Stable Solutions Of Elliptic Partial Differential Equations Monographs And Surveys In Pure And Applied Mathematics

This book is the outcome of a conference held at the Centro De Giorgi of the Scuola Normale of Pisa in September 2012. The aim of the conference was to discuss recent results on nonlinear partial differential equations, and more specifically geometric evolutions and reaction-diffusion equations. Particular attention was paid to self-similar solutions, such as solitons and travelling waves, asymptotic behaviour, formation of singularities and qualitative properties of solutions. These problems arise in many models from Physics, Biology, Image Processing and Applied Mathematics in general, and have attracted a lot of attention in recent years.

This volume comprises selected, revised papers from the Joint CIM-WIAS Workshop, TAAO 2017, held in Lisbon, Portugal, in December 2017. The workshop brought together experts from research groups at the Weierstrass Institute in Berlin and mathematics centres in Portugal to present and discuss current scientific topics and to promote existing and future collaborations. The papers include the following topics: PDEs with applications to material sciences, thermodynamics and laser dynamics, scientific computing, nonlinear optimization and stochastic analysis.

The Ginzburg-Landau equation us a mathematical model of superconductors has become an extremely useful tool in many areas of physics where vortices carrying a topological charge appear. The remarkable progress in the mathematical understanding of this equation involves a combined use of mathematical tools from many branches of mathematics. The Ginzburg-Landau model has been an amazing source of new problems and new ideas in analysis, geometry and topology. This collection will meet the urgent needs of the specialists, scholars and graduate students working in this area or related areas.

The material presented here corresponds to Fermi lectures that I was invited to deliver at the Scuola Normale di Pisa in the spring of 1998. The obstacle problem consists in studying the properties of minimizers of the Dirichlet integral in a domain D of Rn, among all those configurations u with prescribed boundary values and costrained to remain in D above a prescribed obstacle F. In the Hilbert space H1(D) of all those functions with square integrable gradient, we consider the closed convex set K of functions u with fixed boundary value and which are greater than F in D. There is a unique point in K minimizing the Dirichlet integral. That is called the solution to the obstacle problem.

Applied Mechanics Reviews

Stability of Solutions of Integrable Partial Differential Equations

A-Integral — Coordinates

The Navier-Stokes Problem in the 21st Century

Up-to-Date Coverage of the Navier–Stokes Equation from an Expert in Harmonic Analysis The complete resolution of the Navier–Stokes equation—one of the Clay Millennium Prize Problems—remains an important open challenge in partial differential equations (PDEs) research despite substantial studies on turbulence and three-dimensional fluids. The Navier–Stokes Problem in the 21st Century provides a self-contained guide to the role of harmonic analysis in the PDEs of fluid mechanics. The book focuses on incompressible deterministic Navier–Stokes equations in the case of a fluid filling the whole space. It explores the meaning of the equations, open problems, and recent progress. It includes classical results on local existence and studies criterion for regularity or uniqueness of solutions. The book also incorporates historical references to the (pre)history of the equations as well as recent references that highlight active mathematical research in the field.

This volume contains contributions from the INdAM School on Symmetry for Elliptic PDEs, which was held May 25-29, 2009, in Rome, Italy. The school marked ``30 years after a conjecture of De Giorgi, and related problems'' and provided an opportunity for experts to discuss the state of the art and open questions on the subject. Motivated by the classical rigidity properties of the minimal surfaces, De Giorgi proposed the study of the one-dimensional symmetry of the monotone solutions of a semilinear, elliptic partial differential equation. Impressive advances have recently been made in this field, though many problems still remain open. Several generalizations to more complicated operators have attracted the attention of pure and applied mathematicians, both for their important theoretical problems and for their relation, among others, with the gradient theory of phase transitions and the dynamical systems.

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.

The theory of linear Volterra integro-differential equations has been developing rapidly in the last three decades. This book provides an easy to read concise introduction to the theory of ill-posed abstract Volterra integro-differential equations. A major part of the research is devoted to the study of various types of abstract (multi-term) fractional differential equations with Caputo fractional derivatives, primarily from their invaluable importance in modeling of various phenomena appearing in physics, chemistry, engineering, biology and many other sciences. The book also contributes to the theories of abstract first and second order differential equations, as well as to the theories of higher order abstract differential equations and incomplete abstract Cauchy problems, which can be viewed as parts of the theory of abstract Volterra integro-differential equations only in its broad sense. The operators examined in our analyses need not be densely defined and may have empty resolvent set. Divided into three chapters, the book is a logical continuation of some previously published monographs in the field of ill-posed abstract Cauchy problems. It is not written as a traditional text, but rather as a guidebook suitable as an introduction for advanced graduate students in mathematics or engineering science, researchers in abstract partial differential equations and experts from other areas. Most of the subject matter is intended to be accessible to readers whose backgrounds include functions of one complex variable, integration theory and the basic theory of locally convex spaces. An important feature of this book as compared to other monographs and papers on abstract Volterra integro-differential equations is, undoubtedly, the consideration of solutions, and their hypercyclic properties, in locally convex spaces. Each chapter is further divided in sections and subsections and, with the exception of the introductory one, contains a plenty of examples and open problems. The numbering of theorems, propositions, lemmas, corollaries, and definitions are by chapter and section. The bibliography is provided alphabetically by author name and a reference to an item is of the form, The book does not claim to be exhaustive. Degenerate Volterra equations, the solvability and asymptotic behaviour of Volterra equations on the line, almost periodic and positive solutions of Volterra equations, semilinear and quasilinear problems, as some of many topics are not covered in the book. The author's justification for this is that it is not feasible to encompass all aspects of the theory of abstract Volterra equations in a single monograph.

Proceedings

Geometry of PDEs and Related Problems

Steady-State and Time-Dependent Problems

Elliptic Differential Equations

Stable Solutions of Elliptic Partial Differential Equations

This book deals with a systematic study of a dynamical system approach to investigate the symmetrization and stabilization properties of nonnegative solutions of nonlinear elliptic problems in asymptotically symmetric unbounded domains. The usage of infinite dimensional dynamical systems methods for elliptic problems in unbounded domains as well as finite dimensional reduction of their dynamics requires new ideas and tools. To this end, both a trajectory dynamical systems approach and new Liouville type results for the solutions of some class of elliptic equations are used. The work also uses symmetry and monotonicity results for nonnegative solutions in order to characterize an asymptotic profile of solutions and compares a pure elliptic partial differential equations approach and a dynamical systems approach. The new results obtained will be particularly useful for mathematical biologists.

Although the origins of parallel computing go back to the last century, it was only in the 1970s that parallel and vector computers became available to the scientific community. The first of these machines-the 64 processor llliac IV and the vector computers built by Texas Instruments, Control Data Corporation, and then CRA Y Research Corporation-had a somewhat limited impact. They were few in number and available mostly to workers in a few government laboratories. By now, however, the trickle has become a flood. There are over 200 large-scale vector computers now installed, not only in government laboratories but also in universities and in an increasing diversity of industries. Moreover, the National Science Foundation's Super computing Centers have made large vector computers widely available to the academic community. In addition, smaller, very cost-effective vector computers are being manufactured by a number of companies. Parallelism in computers has also progressed rapidly. The largest super computers now consist of several vector processors working in parallel. Although the number of processors in such machines is still relatively small (up to 8), it is expected that an increasing number of processors will be added in the near future (to a total of 16 or 32). Moreover, there are a myriad of research projects to build machines with hundreds, thousands, or even more processors. Indeed, several companies are now selling parallel machines, some with as many as hundreds, or even tens of thousands, of processors.

Stable Solutions of Elliptic Partial Differential EquationsCRC Press

"The goal of this thesis is to widen the class of provably convergent schemes for elliptic partial differential equations (PDEs) and improve their accuracy. We accomplish this by building on the theory of Barles and Souganidis, and its extension by Froese and Oberman to build monotone and filtered schemes.The first problem considered is the widely studied class of first order Hamilton-Jacobi (HJ) equations. The goal is to construct provably convergent accurate schemes, together with an efficient solver, by making use of the large number of discretizations and solvers already available. To this end, we build filtered schemes, whose main idea is to blend a stable monotone convergent scheme with an accurate scheme while retaining the advantages of both: stability and convergence of the former, and higher accuracy of the latter. Indeed, we are able to build schemes which are second, third, and fourth order accurate in one dimension, as well as schemes that are second order accurate in two dimensions. Moreover, the schemes are explicit, allowing us to use the easy-to-implement fast sweeping method. Using different accurate schemes (e.g. from standard centred differences, higher order upwinding and ENO interpolation), the accuracy of the filtered schemes is validated with computational results for the eikonal equation, as well as other HJ equations (both in one and two dimensions).The second problem considered is the 2-Hessian equation, a fully nonlinear PDE related to the intrinsic curvature for three-dimensional manifolds. The goal is to build numerical methods to compute its solution on a bounded domain given prescribed boundary data. We propose two distinct methods. The first is provably convergent to the unique viscosity solution. The second has higher accuracy and converges in practice, but lacks a formal proof of convergence. The PDE is elliptic on a restricted set of functions: a convexity-type constraint is needed for the ellipticity of the PDE operator, which poses additional difficulties when building the numerical methods. Solutions with both discretizations are obtained using Newton's method. Computational results are presented on a number of exact solutions which range in regularity from smooth to non-differentiable, and in shape from convex to non-convex.The third and last problem is to build a provably convergent scheme for the nonlinear PDE that governs the motion of level sets by affine curvature. It is closely related to mean curvature but exhibits instabilities not found in the former. These instabilities and the lack of regularity of the affine curvature operator posed unexpected and additional difficulties in building monotone schemes. A standard finite difference scheme is proposed and an example that illustrates its nonlinear instability is given. We build provably convergent monotone finite difference schemes. Numerical experiments demonstrate the accuracy and stability of the discretization, as well as the fact that our approximate solutions capture the affine invariance and morphological properties of the evolution." --

Elliptic Systems of Phase Transition Type

Applied Singular Integral Equations

Finite Difference Methods for Ordinary and Partial Differential Equations

Elliptic Partial Differential Equations and Quasiconformal Mappings in the Plane (PMS-48)

Qualitative Analysis of Nonlinear Elliptic Partial Differential Equations

Partial Differential Equations presents a balanced and comprehensive introduction to the concepts and techniques required to solve problems containing unknown functions of multiple variables. While focusing on the three most classical partial differential equations (PDEs)—the wave, heat, and Laplace equations—this detailed text also presents a broad practical perspective that merges mathematical concepts with real-world application in diverse areas including molecular structure, photon and electron interactions, radiation of electromagnetic waves, vibrations of a solid, and many more. Rigorous pedagogical tools aid in student comprehension; advanced topics are introduced frequently, with minimal technical jargon, and a wealth of exercises reinforce vital skills and invite additional self-study. Topics are presented in a logical progression, with major concepts such as wave propagation, heat and diffusion, electrostatics, and quantum mechanics placed in contexts familiar to students of various fields in science and engineering. By understanding the properties and applications of PDEs, students will be equipped to better analyze and interpret central processes of the natural world.

MATRIX is Australia's international and residential mathematical research institute. It facilitates new collaborations and mathematical advances through intensive residential research programs, each 1-4 weeks in duration. This book is a scientific record of the eight programs held at MATRIX in 2018: - Non-Equilibrium Systems and Special Functions - Algebraic Geometry, Approximation and Optimisation - On the Frontiers of High Dimensional Computation - Month of Mathematical Biology - Dynamics, Foliations, and Geometry In Dimension 3 - Recent Trends on Nonlinear PDEs of Elliptic and Parabolic Type - Functional Data Analysis and Beyond - Geometric and Categorical Representation Theory The articles are grouped into peer-reviewed contributions and other contributions. The peer-reviewed articles present original results or reviews on a topic related to the MATRIX program; the remaining contributions are predominantly lecture notes or short articles based on talks or activities at MATRIX.

This book focuses on the vector Allen-Cahn equation, which models coexistence of three or more phases and is related to Plateau complexes – non-orientable objects with a stratified structure. The minimal solutions of the vector equation exhibit an analogous structure not present in the scalar Allen-Cahn equation, which models coexistence of two phases and is related to minimal surfaces. The 1978 De Giorgi conjecture for the scalar problem was settled in a series of papers: Ghoussoub and Gui (2d), Ambrosio and Cabré (3d), Savin (up to 8d), and del Pino, Kowalczyk and Wei (counterexample for 9d and above). This book extends, in various ways, the Caffarelli-Córdoba density estimates that played a major role in Savin's proof. It also introduces an alternative method for obtaining pointwise estimates. Key features and topics of this self-contained, systematic exposition include: • Resolution of the structure of minimal solutions in the equivariant class, (a) for general point groups, and (b) for general discrete reflection groups, thus establishing the existence of previously unknown lattice solutions. • Preliminary material beginning with the stress-energy tensor, via which monotonicity formulas, and Hamiltonian and Pohozaev identities are developed, including a self-contained exposition of the existence of standing and traveling waves. • Tools that allow the derivation of general properties of minimizers, without any assumptions of symmetry, such as a maximum principle or density and pointwise estimates. • Application of the general tools to equivariant solutions rendering exponential estimates, rigidity theorems and stratification results. This monograph is addressed to readers, beginning from the graduate level, with an interest in any of the following: differential equations – ordinary or partial; nonlinear analysis; the calculus of variations; the relationship of minimal surfaces to diffuse interfaces; or the applied mathematics of materials science.

Stability analysis for solutions of partial differential equations (PDEs) is important for determining the applicability of a model to the physical world. Establishing stability for PDE solutions is often significantly more challenging than for ordinary differential equation solutions. This task becomes tractable for PDEs possessing a Lax pair. In this dissertation, I provide a general framework for computing large parts of the Lax spectrum for periodic and quasiperiodic solutions of a general class of PDEs possessing a Lax pair. This class consists of the AKNS hierarchy admitting a common reduction and generalizations. I then relate the Lax spectrum to the stability spectrum using the squared-eigenfunction connection. Using this, I demonstrate that the subset of the real line which is part of the Lax spectrum maps to stable elements of the linearization. Several examples that demonstrate the direct applicability of this work are provided. One example is worked out in detail: the stability analysis for the elliptic solutions of the focusing nonlinear Schrödinger (NLS) equation. For the NLS equation, I go further by establishing orbital stability of the elliptic solutions with respect to a class of perturbations of integer multiples of the period of the solution.

Cetraro, Italy 2017

Encyclopaedia of Mathematics

Numerical Methods for Nonlinear Elliptic Partial Differential Equations

2018 MATRIX Annals

Abstract Volterra Integro-Differential Equations

This book simultaneously presents the theory and the numerical treatment of elliptic boundary value problems, since an understanding of the theory is necessary for the numerical analysis of the discretisation. It first discusses the Laplace equation and its finite difference discretisation before addressing the general linear differential equation of second order. The variational formulation together with the necessary background from functional analysis provides the basis for the Galerkin and finite-element methods, which are explored in detail. A more advanced chapter leads the reader to the theory of regularity. Individual chapters are devoted to singularly perturbed as well as to elliptic eigenvalue problems. The book also presents the Stokes problem and its discretisation as an example of a saddle-point problem taking into account its relevance to applications in fluid dynamics.

This volume collects contributions from the speakers at an INdAM Intensive period held at the University of Bari in 2017. The contributions cover several aspects of partial differential equations whose development in recent years has experienced major breakthroughs in terms of both theory and applications. The topics covered include nonlocal equations, elliptic equations and systems, fully nonlinear equations, nonlinear parabolic equations, overdetermined boundary value problems, maximum principles, geometric analysis, control theory, mean field games, and bio-mathematics. The authors are trailblazers in these topics and present their work in a way that is exhaustive and clearly accessible to PhD students and early career researcher. As such, the book offers an excellent introduction to a variety of fundamental topics of contemporary investigation and inspires novel and high-quality research.

The aim of this book is to present different aspects of the deep interplay between Partial Differential Equations and Geometry. It gives an overview of some of the themes of recent research in the field and their mutual links, describing the main underlying ideas, and providing up-to-date references. Collecting together the lecture notes of the five mini-courses given at the CIME Summer School held in Cetraro (Cosenza, Italy) in the week of June 19–23, 2017, the volume presents a friendly introduction to a broad spectrum of up-to-date and hot topics in the study of PDEs, describing the state-of-the-art in the subject. It also gives further details on the main ideas of the proofs, their technical difficulties, and their possible extension to other contexts. Aiming to be a primary source for researchers in the field, the book will attract potential readers from several areas of mathematics.

This ENCYCLOPAEDIA OF MATHEMATICS aims to be a reference work for all parts of mathe matics. It is a translation with updates and editorial comments of the Soviet Mathematical Encyclopaedia published by 'Soviet Encyclopaedia Publishing House' in five volumes in 1977-1985. The annotated translation consists of ten volumes including a special index volume. There are three kinds of articles in this ENCYCLOPAEDIA. First of all there are survey-type articles dealing with the various main directions in mathematics (where a rather fine subdivi sion has been used). The main requirement for these articles has been that they should give a reasonably complete up-to-date account of the current state of affairs in these areas and that they should be maximally accessible. On the whole, these articles should be understandable to mathematics students in their first specialization years, to graduates from other mathematical areas and, depending on the specific subject, to specialists in other domains of science, en gineers and teachers of mathematics. These articles treat their material at a fairly general level and aim to give an idea of the kind of problems, techniques and concepts involved in the area in question. They also contain background and motivation rather than precise statements of precise theorems with detailed definitions and technical details on how to carry out proofs and constructions. The second kind of article, of medium length, contains more detailed concrete problems, results and techniques.

Introduction to Parallel and Vector Solution of Linear Systems

Symmetrization and Stabilization of Solutions of Nonlinear Elliptic Equations

Topics in Stability and Bifurcation Theory

An Introduction To Viscosity Solutions for Fully Nonlinear PDE with Applications to Calculus of Variations in L∞

An Introduction

A collection of self contained, state-of-the-art surveys. The authors have made an effort to achieve readability for mathematicians and scientists from other fields, for this series of handbooks to be a new reference for research, learning and teaching. Partial differential equations represent one of the most rapidly developing topics in mathematics. This is due to their numerous applications in science and engineering on the one hand and to the challenge and beauty of associated mathematical problems on the other. Key features: - Self-contained volume in series covering one of the most rapid developing topics in mathematics. - 7 Chapters, enriched with numerous figures originating from numerical simulations. - Written by well known experts in the field. - Self-contained volume in series covering one of the most rapid developing topics in mathematics. - 7 Chapters, enriched with numerous figures originating from numerical simulations. - Written by well known experts in the field.

The book is an attempt to bring together various topics in partial differential equations related to the Cauchy problem for solutions of an elliptic equation. Ever since Hadamard, the Cauchy problem for solutions of elliptic equations has been known to be ill-posed. It is conditionally stable, just as is the case for even the simplest problems of analytic continuation of functions given on a subset of the boundary. (Such problems of analytic continuation served as a paradigm for the treatment here.) The study of the Cauchy problem is carried out in three directions: determining the degree of instability, which is connected with sharp theorems on approximation by solutions of an elliptic equation; finding solvability conditions, which is based on the development of Hilbert space methods in the Cauchy problem; and reconstructing solutions via their Cauchy data, which requires efficient ways of approximation. A wide range of topics is touched upon, among them are function spaces on compact sets, boundedness theorems for pseudodifferential operators in nonlocal spaces, nonlinear capacity and removable singularities, fundamental solutions, capacitary criteria for approximation by solutions of elliptic equations, and weak boundary values of the solutions. The theory applies as well to the Cauchy problem for solution of overdetermined elliptic systems.

The purpose of this book is to give a quick and elementary, yet rigorous, presentation of the rudiments of the so-called theory of Viscosity Solutions which applies to fully nonlinear 1st and 2nd order Partial Differential Equations (PDE). For such equations, particularly for 2nd order ones, solutions generally are non-smooth and standard approaches in order to define a "weak solution" do not apply: classical, strong almost everywhere, weak, measure-valued and distributional solutions either do not exist or may not even be defined. The main reason for the latter failure is that, the standard idea of using "integration-by-parts" in order to pass derivatives to smooth test functions by duality, is not available for non-divergence structure PDE.

The book is devoted to varieties of linear singular integral equations, with special emphasis on their methods of solution. It introduces the singular integral equations and their applications to researchers as well as graduate students of this fascinating and growing branch of applied mathematics.

Symmetry for Elliptic PDEs

Handbook of Differential Equations:Stationary Partial Differential Equations

The obstacle problem

Topics in Applied Analysis and Optimisation

Volume 6: Subject Index — Author Index

This book provides a comprehensive introduction to the mathematical theory of nonlinear problems described by elliptic partial differential equations. These equations can be seen as nonlinear versions of the classical Laplace equation, and they appear as mathematical models in different branches of physics, chemistry, biology, genetics, and engineering and are also relevant in differential geometry and relativistic physics. Much of the modern theory of such equations is based on the calculus of variations and functional analysis. Concentrating on single-valued or multivalued elliptic equations with nonlinearities of various types, the aim of this volume is to obtain sharp existence or nonexistence results, as well as decay rates for general classes of solutions. Many technically relevant questions are presented and analyzed in detail. A systematic picture of the most relevant phenomena is obtained for the equations under study, including bifurcation, stability, asymptotic analysis, and optimal regularity of solutions. The method of presentation should appeal to readers with different backgrounds in functional analysis and nonlinear partial differential equations. All chapters include detailed heuristic arguments providing thorough motivation of the study developed later on in the text, in relationship with concrete processes arising in applied sciences. A systematic description of the most relevant singular phenomena described in this volume includes existence (or nonexistence) of solutions, unicity or multiplicity properties, bifurcation and asymptotic analysis, and optimal regularity. The book includes an extensive bibliography and a rich index, thus allowing for quick orientation among the vast collection of literature on the mathematical theory of nonlinear phenomena described by elliptic partial differential equations.

This book discusses a new discipline, variational analysis, which contains the calculus of variations, differential calculus, optimization, and variational inequalities. To such classic branches of mathematics, variational analysis provides a uniform theoretical base that represents a powerful tool for the applications. The contributors are among the best experts in the field. Audience The target audience of this book includes scholars in mathematics (especially those in mathematical analysis), mathematical physics and applied mathematics, calculus of variations, optimization and operations research, industrial mathematics, structural engineering, and statistics and economics.

Asymptotic properties of solutions such as stability/ instability,oscillation/ nonoscillation, existence of solutions with specific asymptotics, maximum principles present a classical part in the theory of higher order functional differential equations. The use of these equations in applications is one of the main reasons for the developments in this field. The control in the mechanical processes leads to mathematical models with second order delay differential equations. Stability and stabilization of second order delay equations are one of the main goals of this book. The book is based on the authors' results in the last decade. Features: Stability, oscillatory and asymptotic properties of solutions are studied in correlation with each other. The first systematic description of stability methods based on the Bohl-Perron theorem. Simple and explicit exponential stability tests. In this book, various types of functional differential equations are considered: second and higher orders delay differential equations with measurable coefficients and delays, integro-differential equations, neutral equations, and operator equations. Oscillation/nonoscillation, existence of unbounded solutions, instability, special asymptotic behavior, positivity, exponential stability and stabilization of functional differential equations are studied. New methods for the study of exponential stability are proposed. Noted among them inlcude the W-transform (right regularization), a priory estimation of solutions, maximum principles, differential and integral inequalities, matrix inequality method, and reduction to a system of equations. The book can be used by applied mathematicians and as a basis for a course on stability of functional differential equations for graduate students.

Stable solutions are ubiquitous in differential equations. They represent meaningful solutions from a physical point of view and appear in many applications, including mathematical physics (combustion, phase transition theory) and geometry (minimal surfaces). Stable Solutions of Elliptic Partial Differential Equations offers a self-contained presentation of the notion of stability in elliptic partial differential equations (PDEs). The central questions of regularity and classification of stable solutions are treated at length. Specialists will find a summary of the most recent developments of the theory, such as nonlocal and higher-order equations. For beginners, the book walks you through the fine versions of the maximum principle, the standard regularity theory for linear elliptic equations, and the fundamental functional inequalities commonly used in this field. The text also includes two additional topics: the inverse-square potential and some background material on submanifolds of Euclidean space.

Force-Free Magnetic Fields: Solutions, Topology and Applications

Oscillation, Nonoscillation, Stability and Asymptotic Properties for Second and Higher Order Functional Differential Equations

Opuscula Mathematica

Proceedings of the ... Annual Princeton Conference on Information Sciences and Systems

Theory and Numerical Treatment

This book presents several aspects of research on mathematics that have significant applications in engineering, modelling and social matters, discussing a number of current and future social issues and problems in which mathematical tools can be beneficial. Each chapter enhances our understanding of the research problems in a particular an area of study and highlights the latest advances made in that area. The self-contained contributions make the results and problems discussed accessible to readers, and provides references to enable those interested to follow subsequent studies in still developing fields. Presenting real-world applications, the book is a valuable resource for graduate students, researchers and educators. It appeals to general readers curious about the practical applications of mathematics in diverse scientific areas and social problems.

After an introductory chapter concerned with the history of force-free magnetic fields, and the relation of such fields to hydrodynamics and astrophysics, the book examines the limits imposed by the virial theorem for finite force-free configurations. Various techniques are then used to find solutions to the field equations. The fact that the field lines corresponding to these solutions have the common feature of being "twisted", and may be knotted, motivates a discussion of field line topology and the concept of helicity. The topics of field topology, helicity, and magnetic energy in multiply connected domains make the book of interest to a rather wide audience. Applications to solar prominence models, type-II superconductors, and force-reduced magnets are also discussed. The book contains many figures and a wealth of material not readily available elsewhere. Contents:IntroductionThe Virial TheoremSolutions to the Force-Free Field EquationsField TopologyMagnetic Energy in Multiply Connected DomainsApplicationsForce-Free Fields and Electromagnetic WavesProof of the Jacobi Polynomial IdentitiesSeparation of the Wave Equation, Cyclides, and Boundary Conditions Readership: Students and researchers working in physics, astrophysics, hydrodynamics, plasma physics and energy research. keywords:Force-Free;Magnetic Filed Topology;Helicity (Twist, Kink, Link);Magnetic Energy in Multiply-Connected Domains;Magnetic Knots

This book explores the most recent developments in the theory of planar quasiconformal mappings with a particular focus on the interactions with partial differential equations and nonlinear analysis. It gives a thorough and modern approach to the classical theory and presents important and compelling applications across a spectrum of mathematics: dynamical systems, singular integral operators, inverse problems, the geometry of mappings, and the calculus of variations. It also gives an account of recent advances in harmonic analysis and their applications in the geometric theory of mappings. The book explains that the existence, regularity, and singular set structures for second-order divergence-type equations--the most important class of PDEs in applications--are determined by the mathematics underpinning the geometry, structure, and dimension of fractal sets; moduli spaces of Riemann surfaces; and conformal dynamical systems. These topics are inextricably linked by the theory of quasiconformal mappings. Further, the interplay between them allows the authors to extend classical results to more general settings for wider applicability, providing new and often optimal answers to questions of existence, regularity, and geometric properties of solutions to nonlinear systems in both elliptic and degenerate elliptic settings.

Ginzburg-Landau Vortices

Variational Analysis and Applications

Proceedings of the Princeton Conference on Information Sciences and Systems

Indiana University Mathematics Journal

Introduction to Applicable Mathematics