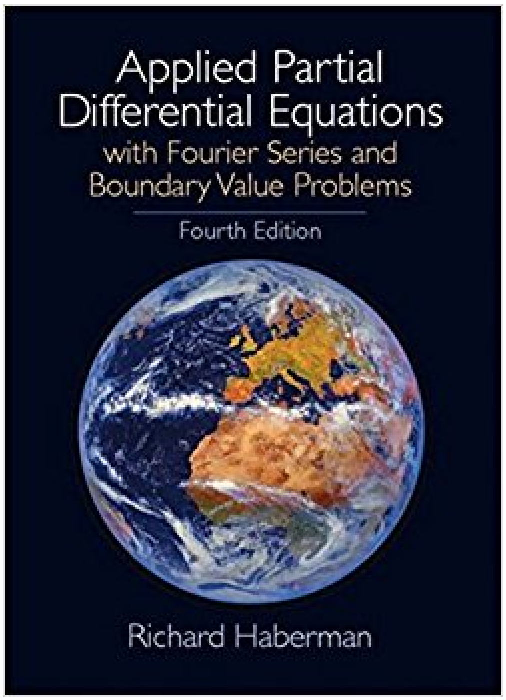
Applied Partial Differential Equations: With Fourier Series And Boundary Value Problems, 4th Edition



Synopsis

Emphasizing the physical interpretation of mathematical solutions, this book introduces applied mathematics while presenting partial differential equations.   Topics addressed include heat equation, method of separation of variables, Fourier series, Sturm-Liouville eigenvalue problems, finite difference numerical methods for partial differential equations, nonhomogeneous problems, Green’s functions for time-independent problems, infinite domain problems, Green’s functions for wave and heat equations, the method of characteristics for linear and quasi-linear wave equations and a brief introduction to Laplace transform solution of partial differential equations.   For scientists and engineers.

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Customer Reviews

Emphasizing the physical interpretation of mathematical solutions, this book introduces applied mathematics while presenting partial differential equations. Topics addressed include heat equation, method of separation of variables, Fourier series, Sturm-Liouville eigenvalue problems, finite difference numerical methods for partial differential equations, nonhomogeneous problems, Green’s functions for time-independent problems, infinite domain problems, Green’s functions for wave and heat equations, the method of characteristics for linear and quasi-linear wave equations and a brief introduction to Laplace transform solution of partial differential equations. For scientists and engineers.

This text discusses partial differential equations in the engineering and physical sciences. It is suited for courses whose titles include Fourier series, orthogonal functions, or boundary value problems. It may also be used in courses on Green’s functions, transform methods, or portions on advanced engineering mathematics and mathematical methods in the physical sciences. It is appropriate as an introduction to applied mathematics.   Simple models (heat flow, vibrating strings, and membranes) are emphasized. Equations are formulated carefully from physical principles, motivating most mathematical topics. Solution techniques are developed patiently. Mathematical results frequently are given physical interpretations. Proofs of theorems (if given at all) are presented after explanations based on illustrative examples. Over 1000 exercises of varying difficulty form an essential part of this text. Answers are provided for those exercises marked with a star (*). Further details concerning the solution for most of the starred exercises are available in an instructor’s manual.   Standard topics such as the method of separation of variables, Fourier series, orthogonal functions, and Fourier transforms are developed with considerable detail. Finite difference numerical methods for partial differential equations are clearly presented with considerable depth. A briefer presentation is made of the finite element method. This text also has an extensive presentation of the method of characteristics for linear and nonlinear wave equations, including discussion of the dynamics of shock waves for traffic flow. Nonhomogeneous problems are carefully introduced, including Green’s functions for Laplace’s, heat, and wave equations. Numerous topics are included such as differentiation and integration of Fourier series, Sturm-Liouville and multidimensional eigenfunctions, Rayleigh quotient, Bessel functions for a vibrating circular membrane, and Legendre polynomials for spherical problems. Some optional advanced material is included (for example, asymptotic expansion of large eigenvalues, calculation of perturbed frequencies using the Fredholm alternative, stability conditions for finite difference methods, and direct and inverse scattering).   Applications briefly discussed include the lift and drag associated with fluid flow past a circular cylinder, Snell’s law of refraction for light and sound waves, the derivation of the Eikonal equation from the wave equation, dispersion relations for water waves, wave guides, and fiber optics.   The text has evolved from the author’s experiences teaching this material to different types of students at various institutions (MIT, UCSD, Rutgers, Ohio State, and Southern Methodist University). Prerequisites for the reader are calculus and elementary ordinary differential equations. (These are occasionally reviewed in the text, where necessary.) For the beginning student, the core material for a typical course consists of most of Chapters 1-5 and 7. This will usually be supplemented by a few other topics. The text is somewhat flexible for an instructor, since most of Chapters 6-13 depend only on Chapters 1-5. Chapter 11 on Green’s functions for the heat and wave equation is an exception, since it requires Chapters 9 and 10.

Chapter 14 is more advanced, discussing linear and nonlinear dispersive waves, stability, and perturbation methods. It is self-contained and accessible to strong undergraduates. Group velocity and envelope equations for linear dispersive waves are analyzed, whose applications include the rainbow caustic of optics. Nonlinear dispersive waves are discussed, including an introductory presentation of solitons for the weakly nonlinear long wave equation (Korteweg-de Vries) and the weakly nonlinear wave envelope equation (Nonlinear Schrodinger). In addition, instability and bifurcation phenomena for partial differential equations are discussed as well as perturbation methods (multiple scale and boundary layer problems). In Chapter 14, I have attempted to show the vitality of the contemporary study of partial differential equations in the context of physical problems.

I have made an effort to preserve the third edition so that previous users will find little disruption. Nearly all exercises from the previous edition have been retained with no change in the order to facilitate a transition for previous users. Only a few new exercises were created (especially for Chapter 1). The fourth edition contains many improvements in presentation and the following new material: diffusion of a chemical pollutant, Galerkin numerical approximation for the frequencies, similarity solution for the heat equation, two-dimensional Green's function for the wave equation, nonuniqueness of shock velocity and its resolution, spatial structure of traveling shock wave, stability and bifurcation theory for systems of ordinary differential equations, two spatial dimensional wave envelope equations, analysis of modulational instability, long wave instabilities, pattern formation for reaction diffusion equations, and the Turing instability. There are over 200 figures to illustrate various concepts, which were prepared by the author using MATLAB. The MATLAB m-files for most of the mathematical figures may be obtained from my Web page: http://faculty.smu.edu/rhaberma . Modern technology is especially important in its graphical ability, and I have tried to indicate throughout the text places where three-dimensional visualization is helpful. Overall, my object has been to explain clearly many fundamental aspects of partial differential equations as an introduction to this vast and important field. After achieving a certain degree of competence and understanding, the student can use this text as a reference, but for additional information the reader should be prepared to refer to other books such as the ones cited in the Bibliography. Finally, it is hoped that this text enables the reader to find enjoyment in the study of the relationships between mathematics and the physical sciences. The author gratefully acknowledges the contributions of the following reviewers of the manuscript: Andrew Belmonte, Penn State University, Julie Levandosky, Stanford University, and Isom Herron, Rensselaer Polytechnic Institute. I wish to thank past, present, and future readers of the book (students and faculty). Shari Webster was of great help in preparing the LATEX for the previous edition. Richard

Haberman

This is the ideal text to learn PDEs from. New material is motivated, with clear, "common-sense" explanations that provide solid grounding for the underlying theory. An abundance of examples offer the reader plenty of opportunities to check their understanding and learn the mechanics of solving PDEs. In addition, most of the solutions are either in the back of the book, or available in popular "study" websites. Excellent text.

One of the better math books I used in college (undergraduate and graduate). In a day and age where it seems like math books struggle, this one is fantastic. Goes through lots of problems step-by-step, and explains the uses in engineering and science for many of the concepts. Highly recommend this book for anyone in partial differential equations.

Great text. Clear explanations and has solutions manual in chegg. What else do you need to master the subject? This is a must book for the pde class, wave physics, engineering math, and physical Chem.

An excellent intro text. Great for undergrads

I found this book much more explanatory than another book I had purchased for a different partial differential equations class. This book does just what it says, it is more applied, and I found that much more useful as I am a scientist. They do a fairly good job of explaining why they are doing things, and have appendixes to show more of the gory detail of a derivation than they show in the regular text if you want it.

This book does an amazing job teaching just what it says it will.

Using in conjunction with an online course. Very in-depth, goes into derivations and fundamentals necessary to grasp the concepts, well put-together.

This book is a good text for the beganner since it has basic therory and lots examples.It is also a good one for researchers to review the material.

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