Introduction to Computation and Modeling for Differential Equations

Lennart Edsberg

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An introduction to scientific computing for differential equations

Introduction to Computation and Modeling for Differential Equations provides a unified and integrated view of numerical analysis, mathematical modeling in applications, and programming to solve differential equations, which is essential in problem-solving across many disciplines, such as engineering, physics, and economics. This book successfully introduces readers to the subject through a unique "Five-M" approach: Modeling, Mathematics, Methods, MATLAB, and Multiphysics. This approach facilitates a thorough understanding of how models are created and preprocessed mathematically with scaling, classification, and approximation, and it also illustrates how a problem is solved numerically using the appropriate mathematical methods.

The book's approach of solving a problem with mathematical, numerical, and programming tools is unique and covers a wide array of topics, from mathematical modeling to implementing a working computer program. The author utilizes the principles and applications of scientific computing to solve problems involving:

- Ordinary differential equations
- Numerical methods for Initial Value Problems (IVPs)
- Numerical methods for Boundary Value Problems (BVPs)
- Partial Differential Equations (PDEs)
- Numerical methods for parabolic, elliptic, and hyperbolic PDEs
- Mathematical modeling with differential equations
- Numerical solution
- Finite difference and finite element methods

Real-world examples from scientific and engineering applications including mechanics, fluid dynamics, solid mechanics, chemical engineering, electromagnetic field theory, and control theory are solved through the use of MATLAB and the interactive scientific computing program Comsol Multiphysics. Numerous illustrations aid in the visualization of the solutions, and a related Web site features demonstrations, solutions to problems, MATLAB programs, and additional data.

Introduction to Computation and Modeling for Differential Equations is an ideal text for courses in differential equations, ordinary differential equations, partial differential equations, and numerical methods at the upper-undergraduate and graduate levels. The book also serves as a valuable reference for researchers and practitioners in the fields of mathematics, engineering, and computer science who would like to refresh and revive their knowledge of the mathematical and numerical aspects as well as the applications of scientific computation.

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