# PREFACE

The tremendous power and usefulness of digital techniques and systems can be seen from the wide variety of industrial machinery, computers, microprocessors, household appliances (washing machines, refrigerators, digital TVs, etc.), medical equipment, internet, e-banking, e-business, e-governance, etc. which are based on the principles of digital electronics. The areas of applications of digital electronics have been increasing day by day, resulting in an unprecedented interest in the subject. In fact, digital systems have invaded all walks of life and have created a digital revolution.

One of the most important reasons for the unprecedented growth of digital electronics is the advent of integrated circuits (ICs). Developments in the IC technology have made it possible to fabricate complex digital circuits, such as microprocessors, memories, complex programmable logic devices (CPLDs) and field programmable gate arrays (FPGAs), etc.

The wonderchip **microprocessor** has been the most fantastic development of the recent years. No other single development has affected our lives as much as the microprocessor in such a short time. Its ever-increasing applications have resulted in developments which were simply unheard of until a few years ago. The emergence of various programmable logic devices have resulted in significant changes in the design methodologies of digital systems. The designers of modern digital systems in industry rarely use conventional manual techniques. Instead, computer aided design (CAD) tools are used. But this has not made the basic concepts and the manual techiques of digital theory and practice obsolete. Rather, the manual techniques are the foundation of CAD tools and they provide a clear insight into the CAD tools. Therefore, it is very essential to have a strong foundation of the basic digital techniques in order to make effective use of automation in design.

This has made it imperative for all those who aspire to design, develop, test, and maintain various electronic systems to learn the principles of modern digital devices and systems.

This book deals with the subject of digital techniques and systems from the basic circuits (gates) to small scale integrated circuits (SSI), medium scale integrated circuits (MSI), large scale integrated circuits (LSI), and very large scale integrated circuits (VLSI). Computer aided design concepts, CAD tools and the hardware description language VHDL have been introduced to familiarize the readers with the CAD techniques.

This book is self contained and is suitable for a course in digital electronics and logic design for electrical, electronics, computer and other engineering disciplines and computer science programmes. Students of physics specializing in electronics will also find the book useful.

The book has been systematically organized and the presentation has been kept at a level suitable for a student with the basic knowledge of circuit theory and electronics.

Chapter 1 introduces the fundamental concepts of digital electronics, advantages of digital systems, and the basic digital circuits. Various number systems and commonly used codes in digitial systems and microprocessors have been discussed in Chapter 2. Error-detecting and error-correcting codes have also been included. Chapter 3 reviews semiconductor devices from the point of view of their applications in digital circuits. Based on these devices, various digital circuits, referred to as logic families, have been discussed in Chapter 4. Availability of various digital functions in ICs have changed the teaching of digital electronics from the good old style using discrete devices to a new style using modern digital ICs. For example, now it is no longer important to minimize the number of gates for the design of a digital circuit, since a number of similar gates are available in a single IC chip; rather it has become necessary to minimize the number of IC packages. Thus the designers of digital systems have to be thoroughly familiar with the principles of operation and flexibilities available in various ICs in order to optimize the design of digital systems from the point of view of cost, space, power requirement, speed of operation, etc. This chapter also deals with the interfacing problems between ICs of the same logic families and between those of different logic families to obtain maximum benefits.

Chapter 5 deals with the conventional methods of combinational circuit design. The Quine-McCluskey method has also been included.

Combinational logic design using MSI circuits is covered in Chapter 6, which is important for the design of digital systems considering the simplicity in design, cost, space, power requirement, speed and other factors.

Chapter 7 introduces the basic building block of a sequential circuit—the FLIP-FLOP. All types of FLIP-FLOPs with their excitation tables and triggering methods have been discussed in detail. Sequential logic design has been discussed in Chapter 8. Here again, both the approaches, namely conventional design using FLIP-FLOPs and the modern approach using available MSI circuits, have been discussed. Design of synchronous sequential as well as asynchronous sequential circuits have been discussed.

Chapter 9 deals with timing circuits and their applications which are essential to a digital system.

The analog-to-digital (A/D) and digital-to-analog (D/A) converters form an important part of many digital systems and the commonly used techniques for such conversions have been discussed in Chapter 10.

Chapter 11 deals with semiconductor memories which have assumed an important role in present-day digital systems. Various semiconductor memories, such as static and dynamic shift registers, static and dynamic RAMs, ROM, PROM, EPROM, EAROM, CAM, and CCD, have been discussed in detail. Programming techniques used for programmable ROMs and erasing techniques used for erasable programmable ROMs have also been discussed.

Chapter 12 presents various programmable logic devices (PLDs), such as programmable logic arrays (PLA), programmable array logic (PAL), Complex Programmable logic devices

(CPLDs) and field programmable gate array (FPGA) devices. These devices are extremely useful for the design of complex digital circuits.

Microprocessors have been introduced in Chapter 13. The fundamentals of microprocessors have been presented in a manner so that even a novice would understand this highly sophisticated device. The most widely used Intel 8085A 8-bit microprocessor has been chosen for discussion. Its organization, operation and programming have been discussed in detail, which will help the students learn the use of microprocessors. The Intel's 16-bit microprocessor 8086 has also been introduced briefly.

Chapter 14 introduces the computer aided design (CAD) approach to digital system design. CAD tools needed for this purpose have been discussed. The VHDL, a hardware description language, has been introduced, which is the basic requirement of designing using CAD tools.

A Glossary of the important terms used in the book and Review Questions with answers for each chapter have been included to enhance the understanding of the users.

The solution manual is also available for the teachers who adopt this book.

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