# PREFACE

The impetus for this book was a conversation I had with my friend, Dr. Jenq-Neng Hwang, during the 1996 ICASSP conference. When I asked why few applications were presented, Jenq-Neng replied that most professors do not have access to data, especially the physiologic data in which I am interested. Later that year, I saw an advertisement in *EMBS Magazine* soliciting book proposals and decided to write a book that could serve to bridge the gap between industrial medical instrumentation applications and academic system theory.

This text is divided into four parts. In Part I, classic and current filtering techniques for real-time applications are discussed. These include frequency-selective filters, the pseudorandom binary sequence, adaptive filters, time-frequency representations, and time-scale representations. In Part II, modeling techniques for real-time applications are discussed. These include the autoregressive moving average with exogenous input model, the artificial neural network model, and the fuzzy model. In Part III, linear and nonlinear compartmental models are discussed. These models have been applied to physiologic data such as metabolite and drug transport with uneven sampling intervals. In Part IV, algorithmic implementations and the need for more system theory in the medical instrumentation industry are highlighted.

## RECOMMENDED READING STRATEGIES

This book is intended as a textbook for a system theory applications course, within the medical instrumentation course series of a biomedical engineering/bioengineering graduate program. It may also be used as a reference book for industrial medical instrumentation. The chapters are intentionally organized in groups of two chapters, with the first chapter describing a system theory technology, and the second chapter describing an industrial application of this technology. Although this organization is somewhat unorthodox, it is designed to sustain the interest of graduate students.

Each theory chapter contains a general overview of a system theory technology, which is intended as background material for the application chapter, rather than as a comprehensive review. Textbooks that may serve as references for each technology are recommended at the end of each theory chapter. Each application chapter contains a history of the highlighted medical instrument, summary of appropriate physiology, discussion of the problem of interest and previous empirical solutions, and review of a solution that utilizes the theory in the previous chapter. When a new term is first introduced, it is set in boldface, and defined in the Glossary. Depending on the reader's background, it is recommended that the chapters be read in the following order:

*Biomedical engineering researchers and graduate students with system theory background:*

Chapters 1–18—original order

*Medical instrumentation engineers:*

Chapter 18—summary chapter
Even numbered chapters—application chapters
Odd numbered chapters—background theories corresponding to applications of interest
Chapter 17—optional; implementation chapter

*Other biomedical engineering researchers and graduate students:*

Even numbered chapters—application chapters
Odd numbered chapters—background theories corresponding to applications of interest
Chapters 17–18—implementation chapters

*Electrical engineering researchers and graduate students with system theory background:*

Even numbered chapters—background applications corresponding to theories of interest (except Chapters 14, 16)
Chapters 17–18—implementation chapters
Chapters 1, 3, 5, 7, 9, 11—optional; theory chapters
Chapters 13–16—optional; contains advanced physiology and biochemistry

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