Preface to the Third Edition

This edition was motivated in large part by the continuously changing educational environment in biomedical engineering. The wide-ranging expertise expected of a competent biomedical engineer continues to grow, putting additional stress on curricula and courses. This text provides a comprehensive introductory coverage of linear systems, including circuit analysis. Not all of the material can be covered in a single 3-h course; rather the book is designed to allow the instructor to choose those topics deemed most essential and to be able to find them in a single, coherent text.

NEW TO THIS EDITION

The third edition presents a number of modifications over the previous text primarily in the form of new material. Each chapter now begins with a section describing and listing the goals of that chapter and ends with a summary of topics covered. In addition, several new chapters have been added.

Noise is ubiquitous in biomedical measurements and nonlinearity is inherent in most biomedical systems. These important measurement features required a new chapter on stochastic, nonstationary, and nonlinear systems and signals. A chapter on basic image analysis has been added along with introductory material. This chapter extends some one-dimensional signal processing tools to two dimensions. Although the only discrete systems a biomedical engineer is likely to encounter are digital filters, their importance in signal processing justifies introducing the z-transform before describing digital filters. Finally, a more traditional approach is followed in this edition in which time-domain concepts such as convolution are presented before introducing frequency-domain analyses.

Many biomedical engineering programs cover circuits in a separate course (usually in electrical engineering). Yet there may come a time when programs include this material, so a section on circuits remains at the end of the book. Chapter 15 on electronics is not usually included in a linear systems course, but since the students will have the necessary background to analyze useful circuits, I thought it worth including. Not all instructors will choose to include these new topics, but they are relevant and I feel they should be available as options. The chapters on circuits also include sections on lumped-parameter mechanical systems that should be considered optional.

Retained from earlier editions is the strong reliance on MATLAB®. This software is an essential adjunct to understanding signals and systems, and this book is not meant to be used without this powerful pedagogical tool. Another concept from earlier editions is the development of some of the deeper concepts, such as the Fourier transform and the transfer function, using an intuitive approach. For example, the Fourier transform is presented in the context of correlation between an unknown signal and a family of sinusoidal probing functions.

The general philosophy of this text is to introduce and develop concepts through computational methods that allow students to explore operations such as correlations, convolution, the Fourier transform, and the transfer function. I also include a few examples and problems that follow more traditional methods of mathematical rigor. A few more intriguing problems have been sprinkled into the problem sets for added interest and challenge, and many more problems are now based on biological examples.

ANCILLARIES

The text comes with a number of educational support materials. For purchasers of the text, a website contains downloadable data and MATLAB® functions needed to solve the problems, a few helpful MATLAB® routines, and all of the MATLAB® examples given in the book. Since many of the problems are extensions or modifications of examples, these files can be helpful in reducing the amount of typing required to carry out an assignment. Please visit www.elsevierdirect.com, search on "Semmlow," select the link to "Circuits, Signals, and Systems for Bioengineers - 3rd Edition," and click on the "companion site" link on the book's web page to download this material.

For instructors, an educational support package is available that contains a set of PowerPoint files that include all of the figures and most of the equations along with supporting text for each chapter. This package also contains the solutions to the problem sets and some sample examinations. The package is available for download from the publisher at: www.textbooks.elsevier.com.

John L. Semmlow, PhD
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