Elliptic Boundary Value Problems In The Spaces Of Distributions 1st Edition

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Methods and Computer-Assisted Proofs for Partial Differential EquationsNumerical Approximation Methods for Elliptic Boundary Value ProblemsEvolution Equations and Their Applications in Physical and Life SciencesElliptic Boundary Value Problems of Second Order in Piecewise Smooth DomainsStrongly Elliptic Systems and Boundary Integral EquationsElliptic Boundary Value Problems of Second Order in Piecewise Smooth DomainsElliptic Differential EquationsElliptic Problems in Nonsmooth DomainsInequalities and ApplicationsGreen's Functions and Boundary Value ProblemsPolyharmonic Boundary Value ProblemsVariational Methods for Boundary Value Problems for Systems of Elliptic EquationsElliptic Boundary Value Problems and Construction of Lp-Strong Feller Processes with Singular Drift and ReflectionSingularities in Elliptic Boundary Value Problems and Elasticity and Their Connection with Failure InitiationElliptic Boundary Value Problems with Fractional Regularity Data: The First Order ApproachHierarchical Matrices

History of Functional Analysis

In recent years, there has been a great deal of activity in the study of boundary value problems with minimal smoothness assumptions on the coefficients or on the boundary of the domain in question. These problems are of interest both because of their theoretical importance and the implications for applications, and they have turned out to have profound and fascinating connections with many areas of analysis. Techniques from harmonic analysis have proved to be

extremely useful in these studies, both as concrete tools in establishing theorems and as models which suggest what kind of result might be true. Kenig describes these developments and connections for the study of classical boundary value problems on Lipschitz domains and for the corresponding problems for second order elliptic equations in divergence form. He also points out many interesting problems in this area which remain open.

Elliptic Boundary Value Problems in the Spaces of Distributions

Innovative developments in science and technology require a thorough knowledge of applied mathematics, particularly in the field of differential equations and special functions. These are relevant in modeling and computing applications of electromagnetic theory and quantum theory, e.g. in photonics and nanotechnology. The problem of solving partial differential equations remains an important topic that is taught at both the undergraduate and graduate level. Separable Boundary-Value Problems in Physics is an accessible and comprehensive treatment of partial differential equations in mathematical physics in a variety of coordinate systems and geometry and their solutions, including a differential geometric formulation, using the method of separation of variables. With problems and modern examples from the fields of nano-technology and other areas of physics. The fluency of the text and the high quality of graphics make the topic easy accessible. The organization of the content

by coordinate systems rather than by equation types is unique and offers an easy access. The authors consider recent research results which have led to a much increased pedagogical understanding of not just this topic but of many other related topics in mathematical physics, and which like the explicit discussion on differential geometry shows - yet have not been treated in the older texts. To the benefit of the reader, a summary presents a convenient overview on all special functions covered. Homework problems are included as well as numerical algorithms for computing special functions. Thus this book can serve as a reference text for advanced undergraduate students, as a textbook for graduate level courses, and as a self-study book and reference manual for physicists, theoretically oriented engineers and traditional mathematicians.

Boundary Value Problems for Elliptic Systems

Harmonic Analysis Techniques for Second Order Elliptic Boundary Value Problems

The Hodge-Laplacian

Elliptic Boundary Value Problems in Domains with Point Singularities

This EMS volume gives an overview of the modern theory of elliptic boundary value problems, with contributions focusing on differential elliptic boundary problems and their spectral properties, elliptic pseudodifferential operators, and general differential elliptic boundary value problems in domains with singularities.

Lectures on Elliptic Boundary Value Problems

The material of the present book has been used for graduate-level courses at the University of Ia~i during the past ten years. It is a revised version of a book which appeared in Romanian in 1993 with the Publishing House of the Romanian Academy. The book focuses on classical boundary value problems for the principal equations of mathematical physics: second order elliptic equations (the Poisson equations), heat equations and wave equations. The existence theory of second order elliptic boundary value problems was a great challenge for nineteenth century mathematics and its development was marked by two decisive steps. Undoubtedly, the first one was the Fredholm proof in 1900 of the existence of solutions to Dirichlet and Neumann problems, which represented a triumph of the classical theory of partial differential equations. The second step is due to S. 1. Sobolev (1937) who introduced the concept of weak solution in partial differential equations and inaugurated the modern theory of boundary value problems. The classical theory which is a product ofthe nineteenth century, is concerned with smooth

(continuously differentiable) sollutions and its methods rely on classical analysis and in particular on potential theory. The modern theory concerns distributional (weak) solutions and relies on analysis of Sob ole v spaces and functional methods. The same distinction is valid for the boundary value problems associated with heat and wave equations. Both aspects of the theory are present in this book though it is not exhaustive in any sense.

Separable Boundary-Value Problems in Physics

Analytical Solution Methods for Boundary Value Problems is an extensively revised, new English language edition of the original 2011 Russian language work, which provides deep analysis methods and exact solutions for mathematical physicists seeking to model germane linear and nonlinear boundary problems. Current analytical solutions of equations within mathematical physics fail completely to meet boundary conditions of the second and third kind, and are wholly obtained by the defunct theory of series. These solutions are also obtained for linear partial differential equations of the second order. They do not apply to solutions of partial differential equations of the first order and they are incapable of solving nonlinear boundary value problems. Analytical Solution Methods for Boundary Value Problems attempts to resolve this issue, using quasi-linearization methods, operational calculus and spatial variable splitting to identify the exact and approximate analytical solutions of three-dimensional

non-linear partial differential equations of the first and second order. The work does so uniquely using all analytical formulas for solving equations of mathematical physics without using the theory of series. Within this work, pertinent solutions of linear and nonlinear boundary problems are stated. On the basis of quasi-linearization, operational calculation and splitting on spatial variables, the exact and approached analytical solutions of the equations are obtained in private derivatives of the first and second order. Conditions of unequivocal resolvability of a nonlinear boundary problem are found and the estimation of speed of convergence of iterative process is given. On an example of trial functions results of comparison of the analytical solution are given which have been obtained on suggested mathematical technology, with the exact solution of boundary problems and with the numerical solutions on well-known methods. Discusses the theory and analytical methods for many differential equations appropriate for applied and computational mechanics researchers Addresses pertinent boundary problems in mathematical physics achieved without using the theory of series Includes results that can be used to address nonlinear equations in heat conductivity for the solution of conjugate heat transfer problems and the equations of telegraph and nonlinear transport equation Covers select method solutions for applied mathematicians interested in transport equations methods and thermal protection studies Features extensive revisions from the Russian original, with 115+ new pages of new textual content

Boundary Value Problems

The aim of the series is to present new and important developments in pure and applied mathematics. Well established in the community over two decades, it offers a large library of mathematics including several important classics. The volumes supply thorough and detailed expositions of the methods and ideas essential to the topics in question. In addition, they convey their relationships to other parts of mathematics. The series is addressed to advanced readers wishing to thoroughly study the topic. Editorial Board Lev Birbrair, Universidade Federal do Ceará, Fortaleza, Brasil Victor P. Maslov, Russian Academy of Sciences, Moscow, Russia Walter D. Neumann, Columbia University, New York, USA Markus J. Pflaum, University of Colorado, Boulder, USA Dierk Schleicher, Jacobs University, Bremen, Germany

Introductory Numerical Analysis of Elliptic Boundary Value Problems

The core of this monograph is the development of tools to derive well-posedness results in very general geometric settings for elliptic differential operators. A new generation of Calderón-Zygmund theory is developed for variable coefficient singular integral operators, which turns out to be particularly versatile in dealing with boundary value problems for the Hodge-Laplacian on uniformly rectifiable subdomains of Riemannian manifolds via boundary layer methods. In addition to absolute and relative boundary conditions for differential forms, this monograph

treats the Hodge-Laplacian equipped with classical Dirichlet, Neumann, Transmission, Poincaré, and Robin boundary conditions in regular Semmes-Kenig-Toro domains. Lying at the intersection of partial differential equations, harmonic analysis, and differential geometry, this text is suitable for a wide range of PhD students, researchers, and professionals. Contents: Preface Introduction and Statement of Main Results Geometric Concepts and Tools Harmonic Layer Potentials Associated with the Hodge-de Rham Formalism on UR Domains Harmonic Layer Potentials Associated with the Levi-Civita Connection on UR Domains Dirichlet and Neumann Boundary Value Problems for the Hodge-Laplacian on Regular SKT Domains Fatou Theorems and Integral Representations for the Hodge-Laplacian on Regular SKT Domains Solvability of Boundary Problems for the Hodge-Laplacian in the Hodge-de Rham Formalism Additional Results and Applications Further Tools from Differential Geometry, Harmonic Analysis, Geometric Measure Theory, Functional Analysis, Partial Differential Equations, and Clifford Analysis Bibliography Index

Asymptotic Theory of Elliptic Boundary Value Problems in Singularly Perturbed Domains Volume II

Partial Differential Equations IX

This 2000 book provided the first detailed exposition of the mathematical theory of boundary integral

equations of the first kind on non-smooth domains.

Analytical Solution Methods for Boundary Value Problems

This research monograph focusses on a large class of variational elliptic problems with mixed boundary conditions on domains with various corner singularities, edges, polyhedral vertices, cracks, slits. In a natural functional framework (ordinary Sobolev Hilbert spaces) Fredholm and semi-Fredholm properties of induced operators are completely characterized. By specially choosing the classes of operators and domains and the functional spaces used, precise and general results may be obtained on the smoothness and asymptotics of solutions. A new type of characteristic condition is introduced which involves the spectrum of associated operator pencils and some ideals of polynomials satisfying some boundary conditions on cones. The methods involve many perturbation arguments and a new use of Mellin transform. Basic knowledge about BVP on smooth domains in Sobolev spaces is the main prerequisite to the understanding of this book. Readers interested in the general theory of corner domains will find here a new basic theory (new approaches and results) as well as a synthesis of many already known results; those who need regularity conditions and descriptions of singularities for numerical analysis will find precise statements and also a means to obtain further one in many explicit situtations.

Elliptic Problems in Domains with

Piecewise Smooth Boundaries

Factorization Method for Boundary Value Problems by Invariant Embedding presents a new theory for linear elliptic boundary value problems. The authors provide a transformation of the problem in two initial value problems that are uncoupled, enabling you to solve these successively. This method appears similar to the Gauss block factorization of the matrix, obtained in finite dimension after discretization of the problem. This proposed method is comparable to the computation of optimal feedbacks for linear quadratic control problems. Develops the invariant embedding technique for boundary value problems Makes a link between control theory, boundary value problems and the Gauss factorization Presents a new theory for successively solving linear elliptic boundary value problems Includes a transformation in two initial value problems that are uncoupled

Asymptotic Theory of Elliptic Boundary Value Problems in Singularly Perturbed Domains

This monograph systematically treats a theory of elliptic boundary value problems in domains without singularities and in domains with conical or cuspidal points. This exposition is self-contained and a priori requires only basic knowledge of functional analysis. Restricting to boundary value problems formed by differential operators and avoiding the use of pseudo-differential operators makes the book accessible for a wider readership. The authors concentrate on

fundamental results of the theory: estimates for solutions in different function spaces, the Fredholm property of the operator of the boundary value problem, regularity assertions and asymptotic formulas for the solutions near singular points. A special feature of the book is that the solutions of the boundary value problems are considered in Sobolev spaces of both positive and negative orders. Results of the general theory are illustrated by concrete examples. The book may be used for courses in partial differential equations.

Quaternionic Analysis and Elliptic Boundary Value Problems

Elliptic Boundary Value Problems

This volume presents a collection of lectures on linear partial differntial equations and semigroups, nonlinear equations, stochastic evolutionary processes, and evolution problems from physics, engineering and mathematical biology. The contributions come from the 6th International Conference on Evolution Equations and Their Applications in Physica

Nonlinear Parabolic and Elliptic Equations

World Scientific Series in Applicable Analysis (WSSIAA) reports new developments of a high mathematical standard and of current interest. Each volume in the series is devoted to mathematical

analysis that has been applied, or is potentially applicable to the solution of scientific, engineering, and social problems. The third volume of WSSIAA contains 47 research articles on inequalities by leading mathematicians from all over the world and a tribute by R.M. Redheffer to Wolfgang Walter — to whom this volume is dedicated — on his 66th birthday. Contributors: A Acker, J D Aczél, A Alvino, K A Ames, Y Avishai, C Bandle, B M Brown, R C Brown, D Brydak, P S Bullen, K Deimling, J Diaz, Á Elbert, P W Eloe, L H Erbe, H Esser, M Essén, W D Evans, W N Everitt, V Ferone, A M Fink, R Ger, R Girgensohn, P Goetgheluck, W Haussmann, S Heikkilä, J Henderson, G Herzog, D B Hinton, T Horiuchi, S Hu, B Kawohl, V G Kirby; N Kirchhoff, G H Knightly, H W Knobloch, Q Kong, H König, A Kufner, M K Kwong, A Laforgia, V Lakshmikantham, S Leela, R Lemmert, E R Love, G Lüttgens, S Malek, R Manásevich, J Mawhin, R Medina, M Migda, R J Nessel, Z Páles, N S Papageorgiou, L E Payne, J Pe…arif, L E Persson, A Peterson, M Pinto, M Plum, J Popenda, G Porru, R M Redheffer, A A Sagle, S Saitoh, D Sather, K Schmitt, D F Shea, A Simon, S Sivasundaram, R Sperb, C S Stanton, G Talenti, G Trombetti, S Varošanec, A S Vatsala, P Volkmann, H Wang, V Weckesser, F Zanolin, K Zeller, A Zettl. Contents:On Free Boundary Problems for Quasi-Linear Elliptic PDE's: Uniqueness and Monotone Ordering of Convex Solutions (A Acker)Stabilizing the Backward Heat Equation Against Errors in the Initial Time Geometry (K A Ames & L E Payne)Two Integral Inequalities (B M Brown et al.)An Interpolation Inequality and Applications (R C Brown & D B Hinton)On Some Properties of the τ-Modulus (H Esser et al.)Majorization for Functions with Monotone Nth

Derivatives (A M Fink)On First Order Differential Equations in Ordered Banach Spaces (S Heikkilä & V Lakshmikantham)Singular Hopf Bifurcation Problems and Rotating-Sliding Spiral Flows (G H Knightly & D Sather)Two Inequalities Resembling an Inequality of Gabushin (E R Love)Isoperimetric Inequalities in a Boundary Value Problem in an Unbounded Domain (R Sperb)On Functions whose Gradients have a Prescribed Rearrangement (G Talenti)A Free Boundary Value Problem with Strong Adsorption (V Weckesser)and other papers Readership: Applied mathematicians and engineers.
keywords:Inequalities;Festschrift;Tribute

Factorization of Boundary Value Problems Using the Invariant Embedding Method

Praise for the Second Edition "This book is an excellent introduction to the wide field of boundary value problems."—Journal of Engineering Mathematics "No doubt this textbook will be useful for both students and research workers."—Mathematical Reviews A new edition of the highly-acclaimed guide to boundary value problems, now featuring modern computational methods and approximation theory Green's Functions and Boundary Value Problems, Third Edition continues the tradition of the two prior editions by providing mathematical techniques for the use of differential and integral equations to tackle important problems in applied mathematics, the physical sciences, and engineering. This new edition presents mathematical concepts and quantitative

tools that are essential for effective use of modern computational methods that play a key role in the practical solution of boundary value problems. With a careful blend of theory and applications, the authors successfully bridge the gap between real analysis, functional analysis, nonlinear analysis, nonlinear partial differential equations, integral equations, approximation theory, and numerical analysis to provide a comprehensive foundation for understanding and analyzing core mathematical and computational modeling problems. Thoroughly updated and revised to reflect recent developments, the book includes an extensive new chapter on the modern tools of computational mathematics for boundary value problems. The Third Edition features numerous new topics, including: Nonlinear analysis tools for Banach spaces Finite element and related discretizations Best and near-best approximation in Banach spaces Iterative methods for discretized equations Overview of Sobolev and Besov space linear Methods for nonlinear equations Applications to nonlinear elliptic equations In addition, various topics have been substantially expanded, and new material on weak derivatives and Sobolev spaces, the Hahn-Banach theorem, reflexive Banach spaces, the Banach Schauder and Banach-Steinhaus theorems, and the Lax-Milgram theorem has been incorporated into the book. New and revised exercises found throughout allow readers to develop their own problem-solving skills, and the updated bibliographies in each chapter provide an extensive resource for new and emerging research and applications. With its careful balance of mathematics and meaningful applications, Green's Functions and Boundary Value

Problems, Third Edition is an excellent book for courses on applied analysis and boundary value problems in partial differential equations at the graduate level. It is also a valuable reference for mathematicians, physicists, engineers, and scientists who use applied mathematics in their everyday work.

Asymptotic Theory of Elliptic Boundary Value Problems in Singularly Perturbed Domains

Originally published: Boston: Pitman Advanced Pub. Program, 1985.

Approximation of Elliptic Boundary-Value Problems

A co-publication of the AMS and Centre de Recherches Mathématiques In this monograph the authors study the well-posedness of boundary value problems of Dirichlet and Neumann type for elliptic systems on the upper half-space with coefficients independent of the transversal variable and with boundary data in fractional Hardy–Sobolev and Besov spaces. The authors use the so-called “first order approach” which uses minimal assumptions on the coefficients and thus allows for complex coefficients and for systems of equations. This self-contained exposition of the first order approach offers new results with detailed proofs in a clear and accessible way and will become a valuable reference for graduate students and researchers working in partial differential equations and harmonic analysis.

Solving Ordinary and Partial Boundary Value Problems in Science and Engineering

This book provides an elementary, accessible introduction for engineers and scientists to the concepts of ordinary and partial boundary value problems, acquainting readers with fundamental properties and with efficient methods of constructing solutions or satisfactory approximations. Discussions include: ordinary differential equations classical theory of partial differential equations Laplace and Poisson equations heat equation variational methods of solution of corresponding boundary value problems methods of solution for evolution partial differential equations The author presents special remarks for the mathematical reader, demonstrating the possibility of generalizations of obtained results and showing connections between them. For the non-mathematician, the author provides profound functional-analytical results without proofs and refers the reader to the literature when necessary. Solving Ordinary and Partial Boundary Value Problems in Science and Engineering contains essential functional analytical concepts, explaining its subject without excessive abstraction.

Partial Differential Equations and Boundary Value Problems

Benedict Baur presents modern functional analytic methods for construction and analysis of Feller processes in general and diffusion processes in

particular. Topics covered are: Construction of Lp-strong Feller processes using Dirichlet form methods, regularity for solutions of elliptic boundary value problems, construction of elliptic diffusions with singular drift and reflection, Skorokhod decomposition and applications to Mathematical Physics like finite particle systems with singular interaction. Emphasize is placed on the handling of singular drift coefficients, as well as on the discussion of point wise and path wise properties of the constructed processes rather than just the quasi-everywhere properties commonly known from the general Dirichlet form theory.

Elliptic Boundary Value Problems on Corner Domains

A brilliant monograph, directed to graduate and advanced-undergraduate students, on the theory of boundary value problems for analytic functions and its applications to the solution of singular integral equations with Cauchy and Hilbert kernels. With exercises.

Numerical Verification Methods and Computer-Assisted Proofs for Partial Differential Equations

Hierarchical matrices are an efficient framework for large-scale fully populated matrices arising, e.g., from the finite element discretization of solution operators of elliptic boundary value problems. In addition to storing such matrices, approximations of the usual matrix operations can be computed with logarithmic-

linear complexity, which can be exploited to setup approximate preconditioners in an efficient and convenient way. Besides the algorithmic aspects of hierarchical matrices, the main aim of this book is to present their theoretical background. The book contains the existing approximation theory for elliptic problems including partial differential operators with nonsmooth coefficients. Furthermore, it presents in full detail the adaptive cross approximation method for the efficient treatment of integral operators with non-local kernel functions. The theory is supported by many numerical experiments from real applications.

Numerical Approximation Methods for Elliptic Boundary Value Problems

The book contains a systematic treatment of the qualitative theory of elliptic boundary value problems for linear and quasilinear second order equations in non-smooth domains. The authors concentrate on the following fundamental results: sharp estimates for strong and weak solutions, solvability of the boundary value problems, regularity assertions for solutions near singular points. Key features: * New the Hardy – Friedrichs – Wirtinger type inequalities as well as new integral inequalities related to the Cauchy problem for a differential equation. * Precise exponents of the solution decreasing rate near boundary singular points and best possible conditions for this. * The question about the influence of the coefficients smoothness on the regularity of solutions. * New existence theorems for the Dirichlet problem for linear and quasilinear equations in domains with conical

points. * The precise power modulus of continuity at singular boundary point for solutions of the Dirichlet, mixed and the Robin problems. * The behaviour of weak solutions near conical point for the Dirichlet problem for m – Laplacian. * The behaviour of weak solutions near a boundary edge for the Dirichlet and mixed problem for elliptic quasilinear equations with triple degeneration. * Precise exponents of the solution decreasing rate near boundary singular points and best possible conditions for this. * The question about the influence of the coefficients smoothness on the regularity of solutions. * New existence theorems for the Dirichlet problem for linear and quasilinear equations in domains with conical points. * The precise power modulus of continuity at singular boundary point for solutions of the Dirichlet, mixed and the Robin problems. * The behaviour of weak solutions near conical point for the Dirichlet problem for m - Laplacian. * The behaviour of weak solutions near a boundary edge for the Dirichlet and mixed problem for elliptic quasilinear equations with triple degeneration.

Evolution Equations and Their Applications in Physical and Life Sciences

This volume endeavours to summarise all available data on the theorems on isomorphisms and their ever increasing number of possible applications. It deals with the theory of solvability in generalised functions of general boundary-value problems for elliptic equations. In the early sixties, Lions and Magenes,

and Berezansky, Krein and Roitberg established the theorems on complete collection of isomorphisms. Further progress of the theory was connected with proving the theorem on complete collection of isomorphisms for new classes of problems, and hence with the development of new methods to prove these theorems. The theorems on isomorphisms were first established for elliptic equations with normal boundary conditions. However, after the Noetherian property of elliptic problems was proved without assuming the normality of the boundary expressions, this became the natural way to consider the problems of establishing the theorems on isomorphisms for general elliptic problems. The present author's method of solving this problem enabled proof of the theorem on complete collection of isomorphisms for the operators generated by elliptic boundary-value problems for general systems of equations. Audience: This monograph will be of interest to mathematicians whose work involves partial differential equations, functional analysis, operator theory and the mathematics of mechanics.

Elliptic Boundary Value Problems of Second Order in Piecewise Smooth Domains

In response to the growing use of reaction diffusion problems in many fields, this monograph gives a systematic treatment of a class of nonlinear parabolic and elliptic differential equations and their applications these problems. It is an important reference for mathematicians and engineers, as well

as a practical text for graduate students.

Strongly Elliptic Systems and Boundary Integral Equations

This book, which is a new edition of a book originally published in 1965, presents an introduction to the theory of higher-order elliptic boundary value problems. The book contains a detailed study of basic problems of the theory, such as the problem of existence and regularity of solutions of higher-order elliptic boundary value problems. It also contains a study of spectral properties of operators associated with elliptic boundary value problems. Weyl's law on the asymptotic distribution of eigenvalues is studied in great generality.

Elliptic Boundary Value Problems of Second Order in Piecewise Smooth Domains

The theory of boundary value problems for elliptic systems of partial differential equations has many applications in mathematics and the physical sciences. The aim of this book is to "algebraize" the index theory by means of pseudo-differential operators and new methods in the spectral theory of matrix polynomials. This latter theory provides important tools that will enable the student to work efficiently with the principal symbols of the elliptic and boundary operators on the boundary. Because many new methods and results are introduced and used throughout the book, all the theorems are

proved in detail, and the methods are well illustrated through numerous examples and exercises. This book is ideal for use in graduate level courses on partial differential equations, elliptic systems, pseudo-differential operators, and matrix analysis.

Elliptic Differential Equations

A famous monograph with an innovative approach to classical boundary value problems, using the general basic scheme for the solution of variational problems first suggested by Hilbert and developed by Tonnelli. Directed to both mathematicians and theoreticians in mechanics.

Elliptic Problems in Nonsmooth Domains

The book offers a simultaneous presentation of the theory and of the numerical treatment of elliptic problems. The author starts with a discussion of the Laplace equation in the classical formulation and its discretisation by finite differences and deals with topics of gradually increasing complexity in the following chapters. He introduces the variational formulation of boundary value problems together with the necessary background from functional analysis and describes the finite element method including the most important error estimates. A more advanced chapter leads the reader into the theory of regularity. The reader will also find more details about the discretisation of singularly perturbed equations and eigenvalue problems. The author discusses the Stokes problem as an example of a saddle point problem

taking into account its relevance to applications in fluid dynamics.

Inequalities and Applications

This book presents a unified theory of the Finite Element Method and the Boundary Element Method for a numerical solution of second order elliptic boundary value problems. This includes the solvability, stability, and error analysis as well as efficient methods to solve the resulting linear systems. Applications are the potential equation, the system of linear elastostatics and the Stokes system. While there are textbooks on the finite element method, this is one of the first books on Theory of Boundary Element Methods. It is suitable for self study and exercises are included.

Green's Functions and Boundary Value Problems

A marriage of the finite-differences method with variational methods for solving boundary-value problems, the finite-element method is superior in many ways to finite-differences alone. This self-contained text for advanced undergraduates and graduate students is intended to imbed this combination of methods into the framework of functional analysis and to explain its applications to approximation of nonhomogeneous boundary-value problems for elliptic operators. The treatment begins with a summary of the main results established in the book. Chapter 1 introduces the variational method

and the finite-difference method in the simple case of second-order differential equations. Chapters 2 and 3 concern abstract approximations of Hilbert spaces and linear operators, and Chapters 4 and 5 study finite-element approximations of Sobolev spaces. The remaining four chapters consider several methods for approximating nonhomogeneous boundary-value problems for elliptic operators.

Polyharmonic Boundary Value Problems

This introductory and self-contained book gathers as much explicit mathematical results on the linear-elastic and heat-conduction solutions in the neighborhood of singular points in two-dimensional domains, and singular edges and vertices in three-dimensional domains. These are presented in an engineering terminology for practical usage. The author treats the mathematical formulations from an engineering viewpoint and presents high-order finite-element methods for the computation of singular solutions in isotropic and anisotropic materials, and multi-material interfaces. The proper interpretation of the results in engineering practice is advocated, so that the computed data can be correlated to experimental observations. The book is divided into fourteen chapters, each containing several sections. Most of it (the first nine Chapters) addresses two-dimensional domains, where only singular points exist. The solution in a vicinity of these points admits an asymptotic expansion composed of eigenpairs and associated generalized flux/stress intensity factors (GFIFs/GSIFs), which are being computed analytically

when possible or by finite element methods otherwise. Singular points associated with weakly coupled thermoelasticity in the vicinity of singularities are also addressed and thermal GSIFs are computed. The computed data is important in engineering practice for predicting failure initiation in brittle material on a daily basis. Several failure laws for two-dimensional domains with V-notches are presented and their validity is examined by comparison to experimental observations. A sufficient simple and reliable condition for predicting failure initiation (crack formation) in micron level electronic devices, involving singular points, is still a topic of active research and interest, and is addressed herein. Explicit singular solutions in the vicinity of vertices and edges in three-dimensional domains are provided in the remaining five chapters. New methods for the computation of generalized edge flux/stress intensity functions along singular edges are presented and demonstrated by several example problems from the field of fracture mechanics; including anisotropic domains and bimaterial interfaces. Circular edges are also presented and the author concludes with some remarks on open questions. This well illustrated book will appeal to both applied mathematicians and engineers working in the field of fracture mechanics and singularities.

Variational Methods for Boundary Value Problems for Systems of Elliptic Equations

For the first time in the mathematical literature, this

two-volume work introduces a unified and general approach to the subject. To a large extent, the book is based on the authors' work, and has no significant overlap with other books on the theory of elliptic boundary value problems.

Elliptic Boundary Value Problems and Construction of Lp-Strong Feller Processes with Singular Drift and Reflection

History of Functional Analysis presents functional analysis as a rather complex blend of algebra and topology, with its evolution influenced by the development of these two branches of mathematics. The book adopts a narrower definition—one that is assumed to satisfy various algebraic and topological conditions. A moment of reflections shows that this already covers a large part of modern analysis, in particular, the theory of partial differential equations. This volume comprises nine chapters, the first of which focuses on linear differential equations and the Sturm-Liouville problem. The succeeding chapters go on to discuss the ""crypto-integral"" equations, including the Dirichlet principle and the Beer-Neumann method; the equation of vibrating membranes, including the contributions of Poincare and H.A. Schwarz's 1885 paper; and the idea of infinite dimension. Other chapters cover the crucial years and the definition of Hilbert space, including Fredholm's discovery and the contributions of Hilbert; duality and the definition of normed spaces, including the Hahn-Banach theorem and the method of the

gliding hump and Baire category; spectral theory after 1900, including the theories and works of F. Riesz, Hilbert, von Neumann, Weyl, and Carleman; locally convex spaces and the theory of distributions; and applications of functional analysis to differential and partial differential equations. This book will be of interest to practitioners in the fields of mathematics and statistics.

Singularities in Elliptic Boundary Value Problems and Elasticity and Their Connection with Failure Initiation

The book contains a systematic treatment of the qualitative theory of elliptic boundary value problems for linear and quasilinear second order equations in non-smooth domains. The authors concentrate on the following fundamental results: sharp estimates for strong and weak solutions, solvability of the boundary value problems, regularity assertions for solutions near singular points. Key features: * New the Hardy – Friedrichs – Wirtinger type inequalities as well as new integral inequalities related to the Cauchy problem for a differential equation. * Precise exponents of the solution decreasing rate near boundary singular points and best possible conditions for this. * The question about the influence of the coefficients smoothness on the regularity of solutions. * New existence theorems for the Dirichlet problem for linear and quasilinear equations in domains with conical points. * The precise power modulus of continuity at singular boundary point for solutions of the Dirichlet, mixed and the Robin problems. * The behaviour of

weak solutions near conical point for the Dirichlet problem for m – Laplacian. * The behaviour of weak solutions near a boundary edge for the Dirichlet and mixed problem for elliptic quasilinear equations with triple degeneration. * Precise exponents of the solution decreasing rate near boundary singular points and best possible conditions for this. * The question about the influence of the coefficients smoothness on the regularity of solutions. * New existence theorems for the Dirichlet problem for linear and quasilinear equations in domains with conical points. * The precise power modulus of continuity at singular boundary point for solutions of the Dirichlet, mixed and the Robin problems. * The behaviour of weak solutions near conical point for the Dirichlet problem for m - Laplacian. * The behaviour of weak solutions near a boundary edge for the Dirichlet and mixed problem for elliptic quasilinear equations with triple degeneration.

Elliptic Boundary Value Problems with Fractional Regularity Data: The First Order Approach

In the last decades, various mathematical problems have been solved by computer-assisted proofs, among them the Kepler conjecture, the existence of chaos, the existence of the Lorenz attractor, the famous four-color problem, and more. In many cases, computer-assisted proofs have the remarkable advantage (compared with a “theoretical” proof) of additionally providing accurate quantitative information. The authors have been working more

than a quarter century to establish methods for the verified computation of solutions for partial differential equations, mainly for nonlinear elliptic problems of the form $-\Delta u=f(x,u,\nabla u)$ with Dirichlet boundary conditions. Here, by “verified computation” is meant a computer-assisted numerical approach for proving the existence of a solution in a close and explicit neighborhood of an approximate solution. The quantitative information provided by these techniques is also significant from the viewpoint of a posteriori error estimates for approximate solutions of the concerned partial differential equations in a mathematically rigorous sense. In this monograph, the authors give a detailed description of the verified computations and computer-assisted proofs for partial differential equations that they developed. In Part I, the methods mainly studied by the authors Nakao and Watanabe are presented. These methods are based on a finite dimensional projection and constructive a priori error estimates for finite element approximations of the Poisson equation. In Part II, the computer-assisted approaches via eigenvalue bounds developed by the author Plum are explained in detail. The main task of this method consists of establishing eigenvalue bounds for the linearization of the corresponding nonlinear problem at the computed approximate solution. Some brief remarks on other approaches are also given in Part III. Each method in Parts I and II is accompanied by appropriate numerical examples that confirm the actual usefulness of the authors’ methods. Also in some examples practical computer algorithms are supplied so that readers can easily implement the verification programs by themselves.

Hierarchical Matrices

This accessible monograph covers higher order linear and nonlinear elliptic boundary value problems in bounded domains, mainly with the biharmonic or poly-harmonic operator as leading principal part. It provides rapid access to recent results and references.