Numerical Solution Of Partial Differential Equations By The Finite Element Method

Numerical Methods in Computational Finance: A Partial Differential Equation (PDE/FDM) Approach defines a repeatable process to introduce PDEs in finance, analyse them mathematically, devise robust and accurate numerical algorithms to approximate these PDEs and then map these algorithms to C++ and C#. Written in an incremental way in order to facilitate a range of readers at various skill levels and experience, each chapter contains hands-on exercises and projects that form an integral part of the text. The book consists of eight parts. Each part contains several chapters and deals with a single autonomous topic: PDEs (generic) PDEs in finance Fundamentals FDM (generic) FDM in finance Advanced FDM (generic) Advanced FDM in finance Software Frameworks in C++ and C# Applications of machine learning in computational finance

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 numerical 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.

This book presents some of the latest developments in numerical analysis and scientific computing. Specifically, it covers central schemes, error estimates for discontinuous Galerkin methods, and the use of wavelets in scientific computing. The subject of partial differential equations holds an exciting and special position in mathematics. Partial differential
equations were not consciously created as a subject but emerged in the 18th century as ordinary differential equations failed to describe the physical principles being studied. The subject was originally developed by the major names of mathematics, in particular, Leonard Euler and Joseph-Louis Lagrange who studied waves on strings; Daniel Bernoulli and Euler who considered potential theory, with later developments by Adrien-Marie Legendre and Pierre-Simon Laplace; and Joseph Fourier's famous work on series expansions for the heat equation. Many of the greatest advances in modern science have been based on discovering the underlying partial differential equation for the process in question. James Clerk Maxwell, for example, put electricity and magnetism into a unified theory by establishing Maxwell's equations for electromagnetic theory, which gave solutions for problems in radio wave propagation, the diffraction of light and X-ray developments. Schrödinger's equation for quantum mechanical processes at the atomic level leads to experimentally verifiable results which have changed the face of atomic physics and chemistry in the 20th century. In fluid mechanics, the Navier Stokes' equations form a basis for huge number-crunching activities associated with such widely disparate topics as weather forecasting and the design of supersonic aircraft. Inevitably the study of partial differential equations is a large undertaking, and falls into several areas of mathematics. This book offers a timely overview of fractional calculus applications, with a special emphasis on fractional derivatives with Mittag-Leffler kernel. The different contributions, written by applied mathematicians, physicists and engineers, offers a snapshot of recent research in the field, highlighting the current methodological frameworks together with applications in different fields of science and engineering, such as chemistry, mechanics, epidemiology and more. It is intended as a timely guide and source of inspiration for graduate students and researchers in the above-mentioned areas. 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.
This is the 2005 second edition of a highly successful and well-respected textbook on the numerical techniques used to solve partial differential equations arising from mathematical models in science, engineering and other fields. The authors maintain an emphasis on finite difference methods for simple but representative examples of parabolic, hyperbolic and elliptic equations from the first edition. However this is augmented by new sections on finite volume methods, modified equation analysis, symplectic integration schemes, convection-diffusion problems, multigrid, and conjugate gradient methods; and several sections, including that on the energy method of analysis, have been extensively rewritten to reflect modern developments. Already an excellent choice for students and teachers in mathematics, engineering and computer science departments, the revised text includes more latest theoretical and industrial developments. The importance of partial differential equations (PDEs) in modeling phenomena in engineering as well as in the physical, natural, and social sciences is well known by students and practitioners in these fields. Striking a balance between theory and applications, Fourier Series and Numerical Methods for Partial Differential Equations presents an introduction to the analytical and numerical methods that are essential for working with partial differential equations. Combining methodologies from calculus, introductory linear algebra, and ordinary differential equations (ODEs), the book strengthens and extends readers' knowledge of the power of linear spaces and linear transformations for purposes of understanding and solving a wide range of PDEs. The book begins with an introduction to the general terminology and topics related to PDEs, including the notion of initial and boundary value problems and also various solution techniques. Subsequent chapters explore: The solution process for Sturm-Liouville boundary value ODE problems and a Fourier series representation of the solution of initial boundary value problems in PDEs The concept of completeness, which introduces readers to Hilbert spaces The application of Laplace transforms and Duhamel's theorem to solve time-dependent boundary conditions The finite element method, using finite dimensional subspaces The finite analytic method with applications of the Fourier series methodology to linear version of non-linear PDEs Throughout the book, the author incorporates his own class-tested material, ensuring an accessible and easy-to-follow presentation that helps readers connect presented objectives with relevant applications to their own work. Maple is used throughout to solve many exercises, and a related Web site features Maple worksheets for readers to use when working with the book's one- and multi-dimensional problems. Fourier Series and Numerical Methods for Partial Differential Equations is an ideal book for courses on applied mathematics and partial differential equations at the upper-undergraduate and graduate levels. It is also a reliable resource for researchers and practitioners in the fields of mathematics, science, and engineering who work with mathematical modeling of physical phenomena, including diffusion and wave aspects. 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.

Numerical Solution of Partial Differential Equations by the Finite Element Method

Theory, methods and software for elliptic (steady-state) and parabolic (diffusion) partial differential equations, plus linear algebra and error estimators.

Everything is more simple than one thinks but at the same time more complex than one can understand Johann Wolfgang von Goethe

To reach the point that is unknown to you, you must take the road that is unknown to you St. John of the Cross

This is a book on the numerical approximation of partial differential equations (PDEs). Its scope is to provide a thorough illustration of numerical methods (especially those stemming from the variational formulation of PDEs), carry out their stability and convergence analysis, derive error bounds, and discuss the algorithmic aspects relative to their implementation. A sound balancing of theoretical analysis, description of algorithms and discussion of applications is our primary concern. Many kinds of problems are addressed: linear and nonlinear, steady and time-dependent, having either smooth or non-smooth solutions. Besides model equations, we consider a number of (initial-) boundary value problems of interest in several fields of applications. Part I is devoted to the description and analysis of general numerical methods for the discretization of partial differential equations. A comprehensive theory of Galerkin methods and its variants (Petrov Galerkin and generalized Galerkin), as well as of collocation methods, is developed for the spatial discretization. This theory is then specified to two numerical subspace realizations of remarkable interest: the finite element method (conforming, non-conforming, mixed, hybrid) and the spectral method (Legendre and Chebyshev expansion).

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
This book covers numerical methods for stochastic partial differential equations with white noise using the framework of Wong-Zakai approximation. The book begins with some motivational and background material in the introductory chapters and is divided into three parts. Part I covers numerical stochastic ordinary differential equations. Here the authors start with numerical methods for SDEs with delay using the Wong-Zakai approximation and finite difference in time. Part II covers temporal white noise. Here the authors consider SPDEs as PDEs driven by white noise, where discretization of white noise (Brownian motion) leads to PDEs with smooth noise, which can then be treated by numerical methods for PDEs. In this part, recursive algorithms based on Wiener chaos expansion and stochastic collocation methods are presented for linear stochastic advection-diffusion-reaction equations. In addition, stochastic Euler equations are exploited as an application of stochastic collocation methods, where a numerical comparison with other integration methods in random space is made. Part III covers spatial white noise. Here the authors discuss numerical methods for nonlinear elliptic equations as well as other equations with additive noise. Numerical methods for SPDEs with multiplicative noise are also discussed using the Wiener chaos expansion method. In addition, some SPDEs driven by non-Gaussian white noise are discussed and some model reduction methods (based on Wick-Malliavin calculus) are presented for generalized polynomial chaos expansion methods. Powerful techniques are provided for solving stochastic partial differential equations. This book can be considered as self-contained. Necessary background knowledge is presented in the appendices. Basic knowledge of probability theory and stochastic calculus is presented in Appendix A. In Appendix B some semi-analytical methods for SPDEs are presented. In Appendix C an introduction to Gauss quadrature is provided. In Appendix D, all the conclusions which are needed for proofs are presented, and in Appendix E a method to compute the convergence rate empirically is included. In addition, the authors provide a thorough review of the topics, both theoretical and computational exercises in the book with practical discussion of the effectiveness of the methods. Supporting Matlab files are made available to help illustrate some of the concepts further. Bibliographic notes are included at the end of each chapter. This book serves as a reference for graduate students and researchers in the mathematical sciences who would like to understand state-of-the-art numerical methods for stochastic partial differential equations with white noise. Numerical Methods for Partial Differential Equations, Second Edition deals with the use of numerical methods to solve partial differential equations. In addition to numerical fluid mechanics, hopscotch and other explicit-implicit methods are also considered, along with Monte Carlo techniques, lines, fast Fourier transform, and fractional steps methods. Comprised of six chapters, this volume begins with an introduction to numerical calculation, paying particular attention to the classification of equations and physical problems, asymptotics, discrete methods, and dimensionless forms. Subsequent chapters focus on parabolic and hyperbolic equations, elliptic equations, and special topics ranging from singularities and shocks to Navier-Stokes equations and Monte Carlo methods. The final chapter discuss the general concepts of weighted residuals, with emphasis on orthogonal collocation and the Bubnov-Galerkin method. The latter procedure is used to introduce finite elements. This book should be a
valuable resource for students and practitioners in the fields of computer science and applied mathematics. This book provides a first, basic introduction into the valuation of financial options via the numerical solution of partial differential equations (PDEs). It provides readers with an easily accessible text explaining main concepts, models, methods and results that arise in this approach. In keeping with the series style, emphasis is placed on intuition as opposed to full rigor, and a relatively basic understanding of mathematics is sufficient. The book provides a wealth of examples, and ample numerical experiments are given to illustrate the theory. The main focus is on one-dimensional financial PDEs, notably the Black-Scholes equation. The book concludes with a detailed discussion of the important step towards two-dimensional PDEs in finance.

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 Systems Initial Value Ordinary Differential Equations The Initial Value Diffusion Problem The Initial Value Transport and Wave Problems Boundary Value Problems The Finite Element Methods Appendix A — Solving PDEs with PDE2D Appendix B — The Fourier Stability Method Appendix C — MATLAB Programs Appendix 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 texts. Students will actually learn to write programs solving a range of simple PDEs using the finite element method in chapter 5! In 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 Analysis Reviews: "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 Supsk Poland
The subject of partial differential equations holds an exciting place in mathematics. Inevitably, the subject falls into several areas of mathematics. At one extreme the interest lies in the existence and uniqueness of solutions, and the functional analysis of the proofs of these properties. At the other extreme lies the applied mathematical and engineering quest to find useful solutions, either analytically or numerically, to these important equations which can be used in design and construction. The book presents a clear introduction of the methods and underlying theory used in the numerical solution of partial differential equations. After revising the mathematical preliminaries, the book covers the finite difference method of parabolic or heat equations, hyperbolic or wave equations and elliptic or Laplace equations. Throughout, the emphasis is on the practical solution rather than the theoretical background, without sacrificing rigour.

Since the dawn of computing, the quest for a better understanding of Nature has been a driving force for technological development. Groundbreaking achievements by great scientists have paved the way from the abacus to the supercomputing power of today. When trying to replicate Nature in the computer's silicon test tube, there is need for precise and computable process descriptions. The scientific fields of Mathematics and Physics provide a powerful vehicle for such descriptions in terms of Partial Differential Equations (PDEs). Formulated as such equations, physical laws can become subject to computational and analytical studies. In the computational setting, the equations can be discretized for efficient solution on a computer, leading to valuable tools for simulation of natural and man-made processes. Numerical solution of PDE-based mathematical models has been an important research topic over centuries, and will remain so for centuries to come. In the context of computer-based simulations, the quality of the computed results is directly connected to the model's complexity and the number of data points used for the computations. Therefore, computational scientists tend to fill even the largest and most powerful computers they can get access to, either by increasing the size of the data sets, or by introducing new model terms that make the simulations more realistic, or a combination of both. Today, many important simulation problems cannot be solved by one single computer, but calls for parallel computing.

Domain decomposition methods are divide and conquer computational methods for the parallel solution of partial differential equations of elliptic or parabolic type. The methodology includes iterative algorithms, and techniques for non-matching grid discretizations and heterogeneous approximations. This book serves as a matrix oriented introduction to domain decomposition methodology. A wide range of topics are discussed include hybrid formulations, Schwarz, and many more.

Nonlinear Partial Differential Equations (PDEs) have become increasingly important in the description of physical phenomena. Unlike Ordinary Differential Equations, PDEs can be used to effectively model multidimensional systems.
The methods put forward in Discrete Variational Derivative Method concentrate on a new class of "structure-preserving num
This book provides an elementary yet comprehensive introduction to the numerical solution of partial differential equations (PDEs). Used to model important phenomena, such as the heating of apartments and the behavior of electromagnetic waves, these equations have applications in engineering and the life sciences, and most can only be solved approximately using computers. Numerical Analysis of Partial Differential Equations Using Maple and MATLAB provides detailed descriptions of the four major classes of discretization methods for PDEs (finite difference method, finite volume method, spectral method, and finite element method) and runnable MATLAB? code for each of the discretization methods and exercises. It also gives self-contained convergence proofs for each method using the tools and techniques required for the general convergence analysis but adapted to the simplest setting to keep the presentation clear and complete. This book is intended for advanced undergraduate and early graduate students in numerical analysis and scientific computing and researchers in related fields. It is appropriate for a course on numerical methods for partial differential equations.
This is the first book on the numerical method of lines, a relatively new method for solving partial differential equations. The Numerical Method of Lines is also the first book to accommodate all major classes of partial differential equations. This is essentially an applications book for computer scientists. The author will separately offer a disk of FORTRAN 77 programs with 250 specific applications, ranging from "Shuttle Launch Simulation" to "Temperature Control of a Nuclear Fuel Rod."
Numerical Methods for Partial Differential Equations: An Introduction Vitoriano Ruas, Sorbonne Universités, UPMC - Université Paris 6, France A comprehensive overview of techniques for the computational solution of PDE's Numerical Methods for Partial Differential Equations: An Introduction covers the three most popular methods for solving partial differential equations: the finite difference method, the finite element method and the finite volume method. The book combines clear descriptions of the three methods, their reliability, and practical implementation aspects. Justifications for why numerical methods for the main classes of PDE's work or not, or how well they work, are supplied and exemplified. Aimed primarily at students of Engineering, Mathematics, Computer Science, Physics and Chemistry among others this book offers a substantial insight into the principles numerical methods in this class of problems are based upon. The book can also be used as a reference for research work on numerical methods for PDE's. Key features: • A balanced emphasis is given to both practical considerations and a rigorous mathematical treatment. • The reliability analyses for the three methods are carried out in a unified framework and in a structured and visible manner, for the basic types of
PDE's. • Special attention is given to low order methods, as practitioner's overwhelming default options for everyday use. • New techniques are employed to derive known results, thereby simplifying their proof. • Supplementary material is available from a companion website.

From the reviews of Numerical Solution of Partial Differential Equations in Science and Engineering: "The book by Lapidus and Pinder is a very comprehensive, even exhaustive, survey of the subject . . . [It] is unique in that it covers equally finite difference and finite element methods." Burrelle's "The authors have selected an elementary (but not simplistic) mode of presentation. Many different computational schemes are described in great detail . . . Numerous practical examples and applications are described from beginning to the end, often with calculated results given."

Mathematics of Computing "This volume . . . devotes its considerable number of pages to lucid developments of the methods [for solving partial differential equations] . . . the writing is very polished and I found it a pleasure to read!"


Partial differential equations (PDEs) play an important role in the natural sciences and technology, because they describe the way systems (natural and other) behave. The inherent suitability of PDEs to characterizing the nature, motion, and evolution of systems, has led to their wide-ranging use in numerical models that are developed in order to analyze systems that are not otherwise easily studied. Numerical Solutions for Partial Differential Equations contains all the details necessary for the reader to understand the principles and applications of advanced numerical methods for solving PDEs. In addition, it shows how the modern computer system algebra Mathematica® can be used for the analytic investigation of such numerical properties as stability, approximation, and dispersion.

This book studies time-dependent partial differential equations and their numerical solution, developing the analytic and the numerical theory in parallel, and placing special emphasis on the discretization of boundary conditions. The theoretical results are then applied to Newtonian and non-Newtonian flows, two-phase flows and geophysical problems. This book will be a useful introduction to the field for applied mathematicians and graduate students.

The description of many interesting phenomena in science and engineering leads to infinite-dimensional minimization or
evolution problems that define nonlinear partial differential equations. While the development and analysis of numerical methods for linear partial differential equations is nearly complete, only few results are available in the case of nonlinear equations. This monograph devises numerical methods for nonlinear model problems arising in the mathematical description of phase transitions, large bending problems, image processing, and inelastic material behavior. For each of these problems the underlying mathematical model is discussed, the essential analytical properties are explained, and the proposed numerical method is rigorously analyzed. The practicality of the algorithms is illustrated by means of short implementations.

This second edition of a highly successful graduate text presents a complete introduction to partial differential equations and numerical analysis. Revised to include new sections on finite volume methods, modified equation analysis, and multigrid and conjugate gradient methods, the second edition brings the reader up-to-date with the latest theoretical and industrial developments. First Edition Hb (1995): 0-521-41855-0 First Edition Pb (1995): 0-521-42922-6

As a satellite conference of the 1998 International Mathematical Congress and part of the celebration of the 650th anniversary of Charles University, the Partial Differential Equations Theory and Numerical Solution conference was held in Prague in August, 1998. With its rich scientific program, the conference provided an opportunity for almost 200 participants to gather and discuss emerging directions and recent developments in partial differential equations (PDEs). This volume comprises the Proceedings of that conference. In it, leading specialists in partial differential equations, calculus of variations, and numerical analysis present up-to-date results, applications, and advances in numerical methods in their fields. Conference organizers chose the contributors to bring together the scientists best able to present a complex view of problems, starting from the modeling, passing through the mathematical treatment, and ending with numerical realization. The applications discussed include fluid dynamics, semiconductor technology, image analysis, motion analysis, and optimal control. The importance and quantity of research carried out around the world in this field makes it imperative for researchers, applied mathematicians, physicists and engineers to keep up with the latest developments. With its panel of international contributors and survey of the recent ramifications of theory, applications, and numerical methods, Partial Differential Equations: Theory and Numerical Solution provides a convenient means to that end.

This book is the result of two courses of lectures given at the University of Cologne in Germany in 1974/75. The majority of the students were not familiar with partial differential equations and functional analysis. This explains why Sections 1, 2, 4 and 12 contain some basic material and results from these areas. The three parts of the book are largely independent of each other and can be read separately. Their topics are: initial value problems, boundary value problems,
solutions of systems of equations. There is much emphasis on theoretical considerations and they are discussed as thoroughly as the algorithms which are presented in full detail and together with the programs. We believe that theoretical and practical applications are equally important for a genuine understanding of numerical mathematics. When writing this book, we had considerable help and many discussions with H. W. Branca, R. Esser, W. Hackbusch and H. Multhei. H. Lehmann, B. Muller, H. J. Niemeyer, U. Schulte and B. Thomas helped with the completion of the programs and with several numerical calculations. Springer-Verlag showed a lot of patience and understanding during the course of the production of the book. We would like to use the occasion of this preface to express our thanks to all those who assisted in our sometimes arduous task.

One of the current main challenges in the area of scientific computing is the design and implementation of accurate numerical models for complex physical systems which are described by time dependent coupled systems of nonlinear PDEs. This volume integrates the works of experts in computational mathematics and its applications, with a focus on modern algorithms which are at the heart of accurate modeling: adaptive finite element methods, conservative finite difference methods and finite volume methods, and multilevel solution techniques. Fundamental theoretical results are revisited in survey articles and new techniques in numerical analysis are introduced. Applications showcasing the efficiency, reliability and robustness of the algorithms in porous media, structural mechanics and electromagnetism are presented. Researchers and graduate students in numerical analysis and numerical solutions of PDEs and their scientific computing applications will find this book useful.

From the reviews of Numerical Solution of Partial Differential Equations in Science and Engineering: "The book by Lapidus and Pinder is a very comprehensive, even exhaustive, survey of the subject . . . [It] is unique in that it covers equally finite difference and finite element methods." Burrelle's "The authors have selected an elementary (but not simplistic) mode of presentation. Many different computational schemes are described in great detail . . . Numerous practical examples and applications are described from beginning to the end, often with calculated results given."

Mathematics of Computing "This volume . . . devotes its considerable number of pages to lucid developments of the methods [for solving partial differential equations] . . . the writing is very polished and I found it a pleasure to read!"

acclaimed work covers fluid mechanics and calculus of variations as well as more modern methods-dimensional analysis and scaling, nonlinear wave propagation, bifurcation, and singular perturbation. 1996 (0-471-16513-1) 496 pp. This text provides an application oriented introduction to the numerical methods for partial differential equations. It covers finite difference, finite element, and finite volume methods, interweaving theory and applications throughout. The book examines modern topics such as adaptive methods, multilevel methods, and methods for convection-dominated problems and includes detailed illustrations and extensive exercises.

A comprehensive guide to numerical methods for simulating physical-chemical systems This book offers a systematic, highly accessible presentation of numerical methods used to simulate the behavior of physical-chemical systems. Unlike most books on the subject, it focuses on methodology rather than specific applications. Written for students and professionals across an array of scientific and engineering disciplines and with varying levels of experience with applied mathematics, it provides comprehensive descriptions of numerical methods without requiring an advanced mathematical background. Based on its author’s more than forty years of experience teaching numerical methods to engineering students, Numerical Methods for Solving Partial Differential Equations presents the fundamentals of all of the commonly used numerical methods for solving differential equations at a level appropriate for advanced undergraduates and first-year graduate students in science and engineering. Throughout, elementary examples show how numerical methods are used to solve generic versions of equations that arise in many scientific and engineering disciplines. In writing it, the author took pains to ensure that no assumptions were made about the background discipline of the reader. Covers the spectrum of numerical methods that are used to simulate the behavior of physical-chemical systems that occur in science and engineering Written by a professor of engineering with more than forty years of experience teaching numerical methods to engineers Requires only elementary knowledge of differential equations and matrix algebra to master the material Designed to teach students to understand, appreciate and apply the basic mathematics and equations on which Mathcad and similar commercial software packages are based Comprehensive yet accessible to readers with limited mathematical knowledge, Numerical Methods for Solving Partial Differential Equations is an excellent text for advanced undergraduates and first-year graduate students in the sciences and engineering. It is also a valuable working reference for professionals in engineering, physics, chemistry, computer science, and applied mathematics.

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.

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.

Numerical Solution of Hyperbolic Partial Differential Equations is a new type of graduate textbook, with both print and interactive electronic components (on CD). It is a comprehensive presentation of modern shock-capturing methods, including both finite volume and finite element methods, covering the theory of hyperbolic conservation laws and the theory of the numerical methods. The range of applications is broad enough to engage most engineering disciplines and many areas of applied mathematics. Classical techniques for judging the qualitative performance of the schemes are used to motivate the development of classical higher-order methods. The interactive CD gives access to the computer code used to create all of the text's figures, and lets readers run simulations, choosing their own input parameters; the CD displays the results of the experiments as movies. Consequently, students can gain an appreciation for both the dynamics of the problem application, and the growth of numerical errors. 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.