Essential Partial Differential Equations Analytical And Computational Aspects Springer Undergraduate Mathematics Series

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Numerical Analysis of Partial Differential Equations Using Maple and MATLAB World Scientific
This is an introductory text for beginners who have a basic knowledge of complex analysis, functional analysis and partial differential equations. Riemann and Riemann-Hilbert boundary value problems are discussed for analytic functions, for inhomogeneous Cauchy-Riemann systems as well as for generalized Beltrami systems. Related problems such as the Poincar problem, pseudoparabolic systems and complex elliptic second order equations are also considered. Estimates for solutions to linear equations existence and uniqueness results are thus available for related nonlinear problems; the method is explained by constructing entire solutions to nonlinear Beltrami equations. Often problems are discussed just for the unit disc but more general domains, even of multiply connectivity, are involved.
Method of Lines Analysis with Matlab Springer
In this book, Professor Copson gives a rigorous account of the theory of partial differential equations of the first order and of linear partial differential equations of the second order, using the methods of classical analysis. In spite of the advent of computers and the applications of the methods of functional analysis to the theory of partial differential equations, the classical theory retains its relevance in several important respects. Many branches of classical analysing have their origins in the rigourous discussion of problems in applies mathematics and theoretical physics, and the classical treatment of the theory of partial differential equations still provides the

best method of treating many physical problems. A knowledge of the classical theory is essential for pure mathematics who intend to undertake research in this field, whatever approach they ultimately adopt. The numerical analyst needs a knowledge of classical theory in order to decide whether a problem has a unique solution or not.

Introduction to Partial Differential Equations SIAM

A balanced guide to the essential techniques for solving elliptic partial differential equations Numerical Analysis of Partial Differential Equations provides a comprehensive, self-contained treatment of the quantitative methods used to solve elliptic partial differential equations (PDEs), with a focus on the efficiency as well as the error of the presented methods. The author utilizes coverage of theoretical PDEs, along with the nu merical solution of linear systems and various examples and exercises, to supply readers with an introduction to the essential concepts in the numerical analysis of PDEs. The book presents the three main discretization methods of elliptic PDEs: finite difference, finite elements, and spectral methods. Each topic has its own devoted chapters and is discussed alongside additional key topics, including: The mathematical theory of elliptic PDEs Numerical linear algebra Time-dependent PDEs Multigrid and domain decomposition PDEs posed on infinite domains The book concludes with a discussion of the methods for nonlinear problems, such as Newton's method, and addresses the importance of hands-on work to facilitate learning. Each chapter concludes with a set of exercises, including theoretical and programming problems, that allows readers to test their understanding of the presented theories and techniques. In addition, the book discusses important nonlinear problems in many fields of science and engineering, providing information as to how they can serve as computing projects across various disciplines. Requiring only a preliminary understanding of analysis, Numerical Analysis of Partial Differential Equations is suitable for courses on numerical PDEs at the upper-undergraduate and graduate levels. The book is also appropriate for students majoring in the mathematical sciences and engineering.

Analytical and Numerical Methods, Second Edition SIAM

This book provides an overview of different topics related to the theory of partial differential equations. Selected exercises are included at the end of each chapter to prepare readers for the "research project for beginners" proposed at the end of the book. It is a valuable resource for advanced graduates and undergraduate students who are interested in specializing in this area. The book is organized in five parts: In Part 1 the authors review the basics and the mathematical prerequisites, presenting two of the most fundamental results in the theory of partial differential equations: the Cauchy-Kovalevskaja theorem and Holmgren's uniqueness theorem in its classical and abstract form. It also introduces the method of characteristics in detail and applies this method to the study of Burger's equation. Part 2 focuses on qualitative properties of solutions to basic partial differential equations, explaining the usual properties of solutions to elliptic, parabolic and hyperbolic equations for the archetypes Laplace equation, heat equation and wave equation as well as the different features of each theory. It also discusses the notion of energy of solutions, a highly effective tool for the treatment of non-stationary or evolution models and shows how to define energies for different models. Part 3 demonstrates how phase space analysis and interpolation techniques are used to prove decay estimates for solutions on and away from the conjugate line. It also examines how terms of lower order (mass or dissipation) or additional regularity of the data may influence expected results. Part 4 addresses semilinear models with power type non-linearity of source and absorbing type in order to determine critical exponents: two well-known critical exponents, the Fujita exponent and the Strauss exponent come into play. Depending on concrete models these critical exponents divide the range of admissible powers in classes which make it possible to prove quite different qualitative properties of solutions, for example, the stability of the zero solution or blow-up behavior of local (in time) solutions. The last part features selected research projects and general background material.

Partial Differential Equations CRC Press

Variational Techniques for Elliptic Partial Differential Equations, intended for graduate students studying applied math, analysis, and/or numerical analysis, provides the necessary tools to understand the structure and solvability of elliptic partial differential equations. Beginning with the necessary definitions and theorems from distribution theory, the book gradually builds the functional analytic framework for studying elliptic PDE using variational formulations. Rather than introducing all of the prerequisites in the first chapters, it is the introduction of new problems which motivates the development of the associated analytical tools. In this way the student who is encountering this material for the first time will be aware of exactly what theory is needed, and for which problems. Features A detailed and rigorous development of the theory of Sobolev spaces on Lipschitz domains, including the trace operator and the normal component of vector fields An integration of functional analysis concepts involving Hilbert spaces and the problems which can be solved with these concepts, rather than separating the two Introduction to the analytical tools needed for physical problems of interest like time-harmonic waves, Stokes and Darcy flow, surface differential equations, Maxwell cavity problems, etc. A variety of problems which serve to reinforce and expand upon the material in each chapter, including applications in fluid and solid mechanics

Basic Linear Partial Differential Equations CUP Archive

The book is intended as an advanced undergraduate or first-year graduate course for students from various disciplines, including applied mathematics, physics and engineering. It has evolved from courses offered on partial differential equations (PDEs) over the last several years at the Politecnico di Milano. These courses had a twofold purpose: on the one hand, to teach students to appreciate the interplay between theory and modeling in problems arising in the applied sciences, and on the other to provide them with a solid theoretical background in numerical methods, such as finite elements. Accordingly, this textbook is divided into two parts. The first part, chapters 2 to 5, is more elementary in nature and focuses on developing and studying basic problems from the macro-areas of diffusion, propagation and transport, waves and vibrations. In turn the second part, chapters 6 to 11, concentrates on the development of Hilbert spaces methods for the variational formulation and the analysis of (mainly) linear boundary and initial-boundary value problems.

Steady-State and Time-Dependent Problems Cambridge University Press

Partial Differential Equations: Analytical Methods and Applications covers all the basic topics of a Partial Differential Equations (PDE) course for undergraduate students or a beginners' course for graduate students. It provides qualitative physical explanation of mathematical results while maintaining the expected level of it rigor. This text introduces and

promotes practice of necessary problem-solving skills. The presentation is concise and friendly to the reader. The "teaching-by-examples" approach provides numerous carefully chosen examples that guide step-by-step learning of concepts and techniques. Fourier series, Sturm-Liouville problem, Fourier transform, and Laplace transform are included. The book’s level of presentation and structure is well suited for use in engineering, physics and applied mathematics courses. Highlights: Offers a complete first course on PDEs The text’s flexible structure promotes varied syllabi for courses Written with a teach-by-example approach which offers numerous examples and applications Includes additional topics such as the Sturm-Liouville problem, Fourier and Laplace transforms, and special functions The text’s graphical material makes excellent use of modern software packages Features numerous examples and applications which are suitable for readers studying the subject remotely or independently

Methods for Constructing Exact Solutions of Partial Differential Equations John Wiley & Sons

Partial Differential Equations with Variable Exponents: Variational Methods and Qualitative Analysis provides researchers and graduate students with a thorough introduction to the theory of nonlinear partial differential equations (PDEs) with a variable exponent, particularly those of elliptic type. The book presents the most important variational methods for elliptic PDEs described by nonhomogeneous differential operators and containing one or more power-type nonlinearities with a variable exponent. The authors give a systematic treatment of the basic mathematical theory and constructive methods for these classes of nonlinear elliptic equations as well as their applications to various processes arising in the applied sciences. The analysis developed in the book is based on the notion of a generalized or weak solution. This approach leads not only to the fundamental results of existence and multiplicity of weak solutions but also to several qualitative properties, including spectral analysis, bifurcation, and asymptotic analysis. The book examines the equations from different points of view while using the calculus of variations as the unifying theme. Readers will see how all of these diverse topics are connected to other important parts of mathematics, including topology, differential geometry, mathematical physics, and potential theory.

A Computational Approach American Mathematical Soc.

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

Qualitative Properties of Solutions, Phase Space Analysis, Semilinear Models Springer

Focusing on the archetypes of linear partial differential equations, this text for upper-level undergraduates and graduate students employs nontraditional methods to explain classical material. Nearly 400 exercises. 1975 edition.

Mathematical Theory of Compressible Viscous Fluids SIAM

Essential Partial Differential EquationsAnalytical and Computational AspectsSpringer

Partial Differential Equation Analysis in Biomedical Engineering Courier Corporation

This book offers an essential introduction to the mathematical theory of compressible viscous fluids. The main goal is to present analytical methods from the perspective of their numerical applications. Accordingly, we introduce the principal theoretical tools needed to handle well-posedness of the underlying Navier-Stokes system, study the problems of sequential stability, and, lastly, construct solutions by means of an implicit numerical scheme. Offering a unique contribution – by exploring in detail the “synergy” of analytical and numerical methods – the book offers a valuable resource for graduate students in mathematics and researchers working in mathematical fluid mechanics. Mathematical fluid mechanics concerns problems that are closely connected to real-world applications and is also an important part of the theory of partial differential equations and numerical analysis in general. This book highlights the fact that numerical and mathematical analysis are not two separate fields of mathematics. It will help graduate students and researchers to not only better understand problems in mathematical compressible fluid mechanics but also to learn something from the field of mathematical and numerical analysis and to see the connections between the two worlds. Potential readers should possess a good command of the basic tools of functional analysis and partial differential equations including the function spaces of Sobolev type.

Fourier Series and Numerical Methods for Partial Differential Equations Essential Partial Differential EquationsAnalytical and Computational Aspects

Presents numerical methods and computer code in Matlab for the solution of ODEs and PDEs with detailed line-by-line discussion.

Nonlinear Partial Differential Equations Springer Science & Business Media

This volume provides an introduction to the analytical and numerical aspects of partial differential equations (PDEs). It unifies an analytical and computational approach for these; the qualitative behaviour of solutions being established using classical concepts: maximum principles and energy methods. Notable inclusions are the treatment of irregularly shaped boundaries, polar coordinates and the use of flux-limiters when approximating hyperbolic conservation laws. The numerical analysis of difference schemes is rigorously developed using discrete maximum principles and discrete Fourier analysis. A novel feature is the inclusion of a chapter containing projects, intended for either individual or group study, that cover a range of topics such as parabolic smoothing, travelling waves, isospectral matrices, and the approximation of multidimensional

advection–diffusion problems. The underlying theory is illustrated by numerous examples and there are around 300 exercises, designed to promote and test understanding. They are starred according to level of difficulty. Solutions to odd-numbered exercises are available to all readers while even-numbered solutions are available to authorised instructors. Written in an informal yet rigorous style, Essential Partial Differential Equations is designed for mathematics undergraduates in their final or penultimate year of university study, but will be equally useful for students following other scientific and engi neering disciplines in which PDEs are of practical importance. The only prerequisite is a familiarity with the basic concepts of calculus and linear algebra.

Essential Partial Differential Equations Cambridge University Press
Although the Partial Differential Equations (PDE) models that are now studied are usually beyond traditional mathematical analysis, the numerical methods that are being developed and used require testing and validation. This is often done with PDEs that have known, exact, analytical solutions. The development of analytical solutions is also an active area of research, with many advances being reported recently, particularly traveling wave solutions for nonlinear evolutionary PDEs. Thus, the current development of analytical solutions directly supports the development of numerical methods by providing a spectrum of test problems that can be used to evaluate numerical methods. This book surveys some of these new developments in analytical and numerical methods, and relates the two through a series of PDE examples. The PDEs that have been selected are largely "named'' since they carry the names of their original contributors. These names usually signify that the PDEs are widely recognized and used in many application areas. The authors’ intention is to provide a set of numerical and analytical methods based on the concept of a traveling wave, with a central feature of conversion of the PDEs to ODEs. The Matlab and Maple software will be available for download from this website shortly. www.pdecomp.net Includes a spectrum of applications in science, engineering, applied mathematics Presents a combination of numerical and analytical methods Provides transportable computer codes in Matlab and Maple

Introduction to Partial Differential Equations Springer Science & Business Media
This book provides an introduction to the use of geometric partial differential equations in image processing and computer vision. This research area brings a number of new concepts into the field, providing a very fundamental and formal approach to image processing. State-of-the-art practical results in a large number of real problems are achieved with the techniques described in this book. Applications covered include image segmentation, shape analysis, image enhancement, and tracking. This book will be a useful resource for researchers and practitioners. It is intended to provide information for people investigating new solutions to image processing problems as well as for people searching for existent advanced solutions.

Variational Techniques for Elliptic Partial Differential Equations Springer Science & Business Media
This is the second edition of the now definitive text on partial differential equations (PDE). It offers a comprehensive survey of modern techniques in the theoretical study of PDE with particular emphasis on nonlinear equations. Its wide scope and clear exposition make it a great text for a graduate course in PDE. For this edition, the author has made numerous changes, including a new chapter on nonlinear wave equations, more than 80 new exercises, several new sections, a significantly expanded bibliography. About the First Edition: I have used this book for both regular PDE and topics courses. It has a wonderful combination of insight and technical detail. ... Evans' book is evidence of his mastering of the field and the clarity of presentation. --Luis Caffarelli, University of Texas It is fun to teach from Evans' book. It explains many of the essential ideas and techniques of partial differential equations ... Every graduate student in analysis should read it. --David Jerison, MIT I use Partial Differential Equations to prepare my students for their Topic exam, which is a requirement before starting working on their dissertation. The book provides an excellent account of PDE's ... I am very happy with the preparation it provides my students. --Carlos Kenig, University of Chicago Evans' book has already attained the status of a classic. It is a clear choice for students just learning the subject, as well as for experts who wish to broaden their knowledge ... An outstanding reference for many aspects of the field. --Rafe Mazzeo, Stanford University

Function Spaces and Partial Differential Equations Birkhäuser
This is a book written primarily for graduate students and early researchers in the fields of Analysis and Partial Differential Equations (PDEs). Coverage of the material is essentially self-contained, extensive and novel with great attention to details and rigour. The strength of the book primarily lies in its clear and detailed explanations, scope and coverage, highlighting and presenting deep and profound inter-connections between different related and seemingly unrelated disciplines within classical and modern mathematics and above all the extensive collection of examples, worked-out and hinted exercises. There are well over 700 exercises of varying level leading the reader from the basics to the most advanced levels and frontiers of research. The book can be used either for independent study or for a year-long graduate level course. In fact it has its origin in a year-long graduate course taught by the author in Oxford in 2004-5 and various parts of it in other institutions later on. A good number of distinguished researchers and faculty in mathematics worldwide have started their research career from the course that formed the basis for this book.

Analysis and Numerics Oxford University Press
Ever since the groundbreaking work of J.J. Kohn in the early 1960s, there has been a significant interaction between the theory of partial differential equations and the function theory of several complex variables. Partial Differential Equations and Complex Analysis explores the background and plumbs the depths of this symbiosis. The book is an excellent introduction to a variety of topics and presents many of the basic elements of linear partial differential equations in the context of how they are applied to the study of complex analysis. The author treats the Dirichlet and Neumann problems for elliptic equations and the related Schauder regularity theory, and examines how those results apply to the boundary regularity of biholomorphic mappings. He studies the ?-Neumann problem, then considers applications to the complex function theory of several variables and to the Bergman projection.

Volume 2 - Contemporary Analysis American Mathematical Soc.
This textbook is a completely revised, updated, and expanded English edition of the important Analyse fonctionnelle (1983). In addition, it contains a wealth of problems and exercises (with solutions) to guide the reader. Uniquely, this book presents in a coherent, concise and unified way the main results from functional analysis together with the main results from the theory of partial differential equations (PDEs). Although there are many books on functional analysis and

many on PDEs, this is the first to cover both of these closely connected topics.

Since the French book was first published, it has been translated into Spanish, Italian, Japanese, Korean, Romanian, Greek and Chinese. The English edition makes a welcome addition to this list.