
Preface

This selected reprint volume is intended for graduate students in electrical and computer engineering as well as practicing engineers, and provides the knowledge and techniques necessary for a good and successful design. This selection of articles deals with issues in logic and circuit design of complex and high-performance systems. These issues range from implementation technology and circuit techniques to pipelining and clocking, as well as system and architectural matters such as mapping an algorithm into a particular implementation technology.

The book is suitable for a one-semester course in Advanced Digital Design and, with some omissions, it is possible to cover the material in one quarter. I have taught such a course since 1992, and the material covered has changed and evolved over the years as technology changed very rapidly. However, a core set of papers remained in this collection regardless of publication date. This book is oriented around this material and supplemented with contemporary results; the core material is presented in its original form because it contains the fundamentals upon which later results were built. Therefore, the useful life of this edited volume should be much longer than a normal technology cycle.

This book resulted from teaching a course in Advanced Logic Design. However, the idea for this course, and consequently this book, came from many papers and design ideas that I collected over the years at the IBM T. J. Watson Research Center and other places in the industry. After I introduced those papers to the academic world, I realized that much of this material was never taught to students. It often left them struggling for important bits of knowledge as they acquired their experience in the industry. Therefore, I decided to create a course and teach this material. Over the years in teaching this course in an academic setting and in short industrial courses through the University of California Extension, the material evolved into a comprehensive set that is covered in this book.

At the suggestion of the IEEE Press editors John Griffin and Russ Hall, I wrote an introduction to each chapter that briefly explains the chapter's main points and ideas. From the introduction, the reader can expand on those ideas by reading the collection of papers that follow.

Chapter 1 contains a set of papers on advanced circuits that are used to implement high-speed logic. This chapter covers dynamic and differential CMOS, and the majority of papers are fundamentally necessary for understanding the new developments and circuit techniques used in today's high-speed processors. The latter part of this chapter focuses on new pass-transistor circuit techniques such as CPL, DPL, DVL, and SRPL which are showing promising results.

Chapter 2 includes papers on BiCMOS technology and advanced ECL circuits that are combining bipolar and MOS technology. Those circuit techniques were used in very high-performance systems and are still finding use in the applications that require a mix of bipolar and MOS technology. They are characterized by excellent driving abilities, while the static power consumption has been somewhat reduced.

Chapter 3 describes the techniques for achieving low-power and relates the recent developments in circuits and logic designed to satisfy those requirements. Attention is also given to a research area of energy-recovery logic and development of the appropriate logic families.

Chapter 4 deals with the clocking of systems, clock generation, and clock distribution techniques. It contains papers dealing with timing issues in high-performance systems, as well as design of the high-performance latches and flip-flops as one of the most important components.

Lastly, Chapter 5 contains papers on VLSI algorithms and computer arithmetic that show the relationship between implementation and choice of algorithm. The papers deal with the issues in realizing a fast and technology-optimal ALU, as well as a fast parallel multiplier. Issues involving design of a floating-point unit as well as square root and divide are also covered. Those papers emphasize the importance of choosing the right algorithm and its proper mapping into the selected technology.

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