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Partial Differential Equations
Analysis, Qualitative Theory and Control
Nonlinear Equations
Initial Value Problems
From Modelling to Theory
A textbook on Ordinary Differential Equations
Dynamic Data Analysis
Differential Equations: Methods and Applications
Numerical Approximation of Partial Differential Equations
Stochastic Differential Equations
Differential Equations
An Introduction to Applied Mathematics
Partial Differential Equations III

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MARELI SELAH

Stiff and Differential - Algebraic Problems

Springer Science & Business Media
The book is intended as an advanced undergraduate or first-year

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

A History of Differential Equations to 1900 Springer This is the practical introduction to the analytical approach taken in Volume 2. Based upon courses in partial differential equations over the last two decades, the text covers the classic canonical equations, with the method of separation of variables introduced at an early stage. The characteristic method for first order equations acts as an introduction to the classification of second order quasi-linear problems by characteristics. Attention then moves to different co-ordinate systems, primarily those with cylindrical or spherical symmetry. Hence a discussion of special functions arises quite naturally, and in each case the major properties are derived. The next section deals with the use of integral transforms and extensive methods for inverting them, and concludes with links to the use of Fourier series.

Elliptic Partial Differential Equations of Second Order Springer Science & Business Media
This modern take on partial differential equations does not require knowledge beyond vector calculus and linear algebra. The author focuses on the most important classical partial differential equations, including conservation equations and

their characteristics , the wave equation, the heat equation, function spaces, and Fourier series, drawing on tools from analysis only as they arise. Within each section the author creates a narrative that answers the five questions: What is the scientific problem we are trying to understand? How do we model that with PDE? What techniques can we use to analyze the PDE? How do those techniques apply to this equation? What information or insight did we obtain by developing and analyzing the PDE? The text stresses the interplay between modeling and mathematical analysis, providing a thorough source of problems and an inspiration for the development of methods.

Ordinary Differential Equations Springer

This textbook is designed for the intermediate-level course on ordinary differential equations offered at many universities and colleges. It treats, as standard topics of such a course: existence and uniqueness theory, linear s- terns, stability theory, and introductory phase-plane analysis of autonomous second order systems. The unique feature of the book is its further inc- sion of a substantial introduction to delay differential eq- tions. Such equations are motivated by problems in control theory, physics, biology, ecology, economics, inventory c- trol, and the theory of nuclear reactors. The surge of interest in delay differential equations during the past two or three decades is evidenced by th- sands of research papers on the subject and about 20 published books devoted in whole or in part to these equations. The v * ... books include those of Myskis [1951], El' sgol' c [1955] and [1964], Pinney [1958], Krasovskil [1959], Bellman and Cooke [1963], Norkin [1965], Halanay [1966], Oguztoreli [1966], Lakshmikantham and Leela [1969], Mitropol'skir and Martynjuk [1969], Martynjuk [1971], and Hale [1971], plus a number of symposium and seminar proceedings published in the U.S. and the U.S.S.R. These books have influenced the present textbook.

Differential Equations Springer Science & Business Media

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

Change and Variations

Springer Differential EquationsSpringer

An Introduction

Springer Science & Business Media

This textbook is designed for a one year course covering the fundamentals of partial differential equations, geared towards advanced undergraduates and beginning graduate students in mathematics, science, engineering, and elsewhere. The exposition carefully balances solution techniques, mathematical rigor, and significant applications, all illustrated by numerous examples. Extensive exercise sets appear at the end of almost every subsection, and include straightforward computational problems to develop and reinforce new techniques and results, details on theoretical developments and proofs, challenging projects both computational and conceptual, and supplementary material that motivates the student to delve further into the subject. No previous experience with the subject of partial differential equations or Fourier theory is assumed, the main prerequisites being undergraduate calculus, both one- and multi-variable, ordinary differential equations, and basic linear algebra. While the classical topics of separation of variables, Fourier analysis, boundary value problems, Green's functions, and special functions continue to form the core of an introductory course, the inclusion of nonlinear equations, shock wave dynamics, symmetry and similarity, the Maximum Principle, financial models, dispersion and solutions, Huygens' Principle, quantum mechanical systems, and more make this text well attuned to recent developments and trends in this active field of contemporary research. Numerical approximation schemes are an important component of any introductory course, and the text covers the two most basic approaches: finite differences and finite elements. Progress in Partial Differential Equations Springer Science & Business Media This book presents a history of differential equations, both ordinary and partial, as well as the calculus of variations, from the origins of the subjects to around 1900. Topics treated include the wave equation in the hands of d'lembert and Euler; Fourier solutions to the heat equation and the contribution of Kovalevskaya; the work of Euler, Gauss, Kummer, Riemann, and Poincaré on the hypergeometric equation; Green's functions, the Dirichlet principle, and Schwarz's solution of the Dirichlet problem; minimal surfaces; the telegraphists' equation and Thomson's successful design of the trans-Atlantic cable; Riemann's paper on shock waves; the geometrical interpretation of mechanics; and aspects of the study of the calculus of variations from the problems of the catenary and the brachistochrone to attempts at a rigorous theory by Weierstrass, Kneser, and Hilbert. Three final chapters look at how the theory of partial differential equations stood around 1900, as they were treated by Picard and Hadamard. There are also extensive, new translations of original papers by Cauchy, Riemann, Schwarz, Darboux, and Picard. The first book to cover the history of differential equations and the calculus of variations in such breadth and detail, it will appeal to anyone with an interest in the field. Beyond secondary school mathematics and physics, a course in mathematical analysis is the only prerequisite to fully appreciate its contents. Based on a course for third-year university students, the book contains numerous historical and mathematical exercises, offers extensive advice to the student on how to write essays, and can easily be used in whole or in part as a course in the history of mathematics. Several appendices help make the book self-contained and suitable for self-study.

Asymptotic Profiles,

Regularity and Well-Posedness

Springer

This text focuses on the use of smoothing methods for developing and estimating differential equations following recent developments in functional data analysis and building on techniques described in Ramsay and Silverman (2005) Functional Data Analysis. The central concept of a dynamical system as a buffer that translates sudden changes in input into smooth controlled output responses has led to applications of previously analyzed data, opening up entirely new opportunities for dynamical systems. The technical level has been kept low so that those with little or no exposure to differential equations as modeling objects can be brought into this data analysis landscape. There are already many texts on the mathematical properties of ordinary differential equations, or dynamic models, and there is a large literature distributed over many fields on models for real world processes consisting of differential equations. However, a researcher interested in fitting such a model to data, or a statistician interested in the properties of differential equations

estimated from data will find rather less to work with. This book fills that gap.
Partial Differential Equations Springer "Whatever regrets may be, we have done our best." (Sir Ernest Shackleton, turning back on 9 January 1909 at 88°23' South.) Brahms struggled for 20 years to write his first symphony. Compared to this, the 10 years we have been working on these two volumes may even appear short. This second volume treats stiff differential equations and differential alge braic equations. It contains three chapters: Chapter IV on one-step (Runge Kutta) methods for stiff problems, Chapter Von multistep methods for stiff problems, and Chapter VI on singular perturbation and differential-algebraic equations. Each chapter is divided into sections. Usually the first sections of a chapter are of an introductory nature, explain numerical phenomena and exhibit numerical results. Investigations of a more theoretieal nature are presented in the later sections of each chapter. As in Volume I, the formulas, theorems, tables and figures are numbered consecutively in each section and indicate, in addition, the

section num ber. In cross references to other chapters the (latin) chapter number is put first. References to the bibliography are again by "author" plus "year" in parentheses. The bibliography again contains only those papers which are discussed in the text and is in no way meant to be complete. *Analysis, Qualitative Theory and Control* Springer Science & Business Media For the past several years the Division of Applied Mathematics at Brown University has been teaching an extremely popular sophomore level differential equations course. The immense success of this course is due primarily to two fac tors. First, and foremost, the material is presented in a manner which is rigorous enough for our mathematics and ap plied mathematics majors, but yet intuitive and practical enough for our engineering, biology, economics, physics and geology majors. Secondly, numerous case histories are given of how researchers have used differential equations to solve real life problems. This book is the outgrowth of this course. It is a rigorous treatment of differential equations and their appli cations, and can be understood by anyone who has had a two semester course in Calculus. It contains all the material usually covered in a one or two semester course in differen tial equations. In addition, it possesses the following unique features which distinguish it from other textbooks on differential equations. *Nonlinear Equations* Springer Science & Business Media Used in undergraduat e classrooms across the USA, this is a clearly written, rigorous introduction to differential equations and their applications. Fully understandabl e to students who have had one year of calculus, this book distinguishes itself from other differential equations texts through its engaging application of the subject matter to interesting scenarios. This fourth edition incorporates earlier introductory material on bifurcation theory and adds a new chapter on Sturm-Liouville boundary value problems. Computer programs in C, Pascal, and Fortran are presented throughout the text to show readers how to apply differential equations towards quantitative problems. Initial Value Problems Springer Abstract semilinear functional differential equations arise from many biological, chemical, and physical systems which are characterized by both spatial and temporal variables and exhibit various spatio-temporal patterns. The aim of this book is to provide an introduction of the qualitative theory and applications of these equations from the dynamical systems point of view. The required prerequisites for that book are at a level of a graduate student. The style of presentation will be appealing to people trained and interested in qualitative theory of ordinary and functional differential equations. *From Modelling to Theory* Springer Progress in Partial Differential Equations is devoted to modern topics in the theory of partial differential equations. It consists of both original articles and survey papers covering a wide scope of research topics in partial differential equations and their applications. The contributors were participants of the 8th ISAAC congress in Moscow in 2011 or are members of the PDE interest group of the ISAAC society. This volume is addressed to graduate students at various levels as well as researchers in partial differential equations and related fields. The readers will find this an excellent resource of both introductory and advanced material. The key topics are: • Linear hyperbolic equations and systems (scattering, symmetrisers) • Non-linear wave models (global existence, decay estimates, blow-up) • Evolution equations (control theory, well-posedness, smoothing) • Elliptic equations (uniqueness, non-uniqueness, positive solutions) • Special models from applications (Kirchhoff equation, Zakharov-Kuznetsov equation, thermoelasticity)

A Textbook on Ordinary Differential Equations

Springer Science & Business Media

This book presents a variety of techniques for solving ordinary differential equations analytically and features a wealth of examples. Focusing on the modeling of real-world phenomena, it begins with a basic introduction to differential equations, followed by linear and nonlinear first order equations and a detailed treatment of the second order linear equations. After presenting solution methods for the Laplace transform and power series, it lastly presents systems of equations and offers an introduction to the stability theory.To help readers practice the theory covered, two types of exercises are provided: those that illustrate the general theory, and others designed to expand on the text material. Detailed solutions to all the exercises are included.The book is excellently suited for use as a textbook for an undergraduat e class (of all disciplines) in ordinary differential equations.

Dynamic Data Analysis

American Mathematical Soc. Therearemany excellenttexts onelementary di?erentialequ ationsdesigne dfor the standard sophomore course. However, in spite of the fact that most courses are one semester in length, the texts have evolved into calculus-like pres- tations that include a large collection of methods and applications, packaged with student manuals, and Web-based notes, projects, and supplements. All of this comes in several hundred pages of text with busy formats. Most students do not have the time or desire to read voluminous texts and explore internet supplements. The format of this di?erential equations book is di?erent; it is a one-semester, brief treatment of the basic ideas, models, and solution methods. Itslimitedcoverageplacesitsomewherebetweenanoutlineandadetailedte-book. I have tried to write concisely, to the point, and in plain language. Many worked examples and exercises are included. A student who works through this primer will have the tools to go to the next level in applying di?erential eq-tions to problems in engineering, science, and applied mathematics. It can give some instructors, who want more concise coverage, an alternative to existing texts.

Differential Equations: Methods and Applications

Springer Science & Business Media

This volume is intended as an essentially self contained exposition of portions of the theory of second order quasilinear elliptic partial differential equations, with emphasis on the Dirichlet problem in bounded domains. It grew out of lecture notes for graduate courses by the authors at Stanford University, the final material extending well beyond the scope of these courses. By including preparatory chapters on topics such as potential theory and functional analysis, we have attempted to make the work accessible to a broad spectrum of readers. Above all, we hope the readers of this book will gain an appreciation of the multitude of ingenious barehanded techniques that have been developed in the study of elliptic equations and have become part of the repertoire of analysis. Many individuals have assisted us during the evolution of this work over the past several years. In particular, we are grateful for the valuable discussions with L. M. Simon and his contributions in Sections 15.4 to 15.8; for the helpful comments and corrections of J. M. Cross, A. S. Geue, J. Nash, P. Trudinger and B. Turkington; for the contributions of G. Williams in Section 10.5 and of A. S. Geue in Section 10.6; and for the impeccably typed manuscript which resulted from the dedicated efforts oflsolde Field at Stanford and Anna Zalucki at Canberra. The research of the authors connected with this volume was supported in part by the National Science Foundation.

Numerical Approximation of Partial

Differential Equations

Springer Science & Business Media
The book comprises a rigorous and self-contained treatment of initial-value problems for ordinary differential equations. It additionally develops the basics of control theory, which is a unique feature in current textbook literature. The following topics are particularly emphasised: • existence, uniqueness and continuation of solutions, • continuous dependence on initial data, • flows, • qualitative behaviour of solutions, • limit sets, • stability theory, • invariance principles, • introductory control theory, • feedback and stabilization. The last two items cover classical control theoretic material such as linear control theory and absolute stability of nonlinear feedback systems. It also includes an introduction to the more recent concept of input-to-state stability. Only a basic grounding in linear algebra and analysis is assumed. Ordinary Differential Equations will be suitable for final year undergraduate students of mathematics and appropriate for beginning postgraduates in mathematics and in mathematically oriented

engineering and science. *Stochastic Differential Equations* Springer Nature This textbook is a comprehensive treatment of ordinary differential equations, concisely presenting basic and essential results in a rigorous manner. Including various examples from physics, mechanics, natural sciences, engineering and automatic theory, Differential Equations is a bridge between the abstract theory of differential equations and applied systems theory. Particular attention is given to the existence and uniqueness of the Cauchy problem, linear differential systems, stability theory and applications to first-order partial differential equations. Upper undergraduate students and researchers in applied mathematics and systems theory with a background in advanced calculus will find this book particularly useful. Supplementary topics are covered in an appendix enabling the book to be completely self-contained.

Differential Equations

Springer Science & Business Media Everything is more simple than one thinks but at the same time more complex than one can understand Johann Wolfgang von Goethe To reach the point that is unknown to you, you must take the road that is unknown to you St. John of the Cross This is a book on the numerical approximation ofpartial differential equations (PDEs). Its scope is to provide a thorough illustration of numerical methods (especially those stemming from the variational formulation of PDEs), carry out their stability and convergence analysis, derive error bounds, and discuss the algorithmic aspects relative to their implementation. A sound balancing of theoretical analysis, description of algorithms and discussion of applications is our primary concern. Many kinds of problems are addressed: linear and nonlinear, steady and time-dependent, having either smooth or non-smooth solutions. Besides model equations, we consider a number of (initial-) boundary value problems of interest in several fields of applications. Part I is devoted to the description and analysis of general numerical methods for the discretization of partial differential equations. A comprehensive theory of Galerkin methods and its variants (Petrov Galerkin and generalized Galerkin), as wellas ofcollocationm ethods, is devel oped for the spatial discretization. This theory is then specified to two numer ical subspace realizations of remarkable interest: the finite element method (conforming, non-conforming, mixed, hybrid) and the spectral method (Leg endre and Chebyshev expansion).

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