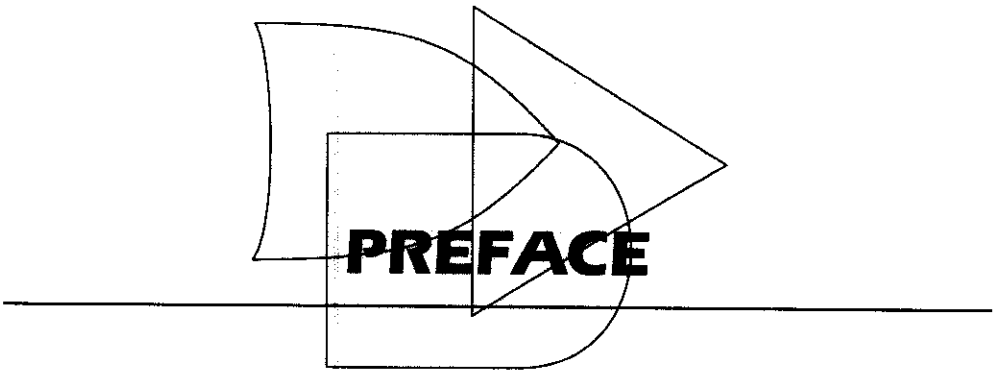

Digital Design is concerned with the design of digital electronic circuits. The subject is also known by other names such as logic design, digital logic, switching circuits, and digital systems. Digital circuits are employed in the design of systems such as digital computers, control systems, data communications, and many other applications that require electronic digital hardware. This book presents the basic tools for the design of digital circuits and provides methods and procedures suitable for a variety of digital design applications.

Many features of the second edition remain the same as those of the first edition. The material is still organized in the same manner. The first five chapters cover combinational circuits. The next three chapters deal with synchronous clocked sequential circuits. Asynchronous sequential circuits are introduced next. The last three chapters deal with various aspects of commercially available integrated circuits.

The second edition, however, offers several improvements over the first edition. Many sections have been rewritten to clarify the presentation. Chapters 1 through 7 and Chapter 10 have been revised by adding new up-to-date material and deleting obsolete subjects. New problems have been formulated for the first seven chapters. These replace the problem set from the first edition. Three new experiments have been added in Chapter 11. Chapter 12, a new chapter, presents the IEEE standard graphic symbols for logic elements.

The following is a brief description of the subjects that are covered in each chapter with an emphasis on the revisions that were made in the second edition.

Chapter 1 presents the various binary systems suitable for representing information in digital systems. The binary number system is explained and binary codes are illustrated. A new section has been added on signed binary numbers.

Chapter 2 introduces the basic postulates of Boolean algebra and shows the correlation between Boolean expressions and their corresponding logic diagrams. All possible logic operations for two variables are investigated and from that, the most useful logic gates used in the design of digital systems are determined. The characteristics of integrated circuit gates are mentioned in this chapter but a more detailed analysis of the electronic circuits of the gates is done in Chapter 11.

Chapter 3 covers the map and tabulation methods for simplifying Boolean expressions. The map method is also used to simplify digital circuits constructed with AND-OR, NAND, or NOR gates. All other possible two-level gate circuits are considered and their method of implementation is summarized in tabular form for easy reference.

Chapter 4 outlines the formal procedures for the analysis and design of combinational circuits. Some basic components used in the design of digital systems, such as adders and code converters, are introduced as design examples. The sections on multilevel NAND and NOR implementation have been revised to show a simpler procedure for converting AND-OR diagrams to NAND or NOR diagrams.

Chapter 5 presents various medium scale integration (MSI) circuits and programmable logic device (PLD) components. Frequently used digital logic functions such as parallel adders and subtractors, decoders, encoders, and multiplexers, are explained, and their use in the design of combinational circuits is illustrated with examples. In addition to the programmable read only memory (PROM) and programmable logic array (PLA) the book now shows the internal construction of the programmable array logic (PAL). These three PLD components are extensively used in the design and implementation of complex digital circuits.

Chapter 6 outlines the formal procedures for the analysis and design of clocked synchronous sequential circuits. The gate structure of several types of flip-flops is presented together with a discussion on the difference between pulse level and pulse transition triggering. Specific examples are used to show the derivation of the state table and state diagram when analyzing a sequential circuit. A number of design examples are presented with added emphasis on sequential circuits that use D-type flip-flops.

Chapter 7 presents various sequential digital components such as registers, shift registers, and counters. These digital components are the basic building blocks from which more complex digital systems are constructed. The sections on the random access memory (RAM) have been completely revised and a new section deals with the Hamming error correcting code.

Chapter 8 presents the algorithmic state machine (ASM) method of digital design. The ASM chart is a special flow chart suitable for describing both sequential and parallel operations with digital hardware. A number of design examples demonstrate the use of the ASM chart in the design of state machines.

Chapter 9 presents formal procedures for the analysis and design of asynchronous sequential circuits. Methods are outlined to show how an asynchronous sequential cir-

cuit can be implemented as a combinational circuit with feedback. An alternate implementation is also described that uses SR latches as the storage elements in an asynchronous sequential circuit.

Chapter 10 presents the most common integrated circuit digital logic families. The electronic circuits of the common gate in each family is analyzed using electrical circuit theory. A basic knowledge of electronic circuits is necessary to fully understand the material in this chapter. Two new sections are included in the second edition. One section shows how to evaluate the numerical values of four electrical characteristics of a gate. The other section introduces the CMOS transmission gate and gives a few examples of its usefulness in the construction of digital circuits.

Chapter 11 outlines 18 experiments that can be performed in the laboratory with hardware that is readily and inexpensively available commercially. These experiments use standard integrated circuits of the TTL type. The operation of the integrated circuits is explained by referring to diagrams in previous chapters where similar components are originally introduced. Each experiment is presented informally rather than in a step-by-step fashion so that the student is expected to produce the details of the circuit diagram and formulate a procedure for checking the operation of the circuit in the laboratory.

Chapter 12 presents the standard graphic symbols for logic functions recommended by ANSI/IEEE standard 91-1984. These graphic symbols have been developed for SSI and MSI components so that the user can recognize each function from the unique graphic symbol assigned to it. The best time to learn the standard symbols is while learning about digital systems. Chapter 12 shows the standard graphic symbols of all the integrated circuits used in the laboratory experiments of Chapter 11.

The various digital componets that are represented throughout the book are similar to commercial MSI circuits. However, the text does not mention specific integrated circuits except in Chapters 11 and 12. The practical application of digital design will be enhanced by doing the suggested experiments in Chapter 11 while studying the theory presented in the text.

Each chapter in the book has a list of references and a set of problems. Answers to most of the problems appear in the Appendix to aid the student and to help the independent reader. A *solutions manual* is available for the instructor from the publisher.

M. Morris Mano