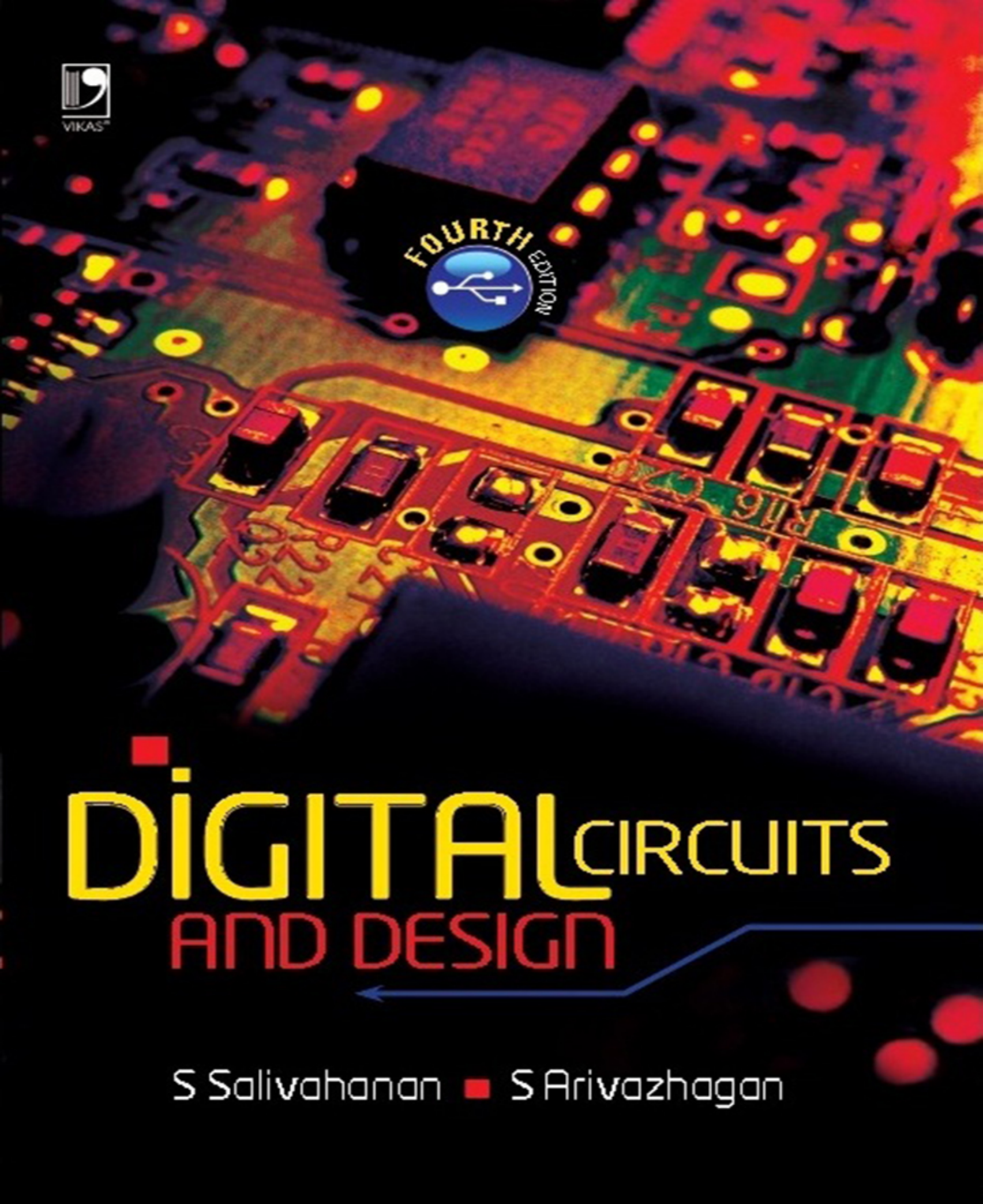
VIKAS
FOURTH EDITION
DIGITAL CIRCUITS
AND DESIGN
S Salivahanan
S Arivazhagan

Digital Circuits and Design

About the Authors

S. Salivahanan is the Principal of SSN College of Engineering, Chennai. He obtained his B.E. degree in Electronics and Communication Engineering from PSG College of Technology, Coimbatore, M E degree in Communication Systems from NIT, Trichy and PhD in the area of Microwave Integrated Circuits from Madurai Kamaraj University. He has three and a half decades of teaching, research, administration and industrial experience both in India and abroad. He had also taught at NIT, Trichy, A C College of Engineering and Technology, Karaikudi, R V College of Engineering, Bangalore, and Mepco Schlenk Engineering College, Sivakasi. He has industrial experience as Scientist/Engineer at Space Applications Centre, ISRO, Ahmedabad, Telecommunication Engineer at State Organisation of Electricity, Iraq and Electronics Engineer at Electric Dar Establishment, Kingdom of Saudi Arabia. He is the author of 26 popular books, which include *Basic Electrical, Electronics and Computer Engineering, Electronic Devices and Circuits* and *Linear Integrated Circuits* all published by TMH, New Delhi and *Digital Signal Processing* by TMH and McGraw-Hill International, which has also been translated into Mandarin, the Chinese language. He has also authored the book titled *Digital Circuits and Design* and also published several papers at the national and international levels.

Professor Salivahanan is the recipient of the Bharatiya Vidya Bhavan National Award for Best Engineering College Principal for 2011 from ISTE, and IEEE Outstanding Branch Counsellor and Advisor Award in the Asia-Pacific region for 1996–97. He was the Chairman of IEEE Madras Section for two years (2008 and 2009) and Syndicate Member of Anna University.

He is the Senior Member of IEEE, Fellow of IETE, Fellow of Institution of Engineers (India), Life Member of ISTE and Life Member of Society for EMC Engineers. He is also a member of IEEE Societies in Microwave Theory and Techniques, Communications, Signal Processing, and Aerospace and Electronics.

S. Arivazhagan is Professor and Head of Department of Electronics and Communication Engineering, Mepco Schlenk Engineering College, Sivakasi. He received his B.E. degree in Electronics and Communication Engineering from A C College of Engineering and Technology, Karaikudi and M.E. degree in Applied Electronics from college of Engineering, Anna University, Chennai. He has more than one and a half decades of teaching and research experience. His areas of interest include Microprocessor-based systems, Computer Communication and Image Processing. He has published several papers at National and International levels. He has been awarded Young Scientist Fellowship by Tamil Nadu State Council for Science and Technology for 1999. He is a Life Member of both IETE and ISTE.

Digital Circuits and Design

Fourth Edition

S. SALIVAHANAN
Principal
S S N College of Engineering
Chennai

S. ARIVAZHAGAN
Professor and Head
ECE, Mepco Schlenk Engineering College
Sivakasi

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First published in 1999
Fourth Edition 2012
ISBN: 978-93-259-6041-1

To
Our Parents

MADURAI KAMARAJ UNIVERSITY

Prof. M. SALIHU
Vice-Chancellor

Palkalainagar,
Madurai - 625021.
11.11.99

Foreword to the First Edition

It gives me immense pleasure to introduce this book Digital Circuits and Design authored by Prof. S. Salivahanan, Head of the department, and Mr. Arivazhagan, Assistant Professor, both from ECE department of Mepco Schlenk Engineering College, Sivakasi. I have known Prof. S. Salivahanan as an Academic Council Member and Member of Board of Studies in Madurai Kamaraj University. I appreciate his sincere efforts in framing the revised syllabus recently for B.E. degree courses in the disciplines of ECE, EEE, EIE and ICE.

Nowadays Digital techniques are used in many gadgets like Telephone, TV, Computers, Clocks, etc. enjoyed by even a common man. Digital Circuits find applications in all branches of Engineering so that students and staff need to have an in-depth knowledge of Digital Circuits and Design. The authors with their rich experience have covered the various topics in simple language along with illustrated examples and exercises.

I feel that this book fills the void of a good textbook in Digital Circuits and Design needed by students and staff. This book will be useful not only for B.E. degree courses but also to B.Sc. in Physics, Electronics and Computer Science, M.Sc. in Physics and Applied Electronics, M.C.A., A.M.I.E., Diploma and Grade I.E.T.E. Courses. A few copies of this book in the libraries of all Colleges and Polytechnics will be found useful.

(M. SALIHU)

Telephone	Grams	Fax	E-Mail
Off: (0452)859166	UNIVERSITY	091-0452-858449	vcmku@pronet.net.in
Res: (0452)602929			
PBX: (0452)858471-75			

Preface to the Fourth Edition

Enhanced use of digital circuits in all disciplines of engineering has created an urge among students to have an in-depth knowledge on them. A single textbook dealing with the basics of digital technology, including the design aspects of circuits, is the need of the hour. We present this revised edition to fulfill the requirements of the students of various BE/BTech, degree courses, including Electronics and Communication Engineering, Electrical and Electronics Engineering, Information Technology, Computer Science and Engineering, and Electronics and Instrumentation Engineering, offered in all Indian universities. The book will also serve as textbook to students of BSc and MSc courses in Electronics and Communication, Information Technology, Computer Science, Applied Physics and Computer Software, MCA, AMIE, Grad. IETE and Diploma courses, and as reference for competitive examinations.

This book is divided into 16 chapters. Each chapter begins with an introduction and ends with review questions and problems. Chapter 1 introduces the number system, binary arithmetic and codes. Chapter 2 deals with Boolean algebra, simplification using Boolean theorems, K-map method and Quine-McCluskey method. In Chapter 3, logic gates and implementation of switching functions using basic and universal gates are discussed. Chapter 4 deals with logic families like TTL and CMOS logic circuits. Chapters 5 and 6 give a brief description on combinational circuits like arithmetic and data processing. Chapter 7 describes flip-flops and realization using flip-flops.

Chapter 8 discusses synchronous and asynchronous counters and the design of synchronous counters in detail. Chapter 9 presents shift registers, shift counters and ring counters and their design. Chapter 10 concentrates on memory devices, which includes ROM, RAM, PLA, PAL and FPGA. Chapters 11 and 12 are devoted to the design of synchronous and asynchronous sequential circuits, respectively. Chapter 13 covers digital to analog and analog to digital converters. Chapters 14 and 15 deal with clock generators and application of digital circuits respectively. Chapter 16 describes Hardware Description Language (HDL) for Digital Circuits. An appendix provides a table of 74XX series TTL gates.

All the topics have been illustrated with clear diagrams. A variety of examples are given to enable students to design digital circuits efficiently.

We sincerely thank the managements of SSN College of Engineering, Chennai, and Mepco Schlenk Engineering College, Sivakasi, for their constant encouragement and providing necessary facilities for completing this project. We express our deep gratitude to Prof M. Salihu, Vice-Chancellor, Madurai Kamaraj University, for giving a Foreword to the first edition of this book. Our colleague Mr Karthie, alias Ayyadurai, has reviewed the additional material. We thank him for his useful comments, which

have improved the book considerably over the previous edition. Our thanks are due to Mr R. Gopalakrishnan for word processing the additional script.

We also thank Dr Debashis De, Department of Computer Science and Engineering, West Bengal University of Technology, for reviewing the additional material.

We specially thank Mr Piyush Chawla, Director, Vikas Publishing House Pvt Ltd, for his initiation to bring out this revised edition in a short span of time.

Professor Salivahanan is greatly thankful to his wife Kalavathy and sons Santhosh Kanna and Subadesh Kanna. Professor Arivazhagan expresses his heartfelt thanks to his wife Rosilin Glory and children Sri Madhu Mitha and Selva Yokesh.

We welcome suggestions for the improvement of the book.

S. Salivahanan
S. Arivazhagan

Preface to the First Edition

The enhanced usage of digital circuits in all disciplines of engineering has created an urge among the students and staff to have an indepth knowledge about Digital Circuits and Design. A single textbook dealing with the basics of digital technology including the design aspects of digital circuits is the need of the day. The authors have made a step in the right direction to fulfill the requirements of the syllabus on the subject of Digital Circuits and Design for B.E. degree courses in Electronics and Communication Engineering, Electrical and Electronics Engineering and Electronic and Instrumentation Engineering. This book will also serve as a textbook to B.Sc (Electronics), M.Sc (Electronics), M.Sc (Applied Physics), A.M.I.E., Grad. I.E.T.E. and diploma courses and as an useful reference for competitive examinations.

The book is divided into 11 chapters. Each chapter begins with an introduction and ends with review questions and problems. Chapter 1 provides an introduction to the number system, binary arithmetic and codes. Chapter 2 is concerned with the Boolean algebra, simplification using Boolean theorems, K-map method and Quine-McCluskey method. In Chapter 3, various logic gates and implementation of switching functions using basic and universal gates are discussed. Chapter 4 deals with various logic families like TTL and CMOS logic circuits. Chapters 5 and 6 give a brief description of combinational circuits like arithmetic and data processing. Chapter 7 describes flip-flops and realization using flip-flops. Chapter 8 discusses synchronous and asynchronous counters and the design of synchronous counters in detail. Chapter 9 presents various shift registers, shift counters and ring counters and their design. Chapter 10 concentrates exclusively on the memory devices, which includes ROM, RAM, PLA, PAL and FPGA. Chapter 11 is devoted to the design of synchronous and asynchronous sequential circuits in detail. An appendix provides a table of 74XX series TTL gates.

All the topics have been illustrated with clear diagrams and simple language is used throughout the textbook to facilitate easy understanding of the concept to the students. A wide variety of worked out examples are given to enable the readers to design digital circuits efficiently.

The authors are greatly thankful to the Management of Mepco Schlenk Engineering College, Sivakasi and Prof. G. Shanmugam, Principal, for their constant encouragement and providing necessary facilities for completing this project in time. They express their deep gratitude to Prof. M. Salihu, Vice-Chancellor of Madurai Kamaraj University for his gesture by giving a Foreword to this book. Our staff memebrs Mr. V. Ilankumaran and Mrs. D. Selvathi have reviewed selected chapters, and also many staff and students have read various portions of the manuscript. The authors thank them for their useful comments, which have improved the book considerably.

Digital Circuits and Design

Publisher : SChand Publications ISBN : 9789325960411

Author : S. Salivahanan & S. Pravin Kumar