PREFACE

Since the publication of my edited volume[a], on nonstandard finite difference (NSFD) methods for the numerical integration of differential equations, a number of new results and applications of these techniques have been obtained. The field of constructing NSFD schemes had its genesis in a paper published in 1989.[b] In recent years, progress has occurred in both the general foundational basis and range of physical/engineering phenomena for which such schemes have been applied. The development of this new edited volume indicates the interest and value of this topic by an increasing number of researchers. An additional, but significant, aspect of this work is that the mathematical basis for NSFD methods is beginning to be studied. These efforts give insight into why such techniques "work" and allow the possibility for their generalization.

This book may be considered an update and extension of the previous edited volume. It consists of fourteen chapters arranged by alphabetical ordering based on the names of the first author for each individual chapter. Our editorial work consisted of having each chapter reviewed for technical correctness and checking for minor errors resulting from typos, misspellings, etc. We have not attempted to change any of the written text into standard American English, but, have pragmatically allowed the use of "international scientific English."

This book contains fourteen chapters, each written by researchers who have applied NSFD methods to investigate particular systems in the natural and/or engineering sciences. The first chapter provides a very brief overview of the fundamental rules for constructing NSFD schemes and a definition

[a]R. E. Mickens (editor), *Application of Nonstandard Finite Difference Schemes* (World Scientific, Singapore, 2000).
[b]R. E. Mickens, "Exact solutions to a finite difference model of a reaction-advection equation: Implications for numerical analysis," *Numerical Methods for Partial Differential Equations* ***5*** (1989), 313–325.

of dynamic consistency (DC). This principle, along with the concept of positivity preserving schemes, plays an extremely important role in the formulation of NSFD schemes for several classes of ordinary and partial differential equations. The chapter concludes with a partial listing of several outstanding problems that need to be resolved within the framework of NSFD methods. The other thirteen chapters consider a wide range of topics:

- simulation of robotic systems
- boundary value problems for Bratu-Gel'Fand and related problems
- computational electromagnetics
- nonlinear micro heat transport
- single and multi-species interacting populations
- non-smooth mechanical systems
- asymptotic consistency in discrete models arising in population biology
- SI, SIS, and multi-population competition models
- robust discretizations and time step-size behavior for chaotic systems
- contributions to the theory of NSFD methods
- singular perturbation problems
- frequency accurate finite difference methods
- Lotka-Volterra systems

The preface to the previous (2000) edited volume contains the following paragraph: "As a contributor to and editor of this volume, I look forward to both personally extending the current knowledge of nonstandard schemes and for advances that will come from the efforts of others. While these schemes may not presently resolve all of the difficulties involved with finite difference models of differential equations, their use clearly gives in many cases much better discrete models than ones obtained using standard methods. My general view is that nonstandard schemes have an exciting future and will provide exciting opportunities for new results in pure mathematics and improved numerical solutions of differential equations." The contributions in this current volume show these sentiments to be true.

Finally, I want to express appreciation to my many colleagues for both their interest in NSFD methods and for the many collaborations that have arisen. As always, I am particularly grateful to Annette Rohrs for her editorial work and related activities that led to the smooth integration of the various manuscripts into a document from which this volume was constructed. Clearly, without her efforts, this publishing project could not have been completed. For support of my research on NSFD methods, during the period 1988–2005, I wish to thank the following agencies and programs for funds: Army Research Office, Department of Energy, the MBRS-SCORE Program at Clark Atlanta University, and NASA.

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