PREFACE

This book is intended as an introductory logic design book for students in computer science, computer engineering, and electrical engineering. It has no prerequisites, although the maturity attained through an introduction to engineering course or a first programming course would be helpful.

The book stresses fundamentals. It teaches through a large number of examples. The philosophy of the author is that the only way to learn logic design is to do a large number of design problems. Thus, in addition to the numerous examples in the body of the text, each chapter has a set of Solved Problems, that is, problems and their solutions, a large set of Exercises (with answers to selected exercises in Appendix B), and a Chapter Test (with answers in Appendix C). Also, six complete examples (from word problem to circuit design) are included in Appendix E. Three of these are combinational and can be used after Chapter 3, and the others are sequential, to follow Chapter 7. In addition, there is a set of laboratory experiments that tie the theory to the real world. Appendix D provides the background to do these experiments with a standard hardware laboratory (chips, switches, lights, and wires), a breadboard simulator (for the PC or Macintosh), and two schematic capture tools. The course can be taught without the laboratory, but the student will benefit significantly from the addition of 8 to 10 selected experiments.

Although computer-aided tools are widely used for the design of large systems, the student must first understand the basics. The basics provide more than enough material for a first course. The schematic capture laboratory exercises and sections on Hardware Design Languages in Chapters 4 and 8 provide some material for a transition to a second course based on one of the computer-aided tool sets.

Chapter 1, after a brief introduction, gives an overview of number systems as it applies to the material of this book. (Those students who have studied this in an earlier course can skip this chapter.)

Chapter 2 discusses the steps in the design process for combinational systems and the development of truth tables. It then introduces switching algebra and the implementation of switching functions using common gates—AND, OR, NOT, NAND, NOR, Exclusive-OR, and Exclusive-NOR. We are only concerned with the logic behavior of the gates, not the electronic implementation.

Although the Karnaugh map is not introduced until Chapter 3, those who wish to use it in conjunction with algebraic simplification can cover Section 3.1 after Section 2.6, and find a number of examples relating the algebra to the map in Appendix A.

Chapter 3 deals with simplification using the Karnaugh map. It provides methods for solving problems (up to six variables) with both single and multiple outputs.

Chapter 4 introduces two algorithmic methods for solving combinational problems—the Quine-McCluskey method and iterated consensus. Both provide all of the prime implicants of a function or set of functions, and then use the same tabular method to find minimum sum of products solutions.

Chapter 5 is concerned with the design of larger combinational systems. It introduces a number of commercially available larger devices, including adders, comparators, decoders, encoders and priority encoders, and multiplexers. That is followed by a discussion of the use of logic arrays—ROMs, PLAs, and PALs for the implementation of medium-scale combinational systems. Finally, two larger systems are designed.

Chapter 6 introduces sequential systems. It starts by examining the behavior of latches and flip flops. It then discusses techniques to analyze the behavior of sequential systems.

Chapter 7 introduces the design process for sequential systems. The special case of counters is studied next. Finally, the solution of word problems, developing the state table or state diagram from a verbal description of the problem is presented in detail.

Chapter 8 looks at larger sequential systems. It starts by examining the design of shift registers and counters. Then, PLDs (logic arrays with memory) are presented. Three techniques that are useful in the design of more complex systems—ASM diagrams, one-hot encoding, and HDLs—are discussed next. Finally, two examples of larger systems are presented.

Chapter 9 (available on the web site of the book, http://www.mhhe.com/marcovitz) deals with state reduction and state assignment issues. First, a tabular approach for state reduction is presented. Then partitions are utilized both for state reduction and for achieving a state assignment that will utilize less combinational logic.

A feature of this text is the Solved Problems. Each chapter has a large number of problems, illustrating the techniques developed in the body of the text, followed by a detailed solution of each problem. Students are urged to solve each problem (without looking at the solution) and then compare their solution with the one shown.

Each chapter contains a large set of exercises. Answers to a selection of these are contained in Appendix B. Solutions will be made available to instructors through the Internet. In addition, each chapter concludes with a Chapter Test; answers are given in Appendix C.

Another unique feature of the book is the laboratory exercises, included in Appendix D. Three platforms are presented—a hardware-based Logic Lab (using chips, wires, etc.); a hardware lab simulator that allows the student to "connect" wires on the computer screen; and a circuit capture program, LogicWorks. Enough information is provided about each to allow the student to perform a variety of experiments. A set of 26 laboratory exercises are presented. Several of these have options, to allow the instructor to change the details from one term to the next.

We teach this material as a four-credit course that includes an average of three and a half hours per week of lecture, plus, typically, eight laboratory exercises. (The lab is unscheduled; it is manned by Graduate Assistants 40 hours per week; they grade the labs.) In that course we cover

Chapter 1: all of it

Chapter 2: all but 2.11

Chapter 3: all of it

Chapter 5: all but 5.8. However, there is a graded design problem based on that material (10 percent of the grade; students usually working in groups of 2 or 3).

Chapter 6: all of it

Chapter 7: all of it

Chapter 8: 8.1, 8.2, 8.3. We sometimes have a second project based on 8.7.

Chapter 9 and Chapter 4: We often have some time to look at one of these. We have never been able to cover both.

With less time, the coverage of Section 2.10 could be minimized. Section 3.5 is not needed for continuity; Section 3.6 is used somewhat in the discussion of PLAs in Section 5.7.2. Chapter 5 is not needed for anything else in the text, although many of the topics are useful to students elsewhere. The instructor can pick and choose among the topics. The *SR* and *T* flip flops could be omitted in Chapters 6 and 7. Sections 7.2 and 7.3 could be omitted without loss of continuity. As is the case for Chapter 5, the instructor can pick and choose among the topics of Chapter 8. With a limited amount of time, Section 9.1 could be covered. With more time, it could be skipped and state reduction taught using partitions (Sections 9.2 and 9.3).

WEBSITE

Teaching and learning resources are available on the website that accompanies this text. For students, these resources include quiz files and sample tests. For instructors, a solutions manual, PowerPoint lecture outlines, and other resources are available. The web address for this site is http://www.mhhe.com/marcovitz.

ELECTRONIC TEXTBOOK OPTIONS

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