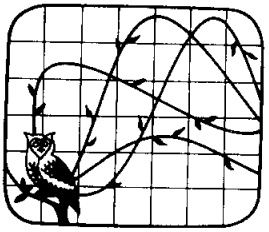
Circuits and Systems

A Modern Approach



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Circuits and Systems

A Modern Approach

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Preface

In recent years, system design has undergone fundamental changes. With the advances in integrated circuits and microprocessors it is possible today to perform digitally and in real time most functions traditionally carried out with analog systems. These developments are incorporated into the programs of most schools in the form of new courses in digital systems and signal processing. The shift in emphasis, however, from classical analog to modern digital concepts is limited mainly to graduate and advanced undergraduate courses. The core curriculum has not been substantially affected.

There seems to be general agreement among educators that the first principles of modeling and analysis should be introduced along the traditional lines of D.C. and A.C. circuits. However, although it is recognized that the core curriculum also should cover digital design methods, it is evident from the lack of uniformity in the second-level courses that there is no consensus on the approach. This suggests a need for innovation.

Recently, I undertook the task of revising our junior-year program in circuits and systems. After careful consideration of various approaches, I concluded that digital techniques should not be taught as a separate unit but should be developed as an integral part of a unified course in system theory and design. I hope to show in this book that this approach is more economical, that it contributes to a better understanding of Laplace transforms, z-transforms, differential equations, and recursion equations and, most importantly, that it clarifies the link between digital and analog concepts.

The prerequisites for the book are modest: basic calculus and sophomore-level mastery of D.C. and A.C. circuits. Some familiarity with differential equations and analog systems is desirable but not essential. No prior knowledge of Laplace transforms, z-transforms, discrete systems, or recursion equations is assumed. These topics are developed systematically from first principles.

The first five chapters of the book form a self-contained unit that can be used as the basis for a one-semester junior course in analysis and simulation. The entire book requires two semesters. However, if prior familiarity with Laplace transforms and Fourier series is assumed, it could be covered in one semester.

The following features might be noteworthy:

Concentration on fundamental ideas explained in the context of simple illustrations.
Parallel development of analog and digital systems.

Emphasis on the concepts of linearity, superposition, impulse response, frequency response, and system function.
Brief but complete treatment of Laplace transforms and z-transforms.
Introduction to digital and sampled-analog simulation based on the approximation of the convolution integral by a sum.
Overview of classical synthesis, passive and active, and modern synthesis involving digital systems and electronic delay lines.
Introduction of discrete Fourier series and fast Fourier transforms in the context of ordinary Fourier series.

I should add that the objective of this book is not merely the presentation of the fundamentals of systems. The material is developed as a deductive discipline that can also be used as a vehicle for strengthening the student's analytical ability in the context of an engineering course.

The book is based on a course designed for the first undergraduate class (EE'78) of the Farmingdale branch of the Polytechnic Institute of New York. In the planning of the course and in the preparation of the manuscript, I was assisted by my colleague Christos Chamzas. It is a pleasure to acknowledge his contributions. I wish, also, to express my appreciation to Mrs. Nina Adamo for her expert typing of the manuscript.

Athanasios Papoulis

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