Mathematical Physics With Partial Differential Equations

This book consists of contributions originating from a conference in Obedo, Portugal, which honoured the 70th birthday of V.A. Solonnikov. A broad variety of topics centering on nonlinear problems is presented, particularly Navier-Stokes equations, viscosity problems, diffusion-absorption equations, free boundaries, and Euler equations.

Mathematical Physics with Partial Differential Equations, Second Edition, is designed for upper division undergraduate and beginning graduate students taking mathematical physics taught out by math departments. The new edition is based on the success of the first, with a continuing focus on clear presentation, detailed examples, mathematical rigor and a careful selection of topics. It presents the familiar classical topics and methods of mathematical physics with more extensive coverage of the three most important partial differential equations in the field of mathematical physics—the heat equation, the wave equation and Laplace's equation. The book presents the most common techniques of solving these equations, and their derivations are developed in detail for a deeper understanding of mathematical applications. Unlike many physics-leaning mathematical physics books on the market, this work is heavily rooted in math, making the book more appealing for students wanting to progress in mathematical physics, with particularly deep coverage of Green's functions, the Fourier transform, and the Laplace transform. A salient characteristic is the focus on fewer topics but at a far more rigorous level of detail than comparable undergraduate-facing textbooks. The depth of some of these topics, such as the Dirac-delta distribution, is not matched elsewhere. New features in this edition include: novel and illustrative examples from physics including the 1-dimensional quantum mechanical oscillator, the hydrogen atom and the rigid rotor model; chapter-length discussion of relevant functions, including the Hermite polynomials, Legendre polynomials, Laguerre polynomials and Bessel functions; and all-new focus on complex examples only solvable by multiple methods. Introduces and evaluates numerous physical and engineering concepts in a rigorous mathematical framework Provides extremely detailed mathematical derivations and solutions with extensive proofs and weighting for application potential Explores an array of detailed examples from physics that give direct application to rigorous mathematics Offers instructors useful resources for teaching, including an illustrated instructor's manual, PowerPoint presentations in each chapter and a solutions manual

Covers the theory of boundary value problems in partial differential equations and discusses a portion of the theory from a unifying point of view while providing an introduction to each branch of its applications. 1953 edition.

This book covers a diverse range of topics in Mathematical Physics, linear and nonlinear PDEs. Though the text reflects the classical theory, the main emphasis is on introducing readers to the latest developments based on the notions of weak solutions and Sobolev spaces. In numerous problems, the student is asked to prove a given statement, e.g. to show the existence of a solution to a certain PDE. Usually there is no closed-formula answer available, which is why there is no answer section, although helpful hints are often provided. This textbook offers a valuable asset for students and educators alike. As it adopts a perspective on PDEs that is neither too theoretical nor too practical, it represents the perfect companion to a broad spectrum of courses.

A classic treatise on partial differential equations, this comprehensive work by one of America's greatest early mathematical physicists covers the basic method, theory, and application of partial differential equations. In addition to its value as an introductory and supplementary text for students, this volume constitutes a fine reference for mathematicians, physicists, and research engineers. Detailed coverage includes Fourier series; integral and elliptic equations; spherical, cylindrical, and ellipsoidal harmonics; Cauchy's method; boundary problems; the Riemann-Volterra method; and many other basic topics. The self-contained treatment fully develops the theory and application of partial differential equations to virtually every relevant field: vibration, elasticity, potential theory, the theory of sound, wave propagation, heat conduction, and many more. A helpful Appendix provides background on Jacobians, double limits, uniform convergence, definite integrals, complex variables, and linear differential equations.

The topic with which I regularly conclude my six-term series of lectures in Munich is the partial differential equations of physics. We do not really deal with mathematical physics, but with physical mathematics; not with the mathematical formulation of physical facts, but with the physical motivation of mathematical methods. The oftmentioned "prestabilized harmony between what is mathematically interesting and what is physically important is met at each step and lends an esthetic - I should like to say metaphysical -- attraction to our subject. The problems to be treated belong mainly to the classical matherhatical literature, as shown by their connection with the names of Laplace, Fourier, Green, Gauss, Riemann, and William Thomson. In order to show that these methods are adequate to deal with actual problems, we treat the propagation of radio waves in some detail in Chapter VI.

During the days 14-18 of October 1991, we had the pleasure of attending a most interesting Conference on New Developments in Partial Differential Equations and Applications to Mathematical Physics in Ferrarra. The Conference was organized within the Scientific Program celebrating the six hundredth birthday of the University of Ferrarra and, after the many stimulating lectures and fruitful discussions, we may certainly conclude, together with the numerous participants, that it has represented a big success. The Conference would not have been possible without the financial support of several sources. In this respect, we are particularly grateful to the Comitato Organizzatore del VI Centenario, the University of Ferrarra in the Office of the Rector, Professor Antonio Rossi, the Consiglio Nationale delle Ricerche, and the Department of Mathematics of the University of Ferrarra. We should like to thank all of the partlClpants and the speakers, and we are especially grateful to those who have contributed to the present volume. G. Buttazzo, University of Pisa G.P. Galdi, University of Ferrarra L. Zanghirati, University of Ferrarra Ferrarra, May 11 th, 1992 v CONTENTS INVITED LECTURES Liapunov Functionals and Qualitative Behaviour of the Solution to the Nonlinear Enskog Equation ...

Useful treatment of classical mechanics, electromagnetic theory, and relativity includes explanations of function theory, vectors, matrices, dyadics, tensors, partial differential equations, other advanced mathematical techniques. Nearly 200 problems with answers.

This volume consists of the proceedings of the conference on Physical Mathematics and Nonlinear Partial Differential Equations held at West Virginia University in Morgantown. It describes some work dealing with weak limits of solutions to nonlinear systems of partial differential equations.

Stochastic Partial Differential Equations analyzes mathematical models of time-dependent physical phenomena on microscopic, macroscopic and mesoscopic levels. It provides a rigorous derivation of each level from the preceding one and examines the resulting mesoscopic equations in detail. Coverage first describes the transition from the microscopic equations to the mesoscopic equations. It then covers a general system for the positions of the large particles.

Outstanding, wide-ranging material on classification and reduction to canonical form of second-order differential equations; hyperbolic, parabolic, elliptic equations, more. Bibliography.

Functional analysis is a well-established powerful method in mathematical physics, especially those mathematical methods used in modern non-perturbative quantum field theory and statistical turbulence. This book presents a unique, modern treatment of solutions to fractional random differential equations in mathematical physics. It follows an analytic approach in applied functional analysis for functional integration in quantum physics and stochastic Langevin?turbulent partial differential equations.

This book is a text on partial differential equations (PDEs) of mathematical physics and boundary value problems, trigonometric Fourier series, and special functions. This is the core content of many courses in the fields of engineering, physics, mathematics, and applied mathematics. The accompanying software provides a laboratory environment that allows the user to generate and model different physical situations and learn by experimentation. From this standpoint, the book along with the software can also be used as a reference book on PDEs, Fourier series and special functions for students and professionals alike.

Presents the state of the art in PDEs, including the latest research and short courses accessible to graduate students.

This book is designed as an introduction to the mathematical concepts used to describe fundamental physics principles. Numerous examples and applications enable the reader to master complex mathematical concepts needed to define topics such as relativity, mechanics, and electromagnetics. Features: • Covers all of the mathematical concepts needed to study physics • Includes applications in every chapter • Instructor ancillaries for use as a textbook

Partial Differential Equations of Mathematical Physics emphasizes the study of second-order partial differential equations of mathematical physics, which is deemed as the foundation of investigations into waves, heat conduction, hydrodynamics, and other physical problems. The book discusses in detail a wide spectrum of topics related to partial differential equations, such as the theories of sets and of Lebesgue integration, integral equations, Green's function, and the proof of the Fourier method. Theoretical physicists, experimental physicists, mathematicians engaged in pure and applied mathematics, and researchers will benefit greatly from this book.

Pure and Applied Mathematics, Volume 56: Partial Differential Equations of Mathematical Physics provides a collection of lectures related to the partial differentiation of mathematical physics. This book covers a variety of topics, including waves, heat conduction, hydrodynamics, and other physical problems. Comprised of 30 lectures, this book begins with an overview of the theory of the equations of mathematical physics that has its object the study of the integral, differential, and functional equations describing various natural phenomena. This text then examines the linear equations of the second order with real coefficients. Other lectures consider the Lebesgue–Fubini theorem on the possibility of changing the order of integration in a multiple integral. This book discusses as well the Dirichlet problem and the Neumann problem for domains other than a sphere or half-space. The final lecture deals with the properties of spherical functions. This book is a valuable resource for mathematicians.

The book's combination of mathematical comprehensiveness and natural scientific motivation represents a step forward in the presentation of the classical theory of PDEs.

In this monograph, the authors present some powerful methods for dealing with singularities in elliptic and parabolic partial differential inequalities. Here, the authors take the unique approach of investigating differential inequalities rather than equations, the reason being that the simplest way to study an equation is often to study a corresponding inequality; for example, using sub and superharmonic functions to study harmonic functions. Another unusual feature of the present book is that it is based on integral representation formulae and nonlinear potentials, which have not been widely investigated so far. This approach can also be used to tackle higher order differential equations. The book will appeal to graduate students interested in analysis, researchers in pure and applied mathematics, and engineers who work with partial differential equations. Readers will require only a basic knowledge of functional analysis, measure theory and Sobolev spaces.

This text provides an introduction to the applications and implementations of partial differential equations. The content is structured in three progressive levels which are suited for upper–level undergraduates with background in multivariable calculus and elementary linear algebra (chapters 1–5), first– and second–year graduate students who have taken advanced calculus and real analysis (chapters 6-7), as well as doctoral-level students with an understanding of linear and nonlinear functional analysis (chapters 7-8) respectively. Level one gives readers a full exposure to the fundamental linear partial differential equations of physics. It details methods to understand and solve these equations leading ultimately to solutions of Maxwell’s equations. Level two addresses nonlinearity and provides examples of separation of variables, linearizing change of variables, and the inverse scattering transform for select nonlinear partial differential equations. Level three presents rich sources of advanced techniques and strategies for the study of nonlinear partial differential equations, including unique and previously unpublished results. Ultimately the text aims to familiarize readers in applied mathematics, physics, and engineering with some of the myriad techniques that have been developed to model and solve linear and nonlinear partial differential equations.

Mathematical Physics with Partial Differential EquationsAcademic Press

Separation of Variables and Exact Solutions to Nonlinear PDEs is devoted to describing and applying methods of generalized and functional separation of variables used to find exact solutions of nonlinear partial differential equations (PDEs). It also presents the direct method of symmetry reductions and its more general version. In addition, the authors describe the differential constraint method, which generalizes many other exact methods. The presentation involves numerous examples of utilizing the methods to find exact solutions to specific nonlinear equations of mathematical physics. The equations of heat and mass transfer, wave theory, hydrodynamics, nonlinear optics, combustion theory, chemical technology, biology, and other disciplines are studied. Particular attention is paid to nonlinear equations of a reasonably general form that depend on one or several arbitrary functions. Such equations are the most difficult to analyze. Their exact solutions are of significant practical interest, as they are suitable to assess the accuracy of various approximate analytical and numerical methods. The book contains new material previously unpublished in monographs. It is intended for a broad audience of scientists, engineers, instructors, and students specializing in applied and computational mathematics, theoretical physics, mechanics, control theory, chemical engineering science, and other disciplines. Individual sections of the book and examples are suitable for lecture courses on partial differential equations, equations of mathematical physics, and methods of mathematical physics, for delivering special courses and for practical training.

This text provides an introduction to the theory of partial differential equations. It introduces basic examples of partial differential equations, arising in continuum mechanics, electromagnetism, complex analysis and other areas, and develops a number of tools for their solution, including particularly Fourier analysis, distribution theory, and Sobolev spaces. These tools are applied to the treatment of basic problems in linear PDE, including the Laplace equation, heat equation, and wave equation, as well as more general elliptic, parabolic, and hyperbolic equations. Companion texts, which take the theory of partial differential equations further, are AMS volume 116, treating more advanced topics in linear PDE, and AMS volume 117, treating problems in nonlinear PDE. This book is addressed to graduate students in mathematics and to professional mathematicians, with an interest in partial differential equations, mathematical physics, differential geometry, harmonic analysis, and complex analysis.

Partial Differential Equations for Mathematical Physicists is intended for graduate students, researchers of theoretical physics and applied mathematics, and professionals who want to take a course in partial differential equations. This book offers the essentials of the subject with the prerequisite being only an elementary knowledge of introductory calculus, ordinary differential equations, and certain aspects of classical mechanics. We have stressed more the methodologies of partial differential equations and how they can be implemented as tools for extracting their solutions rather than dwelling on the foundational aspects. After covering some basic material, the book proceeds to focus mostly on the three main types of second order linear equations, namely those belonging to the elliptic, hyperbolic, and parabolic classes. For such equations a detailed treatment is given of the derivation of Green's functions, and of the roles of characteristics and techniques required in handling the solutions with the expected amount of rigor. In this regard we have discussed at length the method of separation variables, application of Green's function technique, and employment of Fourier and Laplace's transforms. Also collected in the appendices are some useful results from the Dirac delta function, Fourier transform, and Laplace transform meant to be used as supplementary materials to the text. A good number of problems is worked out and an equally large number of exercises has been appended at the end of each chapter keeping in mind the needs of the students. It is expected that this book will provide a systematic and unitary coverage of the basics of partial differential equations. Key Features An adequate and substantive exposition of the subject. Covers a wide range of important topics. Maintains mathematical rigor throughout. Organizes materials in a self-contained way with each chapter ending with a summary. Contains a large number of worked out problems.

DIVThorough, rigorous advanced-undergraduate to graduate-level treatment of problems leading to partial differential equations. Hyperbolic, parabolic, elliptic equations; wave propagation in space, heat conduction in space, more. Problems. Appendixes. /div

?This book presents a concise introduction to a unified Hilbert space approach to the mathematical modelling of physical phenomena which has been developed over recent years by Picard and his co-workers. The main focus is on time-dependent partial differential equations with a particular structure in the Hilbert space setting that ensures well-posedness and causality, two essential properties of any reasonable model in mathematical physics or engineering.However, the application of the theory to other types of equations is also demonstrated. By means of illustrative examples, from the straightforward to the more complex, the authors show that many of the classical models in mathematical physics as well as more recent models of novel materials and interactions are covered, or can be restructured to be covered, by this unified Hilbert space approach. The reader should require only a basic foundation in the theory of Hilbert spaces and operators therein. For convenience, however, some of the more technical background requirements are covered in detail in two appendices The theory is kept as elementary as possible, making the material suitable for a senior undergraduate or master's level course. In addition, researchers in a variety of fields whose work involves partial differential equations and applied operator theory will also greatly benefit from this approach to structuring their mathematical models in order that the general theory can be applied to ensure the essential properties of well-posedness and causality.

Superb treatment for math and physical science students discusses modern mathematical techniques for setting up and analyzing problems. Discusses partial differential equations of the 1st order, elementary modeling, potential theory, parabolic equations, more. 1988 edition.

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.

Transmutations, Singular and Fractional Differential Equations with Applications to Mathematical Physics connects difficult problems with similar more simple ones. The book's strategy works for differential and integral equations and systems and for many theoretical and applied problems in mathematics, mathematical physics, probability and statistics, applied computer science and numerical methods. In addition to being exposed to recent advances, readers learn to use transmutation methods not only as practical tools, but also as vehicles that deliver theoretical insights. Presents the universal transmutation method as the most powerful for solving many problems in mathematics, mathematical physics, probability and statistics, applied computer science and numerical methods Combines mathematical rigor with an illuminating exposition full of historical notes and fascinating details Enables researchers, lecturers and students to find material under the single "roof"

Since the first volume of this work came out in Germany in 1937, this book, together with its first volume, has remained standard in the field. Courant and Hilbert's treatment restores the historically deep connections between physical intuition and mathematical development, providing the reader with a unified approach to mathematical physics. The present volume represents Richard Courant's final revision of 1961.

This work has been selected by scholars as being culturally important and is part of the knowledge base of civilization as we know it. This work is in the public domain in the United States of America, and possibly other nations. Within the United States, you may freely copy and distribute this work, as no entity (individual or corporate) has a copyright on the body of the work. Scholars believe, and we concur, that this work is important enough to be preserved, reproduced, and made generally available to the public. To ensure a quality reading experience, this work has been proofread and republished using a format that seamlessly blends the original graphical elements with text in an easy-to-read typeface. We appreciate your support of the preservation process, and thank you for being an important part of keeping this knowledge alive and relevant.

The third of three volumes on partial differential equations, this is devoted to nonlinear PDE. It treats a number of equations of classical continuum mechanics, including relativistic versions, as well as various equations arising in differential geometry, such as in the study of minimal surfaces, isometric imbedding, conformal deformation, harmonic maps, and prescribed Gauss curvature. In addition, some nonlinear diffusion problems are studied. It also introduces such analytical tools as the theory of L Sobolev spaces, H lder spaces, Hardy spaces, and Morrey spaces, and also a development of Calderon-Zygmund theory and paradifferential operator calculus. The book is aimed at graduate students in mathematics, and at professional mathematicians with an interest in partial differential equations, mathematical physics, differential geometry, harmonic analysis and complex analysis