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R. M. M. Mattheij, S. W. Rienstra, J. H. M. ten Thije Boonkkamp

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Partial differential equations (PDEs) are used to describe a large variety of physical phenomena, from fluid flow to electromagnetic fields, and are indispensable to such disparate fields as aircraft simulation and computer graphics. While most existing texts on PDEs deal with either analytical or numerical aspects of PDEs, this innovative and comprehensive textbook features a unique approach that integrates analysis and numerical solution methods and includes a third component—modeling—to address real-life problems. The authors believe that modeling can be learned only by doing; hence a separate chapter containing 16 user-friendly case studies of elliptic, parabolic, and hyperbolic equations is included and numerous exercises are included in all other chapters. Partial Differential Equations: Modeling, Analysis, Computation enables readers to deepen their understanding of a topic ubiquitous in mathematics and science and to tackle practical problems. The advent of fast computers and the development of numerical methods have enabled the modern engineer to use a large variety of packages to find numerical approximations to solutions of PDEs. Problems are usually standard and a thorough knowledge of a well-chosen subset of analytical and numerical tools and methodologies is necessary when dealing with real-life problems. When one is dealing with PDEs in practice, it becomes clear that both numerical and analytical treatments of the problem are needed. This comprehensive book is intended for graduate students in applied mathematics, engineering, and physics and may be of interest to advanced undergraduate students. Mathematicians, scientists, and engineers also will find the book useful. Contents List of Figures; List of Tables; Notation; Preface; Chapter 1: Differential and difference equations; Chapter 2: Characterization and classification; Chapter 3: Fourier theory; Chapter 4: Distributions and fundamental solutions; Chapter 5: Approximation by finite differences; Chapter 6: The Equations of continuum mechanics and electromagnetics; Chapter 7: The art of modeling; Chapter 8: The analysis of elliptic equations; Chapter 9: Numerical methods for elliptic equations; Chapter 10: Analysis of parabolic equations; Chapter 11: Numerical methods for parabolic equations; Chapter 12: Analysis of hyperbolic equations; Chapter 13: Numerical methods for scalar hyperbolic equations; Chapter 14: Numerical methods for hyperbolic systems; Chapter 15: Perturbation methods; Chapter 16: Modeling, analyzing, and simulating problems from practice; Appendices: Useful definitions and properties; Bibliography; Index.

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