scientific computing pipeline: models, discretization, algorithms, programming, verification, and visualization. The pedagogical strategy is to use one case study – an ordinary differential equation describing exponential decay processes – to illustrate fundamental concepts in mathematics and computer science. The book is easy to read and only requires a command of one-variable calculus and some very basic knowledge about computer programming. Contrary to similar texts on numerical methods and programming, this text has a much stronger focus on implementation and teaches testing and software engineering in particular.

Finite Difference Equations

This book provides a clear summary of the work of the author on the construction of nonstandard finite difference schemes for the numerical integration of differential equations. The major thrust of the book is to show that discrete models of differential equations exist such that the elementary types of numerical instabilities do not occur. A consequence of this result is that in general bigger step-sizes can often be used in actual calculations and/or finite difference schemes can be constructed that are conditionally stable in many instances whereas in using standard techniques no such schemes exist. The theoretical basis of this work is centered on the concepts of ?exact? and ?best? finite difference schemes. In addition, a set of rules is given for the discrete modeling of derivatives and nonlinear expressions that occur in differential equations. These rules often lead to a unique nonstandard finite difference model for a given differential equation.

Nonstandard Finite Difference Models of Differential Equations

These notes developed from a course on the numerical solution of conservation laws first taught at the University of Washington in the fall of 1988 and then at ETH during the following spring. The overall emphasis is on studying the mathematical tools that are essential in de veloping, analyzing, and successfully using numerical methods for nonlinear systems of conservation laws, particularly for problems involving shock waves. A reasonable un derstanding of the mathematical structure of these equations and their solutions is first required, and Part I of these notes deals with this theory. Part II deals more directly with numerical methods, again with the emphasis on general tools that are of broad use. I have stressed the underlying ideas used in various classes of methods rather than present ing the most sophisticated methods in great detail. My aim was to provide a sufficient background that students could then approach the current research literature with the necessary tools and understanding. vVithout the wonders of TeX and LaTeX, these notes would never have been put together. The professional-looking results perhaps obscure the fact that these are indeed lecture notes. Some sections have been reworked several times by now, but others are still preliminary. I can only hope that the errors are not too blatant. Moreover, the breadth and depth of coverage was limited by the length of these courses, and some parts are rather sketchy.

Finite Volume Methods for Hyperbolic Problems

Numerical Methods for Fractional Calculus presents numerical methods for fractional integrals and fractional derivatives, finite difference methods for fractional ordinary differential equations (FODEs) and fractional partial differential equations (FPDEs), and finite element methods for FPDEs.The book introduces the basic definitions and propertie

Spectra and Pseudospectra

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.

Time-Dependent Problems and Difference Methods

Mathematics of Computing -- Numerical Analysis.

Finite Difference and Spectral Methods for Ordinary and Partial Differential Equations

Extensively revised edition of Computational Methods in Partial Differential Equations. A more general approach has been adopted for the splitting of operators for parabolic and hyperbolic equations to include Richtmyer and Strang type splittings in addition to alternating direction implicit and locally one dimensional methods. A description of the now standard factorization and SOR/ADI iterative techniques for solving elliptic difference equations has been supplemented with an account or preconditioned conjugate gradient methods which are currently gaining in popularity. Prominence is also given to the Galerkin method using different test and trial functions as a means of constructing difference approximations to both elliptic and time dependent problems. The applications of finite difference methods have been revised and contain examples involving the treatment of singularities in elliptic equations, free and moving boundary problems, as well as modern developments in computational fluid dynamics. Emphasis throughout is on clear exposition of the construction and solution of difference equations. Material is reinforced with theoretical results when appropriate.

The Numerical Solution of Ordinary and Partial Differential Equations

Emphasizing the finite difference approach for solving differential equations, the second edition of Numerical Methods for Engineers and Scientists presents a methodology for systematically constructing individual computer programs. Providing easy access to accurate solutions to complex scientific and engineering problems, each chapter begins with objectives, a discussion of a representative application, and an outline of special features, summing up with a list of tasks students should be able to complete after reading the chapter- perfect for use as a study guide or for review. The AIAA Journal calls the book "a good, solid instructional text on the basic tools of numerical analysis."

Finite Difference Computing with Exponential Decay Models

Stormy development of electronic computation techniques (computer systems and software), observed during the last decades, has made possible automation of data processing in many important human activity areas, such as science, technology, economics and labor organization. In a broadly understood technology area, this developmentledtoseparationofspecializedformsofusingcomputersforthedesign and manufacturing processes, that is: – computer-aided design (CAD) – computer-aided manufacture (CAM) In order to show the role of computer in the rst of the two applications m- tioned above, let us consider basic stages of the design process for a standard piece of electronic system, or equipment: – formulation of requirements concerning user properties (characteristics, para- ters) of the designed equipment, – elaboration of the initial, possibly general electric structure, – determination of mathematical model of the system on the basis of the adopted electric structure, – determination of basic responses (frequency- or time-domain) of the system, on the base of previously established mathematical model, – repeated modi cation of the adopted diagram (changing its structure or element values) in case, when it does not satisfy the adopted requirements, – preparation of design and technological documentation, – manufacturing of model (prototype) series, according to the prepared docum- tation, – testing the prototype under the aspect of its electric properties, mechanical du- bility and sensitivity to environment conditions, – modi cation of prototype documentation, if necessary, and handing over the documentation to series production. The most important stages of the process under discussion are illustrated in Fig. I. 1. xi xii Introduction Fig. I.

Finite Difference Methods for Ordinary and Partial Differential Equations

Due to the fundamental role of differential equations in science and engineering it has long been a basic task of numerical analysts to generate numerical values of solutions to differential equations. Nearly all approaches to this task involve a "finitization" of the original differential equation problem, usually by a projection into a finite-dimensional space. By far the most popular of these finitization processes consists of a reduction to a difference equation problem for functions which take values only on a grid of argument points. Although some of these finite difference methods have been known for a long time, their wide applica bility and great efficiency came to light only with the spread of electronic computers. This in tum strongly stimulated research on the properties and practical use of finite-difference methods. While the theory or partial differential equations and their discrete analogues is a very hard subject, and progress is consequently slow, the initial value problem for a system of first order ordinary differential equations lends itself so naturally to discretization that hundreds of numerical analysts have felt inspired to invent an ever-increasing number of finite-difference methods for its solution. For about 15 years, there has hardly been an issue of a numerical journal without new results of this kind; but clearly the vast majority of these methods have just been variations of a few basic themes. In this situation, the classical text book by P.

Numerical Solution of Partial Differential Equations by the

Finite Element Method

This book presents methods for the computational solution of differential equations, both ordinary and partial, time-dependent and steady-state. Finite difference methods are introduced and analyzed in the first four chapters, and finite element methods are studied in chapter five. A very general-purpose and widely-used finite element program, PDE2D, which implements many of the methods studied in the earlier chapters, is presented and documented in Appendix A. The book contains the relevant theory and error analysis for most of the methods studied, but also emphasizes the practical aspects involved in implementing the methods. Students using this book will actually see and write programs (FORTRAN or MATLAB) for solving ordinary and partial differential equations, using both finite differences and finite elements. In addition, they will be able to solve very difficult partial differential equations using the software PDE2D, presented in Appendix A. PDE2D solves very general steady-state, time-dependent and eigenvalue PDE systems, in 1D intervals, general 2D regions, and a wide range of simple 3D regions. Contents:Direct Solution of Linear SystemsInitial Value Ordinary Differential EquationsThe Initial Value Diffusion ProblemThe Initial Value Transport and Wave ProblemsBoundary Value ProblemsThe Finite Element MethodsAppendix A — Solving PDEs with PDE2DAppendix B — The Fourier Stability MethodAppendix C — MATLAB ProgramsAppendix D — Answers to Selected Exercises Readership: Undergraduate, graduate students and researchers. Key Features:The discussion of stability, absolute stability and stiffness in Chapter 1 is clearer than in other textsStudents will actually learn to write programs solving a range of simple PDEs using the finite element method in chapter 5In Appendix A, students will be able to solve quite difficult PDEs, using the author's software package, PDE2D. (a free version is available which solves small to moderate sized problems)Keywords:Differential Equations;Partial Differential Equations;Finite Element Method;Finite Difference Method;Computational Science;Numerical AnalysisReviews: "This book is very well written and it is relatively easy to read. The presentation is clear and straightforward but quite rigorous. This book is suitable for a course on the numerical solution of ODEs and PDEs problems, designed for senior level undergraduate or beginning level graduate students. The numerical techniques for solving problems presented in the book may also be useful for experienced researchers and practitioners both from universities or industry." Andrzej Icha Pomeranian Academy in Słupsk Poland

Numerical Methods for Conservation Laws

Finite Difference Methods in Heat Transfer

This is the practical introduction to the analytical approach taken in Volume 2. Based upon courses in partial differential equations over the last two decades, the text covers the classic canonical equations, with the method of separation of variables introduced at an early stage. The characteristic method for first order equations acts as an introduction to the classification of second order quasi-linear problems by characteristics. Attention then moves to different co-ordinate systems, primarily those with cylindrical or spherical symmetry. Hence a discussion of special functions arises quite naturally, and in each case the major properties are derived. The next section deals with the use of integral transforms and extensive methods for inverting them, and concludes with links to the use of Fourier series.

The Finite Difference Method in Partial Differential Equations

The purpose of this book is to introduce and study numerical methods basic and advanced ones for scientific computing. This last refers to the implementation of appropriate approaches to the treatment of a scientific problem arising from physics (meteorology, pollution, etc.) or of engineering (mechanics of structures, mechanics of fluids, treatment signal, etc.). Each chapter of this book recalls the essence of the different methods resolution and presents several applications in the field of engineering as well as programs developed under Matlab software.

Applications of Nonstandard Finite Difference Schemes

Praise for the First Edition ". . . fills a considerable gap in the numerical analysisliterature by providing a self-contained treatment . . . this is animportant work written in a clear style . . . warmly recommended toany graduate student or researcher in the field of the numericalsolution of partial differential equations." —SIAM Review Time-Dependent Problems and Difference Methods, SecondEdition continues to provide guidance for the analysis ofdifference methods for computing approximate solutions to partialdifferential equations for time-dependent problems. The book treatsdifferential equations and difference methods with a paralleldevelopment, thus achieving a more useful analysis of numericalmethods. The Second Edition presents hyperbolic equations in greatdetail as well as new coverage on second-order systems of waveequations including acoustic waves, elastic waves, and Einsteinequations. Compared to first-order hyperbolic systems,initial-boundary value problems for such systems contain newproperties that must be taken into account when analyzingstability. Featuring the latest material in partial differentialequations with new theorems, examples, andillustrations,Time-Dependent Problems and Difference Methods,Second Edition also includes: High order methods on staggered grids Extended treatment of Summation By Parts operators and theirapplication to second-order derivatives Simplified presentation of certain parts and proofs Time-Dependent Problems and Difference Methods, SecondEdition is an ideal reference for physical scientists,engineers, numerical analysts, and mathematical modelers who usenumerical experiments to test designs and to predict andinvestigate physical phenomena. The book is also excellent forgraduate-level courses in applied mathematics and scientificcomputations.

Numerical Partial Differential Equations: Finite Difference Methods

Finite Difference Methods in Financial Engineering

Numerical Methods for Partial Differential Equations: Finite Difference and Finite

Volume Methods focuses on two popular deterministic methods for solving partial differential equations (PDEs), namely finite difference and finite volume methods. The solution of PDEs can be very challenging, depending on the type of equation, the number of independent variables, the boundary, and initial conditions, and other factors. These two methods have been traditionally used to solve problems involving fluid flow. For practical reasons, the finite element method, used more often for solving problems in solid mechanics, and covered extensively in various other texts, has been excluded. The book is intended for beginning graduate students and early career professionals, although advanced undergraduate students may find it equally useful. The material is meant to serve as a prerequisite for students who might go on to take additional courses in computational mechanics, computational fluid dynamics, or computational electromagnetics. The notations, language, and technical jargon used in the book can be easily understood by scientists and engineers who may not have had graduate-level applied mathematics or computer science courses. Presents one of the few available resources that comprehensively describes and demonstrates the finite volume method for unstructured mesh used frequently by practicing code developers in industry Includes step-by-step algorithms and code snippets in each chapter that enables the reader to make the transition from equations on the page to working codes Includes 51 worked out examples that comprehensively demonstrate important mathematical steps, algorithms, and coding practices required to numerically solve PDEs, as well as how to interpret the results from both physical and mathematic perspectives

Partial Differential Equations with Numerical Methods

This text introduces the quantitative treatment of differential equations arising from modeling physical phenomena in chemical engineering. Coverage includes recent topics such as ODE-IVPs, emphasizing numerical methods and modeling of 1984-era commercial mathematical software.

Finite Difference Methods. Theory and Applications

The world of quantitative finance (QF) is one of the fastest growing areas of research and its practical applications to derivatives pricing problem. Since the discovery of the famous Black-Scholes equation in the 1970's we have seen a surge in the number of models for a wide range of products such as plain and exotic options, interest rate derivatives, real options and many others. Gone are the days when it was possible to price these derivatives analytically. For most problems we must resort to some kind of approximate method. In this book we employ partial differential equations (PDE) to describe a range of one-factor and multi-factor derivatives products such as plain European and American options, multi-asset options, Asian options, interest rate options and real options. PDE techniques allow us to create a framework for modeling complex and interesting derivatives products. Having defined the PDE problem we then approximate it using the Finite Difference Method (FDM). This method has been used for many application areas such as fluid dynamics, heat transfer, semiconductor simulation and astrophysics, to name just a few. In this book we apply the same techniques to pricing real-life derivative products. We use both traditional (or well-known) methods as well as a number of advanced schemes that are making their way into the QF literature: Crank-Nicolson, exponentially fitted and higher-order schemes for one-factor and multi-factor options Early exercise features and approximation using front-fixing, penalty and variational methods Modelling stochastic volatility models using Splitting methods Critique of ADI and Crank-Nicolson schemes; when they work and when they don't work Modelling jumps using Partial Integro Differential Equations (PIDE) Free and moving boundary value problems in QF Included with the book is a CD containing information on how to set up FDM algorithms, how to map these algorithms to C++ as well as several working programs for one-factor and two-factor models. We also provide source code so that you can customize the applications to suit your own needs.