Preface

Methods and tools of applied mathematics and computational science are becoming increasingly important in an ever increasing range of application areas. Mathematical models are becoming pervasive in our society, in its development and well-being. Along with more traditional areas of mathematics applications in natural sciences and engineering, mathematical models steadily and convincingly penetrate such areas as business and economics, urban planning and information management, health, social and political sciences, to name just a few. With such a wide spectrum of application areas, in describing recent advances in applied mathematics, modeling and computational science, we necessarily have to restrict ourselves by a selection of topics. As a result, this volume presents a selection of in-depth studies and state-of-the-art surveys of several challenging topics that are at the forefront of modern applied mathematics, mathematical modeling, and computational science. These three areas represent the foundation upon which the methodology of mathematical modeling and computational experiment is built as a major tool in all areas of applications of mathematics. The nine chapters of this book cover both fundamental and applied research, and provide the reader with state-of-the-art achievements in the development and application of new theories at the interfaces of applied mathematics, modeling and computational science.

The book can serve as a reference on several important current topics in modern applied mathematics and modeling, including random matrix theory with its innovative applications, dynamic blocking problems, elliptic curves over finite fields and their cryptographic applications, optimal control applications combining discrete and continuous features, among others. The reader can find in this book comprehensive accounts of recent advances in other important topics such as multiple scale methods coupling network and continuum models and their applications in various areas involving porous media, as well as statistical geometric and topological techniques and their applications in the life sciences. Two chapters of the book are devoted to recent developments in state-of-the-art numerical procedures for solving complex mathematical models based on partial differential equations. This includes energy stable weighted essentially non-oscillatory schemes with applications in fluid dynamics and aerospace sciences, as well as new efficient schemes

for hyperbolic equations based on the inverse Lax–Wendroff procedure for numerical boundary conditions. In these and other chapters of the book, the reader can find a wide spectrum of most advanced modeling techniques with their demonstration on a series of examples. Such techniques are explained with both, rigorous mathematics and details of numerical algorithms for their computer implementation. Several easy-to-run computer codes are also provided.

The material presented in this book aims at fostering interdisciplinary collaborations required to meet the modern challenges of applied mathematics, modeling and computational science. Due to a combination of rigorous mathematical and computational procedures with examples from a variety of applications ranging from engineering to life sciences, the book can be useful for a wide audience of professionals from different disciplines, including graduate students. It provides a rich source for graduate student projects, and can be used in courses or seminars on selected topics. Researchers in academia and industry and anyone who is interested in modern applications of mathematics and computational science, and advanced mathematical modeling techniques would benefit from this book.

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