Electronic Signals and Systems

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Electronic Signals and Systems

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List of Computer Programs

The following BASIC programs appear in the main text

<i>Program no.</i>	<i>Title</i>	<i>Page</i>
1	Moving-average low-pass filter	74
2	Discrete-time convolution	77
3	Synthesis of rectangular pulse	139
4	Discrete-time Fourier Series	190
5	Fast Fourier Transform	207
6	Discrete-time oscillator	293
7	Hanning data-window	309
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All programs have been developed and tested on an Amstrad personal microcomputer. They use relatively few of the available BASIC instructions, and should run on a wide range of other machines with only minor modifications.

Most programs include both a *plot option* and a *print option* for the output. The relevant program lines may be included or omitted, as required. The plot options use the Amstrad BASIC instructions CLS (clear screen), PLOT (plot pixel at stated X, Y coordinates), and DRAW (draw line to stated X, Y coordinates). They are based on a screen resolution of 640×400 pixels. All plots have been kept simple, and it should be straightforward to produce equivalent graphical outputs on other computers.

In most cases programs are based on mathematics developed in the accompanying text. Their structure and content should therefore be clear to the reader. The only exceptions are program no. 5 and program no. 8. These are presented without detailed explanation, and used to illustrate important techniques described in more general terms in the text.

Preface

This book is designed as an introductory text in electronic signals and systems for the early stages of degree courses in universities and polytechnics. Its level and scope should make it suitable not only for electronic and electrical engineering courses, but also for those covering other branches of engineering, physics, and computer studies. The initial pace of the book is deliberately gentle. Students with very little previous knowledge of electronics should find its first few chapters quite easy to follow.

Pressure on the electronic and electrical syllabus continues to grow. New material, particularly in microelectronics and computing, constantly competes for the student's time. Yet most lecturers (and employers) are reluctant to see important topics such as linear circuit theory, communications, and control seriously reduced. A partial solution to the problem is to teach Signals and Systems early in the course, using it as a foundation for much that follows. This can substantially reduce double-teaching. It also has the great intellectual advantage for the student of emphasising links between the many branches of electronic engineering.

Quite a number of Signals and Systems textbooks have appeared in recent years. However, in my view these are often too difficult for the early stages of an undergraduate course. Furthermore, many use a 'black box' approach. Students get much of their initial motivation from practical work with circuits, and they appreciate a Signals and Systems approach which illustrates ideas with circuit applications. I have decided to meet this need by including many examples based on operational amplifier techniques. These have the advantage of requiring no detailed understanding of active devices or circuits.

The book offers a number of features

A unified treatment of continuous-time and discrete-time signals and systems.

A thorough introduction to time and frequency domain analysis.

Circuit examples—passive and active, analog and digital—to illustrate the text.

Worked examples in the text, problems at the end of each chapter, and solutions at the end of the book.

BASIC computer programs, integrated with the main text, to illustrate important concepts and applications.

The last item deserves a little explanation. Digital computers are becoming more and more important in teaching, and many students now have the use of a personal microcomputer. All programs in this book are suitable for such machines, and I believe that most readers will gain a

lot by using them. I should add that the programs are included as aids to understanding signals and systems, *not* computer programming. I make no claims at all for them in this latter respect.

In slightly more detail, the first two chapters are intended as a gentle introduction to the background and scope of the subject. I have, with some misgivings, decided to summarise the basic circuit ideas needed for this book in chapter 1. The aim here is to make the book self-contained. I have emphasised in the text itself that these sections are in no sense to be regarded as a course in circuit theory! Chapters 3 to 6 offer a fairly conventional account of the basic tools of signal and system analysis. Convolution is covered *before* frequency-domain transforms, because discrete-time convolution is so straightforward and illuminating. If the student understands it well, such notions as the transient and steady-state response of a system, stability, causality, and so on, present very little difficulty. I hope that these first six chapters form a coherent and readable introduction to linear signal and system theory. I have tried to suggest and include plenty of applications, and have commented on some of the practical problems of design. The chapters contain many cross-references, and should preferably be studied in the correct sequence.

Chapter 7 consolidates and extends ideas about feedback, and introduces a number of important applications. I have tried to show how the major characteristics of negative and positive feedback are put to use in a variety of practical systems—analog and digital. Chapter 8 on signal processing first covers signal sampling and reconstitution with some care. It then outlines the processes of signal truncation and windowing, and introduces analog and digital versions of the widely used Butterworth and Chebyshev filter families. These last two chapters are independent of one another, although each relies heavily on material in chapters 1 to 6. They may therefore be included, or omitted, as required.

It would be impossible to list all the sources which I used, consciously or unconsciously, in the writing of this book. I have referred to numerous books on signal analysis, system theory, circuits, and filters. I have also drawn on personal experience, lecture notes generated over a number of years, and unrecorded conversations with colleagues. I gratefully acknowledge all these contributions. I also wish to make a few more specific acknowledgements. Dr W.A. Atherton's excellent book on the history of electrical and electronic engineering, *From Compass to Computer* (Macmillan, 1984), suggested the use of the photographs and historical material in chapter 1. I am grateful for permission from the Bell Laboratories, the Siemens Museum, the Marconi Company, and *Punch* magazine, to include them. I should finally like to record my thanks to Jeana Price for all her work on the typescript; and to express gratitude to those, near and far, without whose support this book would not have been completed.

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