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This book covers a diverse range of topics

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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

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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

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practical, it represents the perfect companion to a broad spectrum of courses.

Explore Theory and Techniques to Solve Physical, Biological, and Financial Problems Since the first edition was published, there has been a surge of interest in stochastic partial differential

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equations (PDEs) driven by the Lévy type of noise. Stochastic Partial Differential Equations, Second Edition incorporates these recent developments and improves the presentation of material. New to the Second Edition Two sections on the Lévy type of stochastic integrals and the related stochastic differential equations

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in finite dimensions Discussions of Poisson random fields and related stochastic integrals, the solution of a stochastic heat equation with Poisson noise, and mild solutions to linear and nonlinear parabolic equations with Poisson noises Two sections on linear and semilinear wave equations driven by

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the Poisson type of noises Treatment of
the Poisson stochastic integral in a
Hilbert space and mild solutions of
stochastic evolutions with Poisson noises
Revised proofs and new theorems, such
as explosive solutions of stochastic
reaction diffusion equations Additional
applications of stochastic PDEs to

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population biology and finance Updated section on parabolic equations and related elliptic problems in Gauss–Sobolev spaces The book covers basic theory as well as computational and analytical techniques to solve physical, biological, and financial problems. It first presents classical concrete problems

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before proceeding to a unified theory of stochastic evolution equations and describing applications, such as turbulence in fluid dynamics, a spatial population growth model in a random environment, and a stochastic model in bond market theory. The author also explores the connection of stochastic

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PDEs to infinite-dimensional stochastic analysis.

The book extensively introduces classical and variational partial differential equations (PDEs) to graduate and post-graduate students in Mathematics. The topics, even the most delicate, are presented in a detailed way. The book

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consists of two parts which focus on second order linear PDEs. Part I gives an overview of classical PDEs, that is, equations which admit strong solutions, verifying the equations pointwise.

Classical solutions of the Laplace, heat, and wave equations are provided. Part II deals with variational PDEs, where weak

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(variational) solutions are considered. They are defined by variational formulations of the equations, based on Sobolev spaces. A comprehensive and detailed presentation of these spaces is given. Examples of variational elliptic, parabolic, and hyperbolic problems with different boundary conditions are

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discussed.

Developed from a course taught to senior undergraduates, this book provides a unified introduction to Fourier analysis and special functions based on the Sturm-Liouville theory in L^2 . The text's presentation follows a clear, rigorous mathematical style that is highly

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readable. The author first establishes the basic results of Sturm-Liouville theory and then provides examples and applications to illustrate the theory. The final two chapters, on Fourier and Laplace transformations, demonstrate the use of the Fourier series method for representing functions to integral

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representations.

Applications to Nonlinear Partial
Differential Equations and Hamiltonian
Systems

The Second Symposium on Analysis and
PDE's, June 7-10, 2004, Purdue
University, West Lafayette, Indiana
Partial Differential Equations and

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Boundary-value Problems with
Applications

Differential Geometry

Recent Developments in Nonlinear
Partial Differential Equations

The purpose of this book is to
explain systematically and clearly
many of the most important

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techniques set forth in recent years for using weak convergence methods to study nonlinear partial differential equations. This work represents an expanded version of a series of ten talks presented by the author at Loyola University of

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Chicago in the summer of 1988. The author surveys a wide collection of techniques for showing the existence of solutions to various nonlinear partial differential equations, especially when strong analytic estimates are unavailable.

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The overall guiding viewpoint is that when a sequence of approximate solutions converges only weakly, one must exploit the nonlinear structure of the PDE to justify passing to limits. The author concentrates on several areas that

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are rapidly developing and points to some underlying viewpoints common to them all. Among the several themes in the book are the primary role of measure theory and real analysis (as opposed to functional analysis) and the

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continual use in diverse settings of low-amplitude, high-frequency periodic test functions to extract useful information. The author uses the simplest problems possible to illustrate various key techniques. Aimed at research mathematicians

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in the field of nonlinear PDEs, this book should prove an important resource for understanding the techniques being used in this important area of research.

Building on the basic techniques of separation of variables and Fourier

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series, the book presents the solution of boundary-value problems for basic partial differential equations: the heat equation, wave equation, and Laplace equation, considered in various standard coordinate

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systems--rectangular, cylindrical, and spherical. Each of the equations is derived in the three-dimensional context; the solutions are organized according to the geometry of the coordinate system, which makes the mathematics

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especially transparent. Bessel and Legendre functions are studied and used whenever appropriate throughout the text. The notions of steady-state solution of closely related stationary solutions are developed for the heat equation;

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applications to the study of heat flow in the earth are presented. The problem of the vibrating string is studied in detail both in the Fourier transform setting and from the viewpoint of the explicit representation (d'Alembert

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formula). Additional chapters include the numerical analysis of solutions and the method of Green's functions for solutions of partial differential equations. The exposition also includes asymptotic methods (Laplace transform and

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stationary phase). With more than 200 working examples and 700 exercises (more than 450 with answers), the book is suitable for an undergraduate course in partial differential equations.

Partial Differential

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Equations American Mathematical
Soc.

In 1910 Herman Weyl published
one of the most widely quoted
papers of the 20th century in
Analysis, which initiated the study
of singular Sturm-Liouville

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problems. The work on the foundations of Quantum Mechanics in the 1920s and 1930s, including the proof of the spectral theorem for unbounded self-adjoint operators in Hilbert space by von Neumann and Stone, provided some of the

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motivation for the study of differential operators in Hilbert space with particular emphasis on self-adjoint operators and their spectrum. Since then the topic developed in several directions and many results and applications have

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been obtained. In this monograph the authors summarize some of these directions discussing self-adjoint, symmetric, and dissipative operators in Hilbert and Symplectic Geometry spaces. Part I of the book covers the theory of

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differential and quasi-differential expressions and equations, existence and uniqueness of solutions, continuous and differentiable dependence on initial data, adjoint expressions, the Lagrange Identity, minimal and

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maximal operators, etc. In Part II characterizations of the symmetric, self-adjoint, and dissipative boundary conditions are established. In particular, the authors prove the long standing Deficiency Index Conjecture. In

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Part III the symmetric and self-adjoint characterizations are extended to two-interval problems. These problems have solutions which have jump discontinuities in the interior of the underlying interval. These jumps may be

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infinite at singular interior points. Part IV is devoted to the construction of the regular Green's function. The construction presented differs from the usual one as found, for example, in the classical book by Coddington and

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Levinson.

Geometric Partial Differential
Equations - Part I

An Introduction to Second Order
Partial Differential Equations
From Modelling to Theory
Second Edition

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Classical and Variational Solutions

These lectures concentrate on fundamentals of the modern theory of linear elliptic and parabolic equations in Hölder spaces. Krylov shows that this theory - including some issues of the theory of nonlinear equations - is based on some general and extremely powerful ideas and

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some simple computations. The main object of study is the first boundary-value problems for elliptic and parabolic equations, with some guidelines concerning other boundary-value problems such as the Neumann or oblique derivative problems or problems involving higher-order elliptic operators acting on the

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boundary. Numerical approximations are also discussed. This book, containing 200 exercises, aims to provide a good understanding of what kind of results are available and what kinds of techniques are used to obtain them.

Does entropy really increase no matter what we do? Can light pass through a Big

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Bang? What is certain about the Heisenberg uncertainty principle? Many laws of physics are formulated in terms of differential equations, and the questions above are about the nature of their solutions. This book puts together the three main aspects of the topic of partial differential equations, namely theory,

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phenomenology, and applications, from a contemporary point of view. In addition to the three principal examples of the wave equation, the heat equation, and Laplace's equation, the book has chapters on dispersion and the Schrödinger equation, nonlinear hyperbolic conservation laws, and shock waves. The book covers

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material for an introductory course that is aimed at beginning graduate or advanced undergraduate level students. Readers should be conversant with multivariate calculus and linear algebra. They are also expected to have taken an introductory level course in analysis. Each chapter includes a comprehensive set of exercises,

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and most chapters have additional projects, which are intended to give students opportunities for more in-depth and open-ended study of solutions of partial differential equations and their properties.

Besides their intrinsic mathematical interest, geometric partial differential

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equations (PDEs) are ubiquitous in many scientific, engineering and industrial applications. They represent an intellectual challenge and have received a great deal of attention recently. The purpose of this volume is to provide a missing reference consisting of self-contained and comprehensive presentations. It includes

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basic ideas, analysis and applications of state-of-the-art fundamental algorithms for the approximation of geometric PDEs together with their impacts in a variety of fields within mathematics, science, and engineering. About every aspect of computational geometric PDEs is discussed in this and a companion volume.

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Topics in this volume include stationary and time-dependent surface PDEs for geometric flows, large deformations of nonlinearly geometric plates and rods, level set and phase field methods and applications, free boundary problems, discrete Riemannian calculus and morphing, fully nonlinear PDEs including

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Monge-Ampere equations, and PDE
constrained optimization Each chapter is a
complete essay at the research level but
accessible to junior researchers and
students. The intent is to provide a
comprehensive description of algorithms
and their analysis for a specific geometric
PDE class, starting from basic concepts

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and concluding with interesting applications. Each chapter is thus useful as an introduction to a research area as well as a teaching resource, and provides numerous pointers to the literature for further reading. The authors of each chapter are world leaders in their field of expertise and skillful writers. This book is

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thus meant to provide an invaluable,
readable and enjoyable account of
computational geometric PDEs

These notes provide a concise introduction
to stochastic differential equations and
their application to the study of financial
markets and as a basis for modeling
diverse physical phenomena. They are

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accessible to non-specialists and make a valuable addition to the collection of texts on the topic. --Srinivasa Varadhan, New York University This is a handy and very useful text for studying stochastic differential equations. There is enough mathematical detail so that the reader can benefit from this introduction with only a

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basic background in mathematical analysis and probability. --George Papanicolaou, Stanford University This book covers the most important elementary facts regarding stochastic differential equations; it also describes some of the applications to partial differential equations, optimal stopping, and options pricing. The book's

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style is intuitive rather than formal, and emphasis is made on clarity. This book will be very helpful to starting graduate students and strong undergraduates as well as to others who want to gain knowledge of stochastic differential equations. I recommend this book enthusiastically.

--Alexander Lipton, Mathematical Finance

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Executive, Bank of America Merrill
Lynch This short book provides a quick,
but very readable introduction to
stochastic differential equations, that is, to
differential equations subject to additive
"white noise" and related random
disturbances. The exposition is concise
and strongly focused upon the interplay

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between probabilistic intuition and mathematical rigor. Topics include a quick survey of measure theoretic probability theory, followed by an introduction to Brownian motion and the Ito stochastic calculus, and finally the theory of stochastic differential equations. The text also includes applications to partial

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differential equations, optimal stopping problems and options pricing. This book can be used as a text for senior undergraduates or beginning graduate students in mathematics, applied mathematics, physics, financial mathematics, etc., who want to learn the basics of stochastic differential equations.

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The reader is assumed to be fairly familiar with measure theoretic mathematical analysis, but is not assumed to have any particular knowledge of probability theory (which is rapidly developed in Chapter 2 of the book).

Second Order Parabolic Differential
Equations

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Estimates for Second Order Elliptic Partial
Differential Equations

Partial Differential Equations

Partial Differential Equations III

Partial Differential Equations in Action

This book is the second of
two volumes that contain
the proceedings of the

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Workshop on Nonlinear
Partial Differential
Equations, held from May
28-June 1, 2012, at the
University of Perugia in
honor of Patrizia Pucci's
60th birthday. The

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workshop brought together
leading experts and
researchers in nonlinear
partial differential
equations to promote
research and to stimulate
interactions among the

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participants. The workshop program testified to the wide ranging influence of Patrizia Pucci on the field of nonlinear analysis and partial differential equations. In

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her own work, Patrizia Pucci has been a seminal influence in many important areas: the maximum principle, qualitative analysis of solutions to many classes

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of nonlinear PDEs
(Kirchhoff problems,
polyharmonic systems),
mountain pass theorem in
the critical case,
critical exponents,
variational identities, as

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well as various degenerate or singular phenomena in mathematical physics. This same breadth is reflected in the mathematical papers included in this volume. The companion volume

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(Contemporary Mathematics,
Volume 594) is devoted to
evolution problems in
nonlinear partial
differential equations.
Partial Differential
Equations presents a

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balanced and comprehensive introduction to the concepts and techniques required to solve problems containing unknown functions of multiple variables. While focusing

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on the three most
classical partial
differential equations
(PDEs)—the wave, heat, and
Laplace equations—this
detailed text also
presents a broad practical

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perspective that merges
mathematical concepts with
real-world application in
diverse areas including
molecular structure,
photon and electron
interactions, radiation of

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electromagnetic waves,
vibrations of a solid, and
many more. Rigorous
pedagogical tools aid in
student comprehension;
advanced topics are
introduced frequently,

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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

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major concepts such as
wave propagation, heat and
diffusion, electrostatics,
and quantum mechanics
placed in contexts
familiar to students of
various fields in science

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and engineering. By understanding the properties and applications of PDEs, students will be equipped to better analyze and interpret central

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processes of the natural world.

This volume contains the proceedings of a NATO/London Mathematical Society Advanced Study Institute held in Oxford

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from 25 July - 7 August
1982. The institute
concerned the theory and
applications of systems of
nonlinear partial
differential equations,
with emphasis on

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techniques appropriate to systems of more than one equation. Most of the lecturers and participants were analysts specializing in partial differential equations, but also

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present were a number of numerical analysts, workers in mechanics, and other applied mathematicians. The organizing committee for the institute was J.M.

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Ball (Heriot-Watt), T.B.

Benjamin (Oxford), J. Carr

(Heriot-Watt), C.M.

Dafermos (Brown), S.

Hildebrandt (Bonn) and

J.S. pym (Sheffield) . The

programme of the institute

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consisted of a number of courses of expository lectures, together with special sessions on different topics. It is a pleasure to thank all the lecturers for the care

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they took in the preparation of their talks, and S.S. Antman, A.J. Chorin, J.K. Hale and J.E. Marsden for the organization of their special sessions. The

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institute was made possible by financial support from NATO, the London Mathematical Society, the u.S. Army Research Office, the u.S. Army European Research

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Office, and the u.S.
National Science
Foundation. The lectures
were held in the
Mathematical Institute of
the University of Oxford,
and residential

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accommodation was provided
at Hertford College.

The description for this
book, Introduction to
Partial Differential
Equations. (MN-17), Volume
17, will be forthcoming.

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Analytic Methods for
Partial Differential
Equations
Workshop in Honor of
Patrizia Pucci's 60th
Birthday : Nonlinear
Partial Differential

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Equations, May 28-June 1,
2012, University of
Perugia, Perugia, Italy
Lectures on Elliptic and
Parabolic Equations in
Sobolev Spaces
Recent Trends in Nonlinear

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Partial Differential
Equations

This is the practical introduction to the analytical approach taken in Volume 2. Based upon courses in partial differential

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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

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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.

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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

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concludes with links to the use of Fourier series.

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,

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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.

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In addition, some nonlinear diffusion problems are studied. It also introduces such analytical tools as the theory of L^p Sobolev spaces, H^1 Hilbert spaces, Hardy spaces, and Morrey spaces, and also a development of Calderon-

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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,

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mathematical physics, differential geometry, harmonic analysis and complex analysis. ^

This text presents a graduate-level introduction to differential geometry for mathematics and physics students. The exposition

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follows the historical development of the concepts of connection and curvature with the goal of explaining the Chern–Weil theory of characteristic classes on a principal bundle. Along the way

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we encounter some of the high points in the history of differential geometry, for example, Gauss' Theorema Egregium and the Gauss–Bonnet theorem.

Exercises throughout the book test the reader's understanding

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of the material and sometimes illustrate extensions of the theory. Initially, the prerequisites for the reader include a passing familiarity with manifolds. After the first chapter, it becomes necessary to understand and

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manipulate differential forms. A knowledge of de Rham cohomology is required for the last third of the text. Prerequisite material is contained in author's text An Introduction to Manifolds, and can be learned in one

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semester. For the benefit of the reader and to establish common notations, Appendix A recalls the basics of manifold theory.

Additionally, in an attempt to make the exposition more self-contained, sections on algebraic

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constructions such as the tensor product and the exterior power are included. Differential geometry, as its name implies, is the study of geometry using differential calculus. It dates back to Newton and Leibniz in the

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seventeenth century, but it was not until the nineteenth century, with the work of Gauss on surfaces and Riemann on the curvature tensor, that differential geometry flourished and its modern foundation was laid.

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Over the past one hundred years, differential geometry has proven indispensable to an understanding of the physical world, in Einstein's general theory of relativity, in the theory of gravitation, in gauge theory,

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and now in string theory.

Differential geometry is also useful in topology, several complex variables, algebraic geometry, complex manifolds, and dynamical systems, among other fields. The field has even

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found applications to group theory as in Gromov's work and to probability theory as in Diaconis's work. It is not too far-fetched to argue that differential geometry should be in every mathematician's arsenal.

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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

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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

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also introduces such analytical tools as the theory of L^p Sobolev spaces, Hölder spaces, Hardy spaces, and Morrey spaces, and also a development of Calderon-Zygmund theory and paradifferential operator

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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

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complex analysis

Project Typhoon

Basic Linear Algebra

Maximal Function Methods for
Sobolev Spaces

Nonlinear Wave Equations

Stochastic Partial Differential

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Equations, Second Edition

This is a textbook for an introductory graduate course on partial differential equations. It focuses on linear equations of first and second order. An important feature of his

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treatment is that the majority of the techniques are applicable more generally. In particular, Han emphasizes a priori estimates throughout the text, even for those equations that can be solved

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explicitly. Such estimates are indispensable tools for proving the existence and uniqueness of solutions to PDEs, being especially important for nonlinear equations. The estimates are also crucial to establishing

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*properties of the solutions,
such as the continuous
dependence on parameters.
Han's book is suitable for
students interested in the
mathematical theory of
partial differential
equations, either as an*

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*overview of the subject or
as an introduction leading
to further study.*

*This textbook is a
completely revised, updated,
and expanded English edition
of the important Analyse
fonctionnelle (1983). In*

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*addition, it contains a
wealth of problems and
exercises (with solutions)
to guide the reader.
Uniquely, this book presents
in a coherent, concise and
unified way the main results
from functional analysis*

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together with the main results from the theory of partial differential equations (PDEs). Although there are many books on functional analysis and many on PDEs, this is the first to cover both of these

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

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list.

***Hilberts talk at the second
International Congress of
1900 in Paris marked the
beginning of a new era in
the calculus of variations.
A development began which,
within a few decades,***

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***brought tremendous success,
highlighted by the 1929
theorem of Ljusternik and
Schnirelman on the existence
of three distinct prime
closed geodesics on any
compact surface of genus
zero, and the 1930/31***

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***solution of Plateaus problem
by Douglas and Rad. This
third edition gives a
concise introduction to
variational methods and
presents an overview of
areas of current research in
the field, plus a survey on***

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new developments.

This book provides a basic introductory course in partial differential equations, in which theory and applications are interrelated and developed side by side. Emphasis is on

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proofs, which are not only mathematically rigorous, but also constructive, where the structure and properties of the solution are investigated in detail. The authors feel that it is no longer necessary to follow

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*the tradition of introducing
the subject by deriving
various partial differential
equations of continuum
mechanics and theoretical
physics. Therefore, the
subject has been introduced
by mathematical analysis of*

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the simplest, yet one of the most useful (from the point of view of applications), class of partial differential equations, namely the equations of first order, for which existence, uniqueness and

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stability of the solution of the relevant problem (Cauchy problem) is easy to discuss. Throughout the book, attempt has been made to introduce the important ideas from relatively simple cases, some times by referring to

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*physical processes, and then
extending them to more
general systems.*

*Ordinary Differential
Operators*

*Sturm-Liouville Theory and
its Applications*

Weak Convergence Methods for

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***Nonlinear Partial
Differential Equations
Elliptic Partial
Differential Equations
Elliptic Partial
Differential Equations of
Second Order***

This book concentrates on the

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basic facts and ideas of the modern theory of linear elliptic and parabolic equations in Sobolev spaces. The main areas covered in this book are the first boundary-value problem for elliptic equations and the

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Cauchy problem for parabolic equations. In addition, other boundary-value problems such as the Neumann or oblique derivative problems are briefly covered. As is natural for a textbook, the main emphasis is

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on organizing well-known ideas
in a self-contained exposition.
Among the topics included that
are not usually covered in a
textbook are a relatively recent
development concerning
equations with VMO

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coefficients and the study of parabolic equations with coefficients measurable only with respect to the time variable. There are numerous exercises which help the reader better understand the material.

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After going through the book, the reader will have a good understanding of results available in the modern theory of partial differential equations and the technique used to obtain them. Prerequisites are

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basics of measure theory, the theory of L_p spaces, and the Fourier transform.

This textbook is designed for a one year course covering the fundamentals of partial differential equations, geared

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towards advanced
undergraduates and beginning
graduate students in
mathematics, science,
engineering, and elsewhere.
The exposition carefully
balances solution techniques,

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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

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problems to develop and
reinforce new techniques and
results, details on theoretical
developments and proofs,
challenging projects both
computational and conceptual,
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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

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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,

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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

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equations in the absence of
shocks began in the 1960s.
Despite a great deal of recent

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activity in this area, some major issues remain unsolved, such as sharp conditions for the global existence of solutions with arbitrary initial data, and the global phase portrait in the presence of periodic solutions

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and traveling waves. This book, based on lectures presented by the author at George Mason University in January 1989, seeks to present the sharpest results to date in this area. The author surveys the fundamental

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qualitative properties of the solutions of nonlinear wave equations in the absence of boundaries and shocks. These properties include the existence and regularity of global solutions, strong and weak

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singularities, asymptotic properties, scattering theory and stability of solitary waves. Wave equations of hyperbolic, Schrodinger, and KdV type are discussed, as well as the Yang-Mills and the Vlasov-Maxwell

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equations. The book offers readers a broad overview of the field and an understanding of the most recent developments, as well as the status of some important unsolved problems. Intended for mathematicians

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and physicists interested in nonlinear waves, this book would be suitable as the basis for an advanced graduate-level course.

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The book is intended as an advanced undergraduate or first-year graduate course for students from various disciplines, including applied mathematics, physics and engineering.

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(PDEs) over the last
several years at the
Politecnico di Milano.
These courses had a*

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*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*

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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

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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,

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*waves and vibrations. In
turn the second part,
chapters 6 to 11,
concentrates on the
development of Hilbert
spaces methods for the
variational formulation*

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*and the analysis of
(mainly) linear boundary
and initial-boundary value
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texts. The assumed
mathematical background is
at the level of multivariable
calculus and basic metric
space material, but the***

latter is recalled as relevant as the text progresses. The key goal of this book is to be mathematically complete without overwhelming the reader, and to develop PDE theory in a manner that

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reflects how researchers would think about the material. A concrete example is that distribution theory and the concept of weak solutions are introduced early because

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***are quite important in the
later development are
introduced via completions
which give essentially all the
features one wants without
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functions and
characterization of Sobolev
spaces with zero boundary
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several uniform quantitative conditions that are self-improving, such as Hardy's inequalities, capacity density conditions, and reverse Hölder inequalities. They also study

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***Muckenhoupt weight
properties of distance
functions and combine these
with weighted norm
inequalities; notions of
dimension are then used to
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This is the second edition of the now definitive text on partial differential equations (PDE). It offers a comprehensive survey of modern techniques in the theoretical study of PDE with particular emphasis on nonlinear equations. Its wide scope and

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clear exposition make it a great text for a graduate course in PDE. For this edition, the author has made numerous changes, including a new chapter on nonlinear wave equations, more than 80 new exercises, several new sections, a significantly expanded bibliography.

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Introduction to the theory of weak
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Further theory of weak solutions.
Strong solutions. Fixed point theorems

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Monge-Ampère and Hessian
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The subject of partial differential
equations holds an exciting and special
position in mathematics. Partial
differential equations were not

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consciously created as a subject but emerged in the 18th century as ordinary differential equations failed to describe the physical principles being studied. The subject was originally developed by the major names of mathematics, in particular, Leonard

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Euler and Joseph-Louis Lagrange who studied waves on strings; Daniel Bernoulli and Euler who considered potential theory, with later developments by Adrien-Marie Legendre and Pierre-Simon Laplace; and Joseph Fourier's famous work on

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series expansions for the heat equation. Many of the greatest advances in modern science have been based on discovering the underlying partial differential equation for the process in question. James Clerk Maxwell, for example, put electricity and magnetism

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into a unified theory by establishing Maxwell's equations for electromagnetic theory, which gave solutions for problems in radio wave propagation, the diffraction of light and X-ray developments. Schrodinger's equation for quantum mechanical

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processes at the atomic level leads to experimentally verifiable results which have changed the face of atomic physics and chemistry in the 20th century. In fluid mechanics, the Navier Stokes' equations form a basis for huge number-crunching activities associated

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with such widely disparate topics as weather forecasting and the design of supersonic aircraft. Inevitably the study of partial differential equations is a large undertaking, and falls into several areas of mathematics.