

# SWITCHING THEORY FOR LOGIC SYNTHESIS



Tsutomu Sasao

# Switching Theory For Logic Synthesis

**Radomir S. Stanković, Milena  
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Astola**



## **Switching Theory For Logic Synthesis:**

*Switching Theory for Logic Synthesis* Tsutomu Sasao, 2012-12-06 Switching Theory for Logic Synthesis covers the basic topics of switching theory and logic synthesis in fourteen chapters Chapters 1 through 5 provide the mathematical foundation Chapters 6 through 8 include an introduction to sequential circuits optimization of sequential machines and asynchronous sequential circuits Chapters 9 through 14 are the main feature of the book These chapters introduce and explain various topics that make up the subject of logic synthesis multi valued input two valued output function logic design for PLDs FPGAs EXOR based design and complexity theories of logic networks An appendix providing a history of switching theory is included The reference list consists of over four hundred entries Switching Theory for Logic Synthesis is based on the author's lectures at Kyushu Institute of Technology as well as seminars for CAD engineers from various Japanese technology companies Switching Theory for Logic Synthesis will be of interest to CAD professionals and students at the advanced level It is also useful as a textbook as each chapter contains examples illustrations and exercises

*Fundamentals of Logic Design and Switching Theory* Arthur D. Friedman, 1986

**Progress in Applications of Boolean Functions** Tsutomu Sasao, Jon Butler, 2022-05-31 This book brings together five topics on the application of Boolean functions They are 1 Equivalence classes of Boolean functions The number of  $n$  variable functions is large even for values as small as  $n = 6$  and there has been much research on classifying functions There are many classifications each with their own distinct merit 2 Boolean functions for cryptography The process of encrypting decrypting plaintext messages often depends on Boolean functions with specific properties For example highly nonlinear functions are valued because they are less susceptible to linear attacks 3 Boolean differential calculus An operation analogous to taking the derivative of a real valued function offers important insight into the properties of Boolean functions One can determine tests or susceptibility to hazards 4 Reversible logic Most logic functions are irreversible it is impossible to reconstruct the input given the output However Boolean functions that are reversible are necessary for quantum computing and hold significant promise for low power computing 5 Data mining The process of extracting subtle patterns from enormous amounts of data has benefited from the use of a graph based representation of Boolean functions This has use in surveillance fraud detection scientific discovery including bio informatics genetics medicine and education Written by experts these chapters present a tutorial view of new and emerging technologies in Boolean functions

Table of Contents Equivalence Classes of Boolean Functions Boolean Functions for Cryptography Boolean Differential Calculus Synthesis of Boolean Functions in Reversible Logic Data Mining Using Binary Decision Diagrams

**Fourier Analysis on Finite Groups with Applications in Signal Processing and System Design** Radomir S. Stankovic, Claudio Moraga, Jaakko Astola, 2005-08-08 Discover applications of Fourier analysis on finite non Abelian groups The majority of publications in spectral techniques consider Fourier transform on Abelian groups However non Abelian groups provide notable advantages in efficient implementations of spectral methods

Fourier Analysis on Finite Groups with

Applications in Signal Processing and System Design examines aspects of Fourier analysis on finite non Abelian groups and discusses different methods used to determine compact representations for discrete functions providing for their efficient realizations and related applications. Switching functions are included as an example of discrete functions in engineering practice. Additionally, consideration is given to the polynomial expressions and decision diagrams defined in terms of Fourier transform on finite non Abelian groups. A solid foundation of this complex topic is provided by beginning with a review of signals and their mathematical models and Fourier analysis. Next, the book examines recent achievements and discoveries in Matrix interpretation of the fast Fourier transform, Optimization of decision diagrams, Functional expressions on quaternion groups, Gibbs derivatives on finite groups, Linear systems on finite non Abelian groups, Hilbert transform on finite groups. Among the highlights is an in depth coverage of applications of abstract harmonic analysis on finite non Abelian groups in compact representations of discrete functions and related tasks in signal processing and system design including logic design. All chapters are self contained each with a list of references to facilitate the development of specialized courses or self study. With nearly 100 illustrative figures and fifty tables, this is an excellent textbook for graduate level students and researchers in signal processing, logic design and system theory as well as the more general topics of computer science and applied mathematics.

Applications of Zero-Suppressed Decision Diagrams Tsutomu Sasao, Jon T. Butler, 2014-11-01. A zero suppressed decision diagram ZDD is a data structure to represent objects that typically contain many zeros. Applications include combinatorial problems such as graphs, circuits, faults, and data mining. This book consists of four chapters on the applications of ZDDs. The first chapter by Alan Mishchenko introduces the ZDD. It compares ZDDs to BDDs showing why a more compact representation is usually achieved in a ZDD. The focus is on sets of subsets and on sum of products SOP expressions. Methods to generate all the prime implicants PIs and to generate irredundant SOPs are shown. A list of papers on the applications of ZDDs is also presented. In the appendix, ZDD procedures in the CUDD package are described. The second chapter by Tsutomu Sasao shows methods to generate PIs and irredundant SOPs using a divide and conquer method. This chapter helps the reader to understand the methods presented in the first chapter. The third chapter by Shin Ichi Minato introduces the frontier based method that efficiently enumerates certain subsets of a graph. The final chapter by Shinobu Nagayama shows a method to match strings of characters. This is important in routers, for example, where one must match the address information of an internet packet to the proper output port. It shows that ZDDs are more compact than BDDs in solving this important problem. Each chapter contains exercises and the appendix contains their solutions. Table of Contents, Preface, Acknowledgments, Introduction to Zero Suppressed Decision Diagrams, Efficient Generation of Prime Implicants and Irredundant Sum of Products Expressions, The Power of Enumeration, BDD ZDD Based Algorithms for Tackling Combinatorial Explosion, Regular Expression Matching Using Zero Suppressed Decision Diagrams, Authors and Editors Biographies, Index.

**Logic Functions and Equations** Bernd Steinbach, Christian Posthoff, 2009-01-29. Tsutomu Sasao, Kyushu Institute of

Technology Japan The material covered in this book is quite unique especially for people who are reading English since such material is quite hard to find in the U S literature German and Russian people have independently developed their theories but such work is not well known in the U S societies On the other hand the theories developed in the U S are not conveyed to the other places Thus the same theory is re-invented or re-discovered in various places For example the switching theory was developed independently in the U S Europe and Japan almost at the same time 4 18 19 Thus the same notions are represented by different terminologies For example the Shegalkin polynomial is often called complement free ring sum Reed Muller expression 10 or Positive polarity Reed Muller expression 19 Anyway it is quite desirable that such a unique book like this is written in English and many people can read it without any difficulties The authors have developed a logic system called XBOOLE It performs logical operations on the given functions With XBOOLE the readers can solve the problems given in the book Many examples and complete solutions to the problems are shown so the readers can study at home I believe that the book containing many exercises and their solutions 9 is quite useful not only for the students but also the professors

*VLSI-SoC: Advanced Topics on Systems on a Chip* Ricardo Reis, Vincent Mooney, Paul Hasler, 2009-04-13 This book contains extended and revised versions of the best papers that were presented during the fifteenth edition of the IFIP IEEE WG10 5 International Conference on Very Large Scale Integration a global System on a Chip Design CAD conference The 15th conference was held at the Georgia Institute of Technology Atlanta USA October 15 17 2007 Previous conferences have taken place in Edinburgh Trondheim Vancouver Munich Grenoble Tokyo Gramado Lisbon Montpellier Darmstadt Perth and Nice The purpose of this conference sponsored by IFIP TC 10 Working Group 10 5 and by the IEEE Council on Electronic Design Automation CEDA is to provide a forum to exchange ideas and show industrial and academic research results in the field of microelectronics design The current trend toward increasing chip integration and technology process advancements brings about stimulating new challenges both at the physical and system design levels as well in the test of these systems VLSI SoC conferences aim to address these exciting new issues

*VLSI Circuits and Embedded Systems* Hafiz Md. Hasan Babu, 2022-07-29 Very Large Scale Integration VLSI creates an integrated circuit IC by combining thousands of transistors into a single chip While designing a circuit reduction of power consumption is a great challenge VLSI designs reduce the size of circuits which eventually reduces the power consumption of the devices However it increases the complexity of the digital system Therefore computer aided design tools are introduced into hardware design processes Unlike the general purpose computer an embedded system is engineered to manage a wide range of processing tasks Single or multiple processing cores manage embedded systems in the form of microcontrollers digital signal processors field programmable gate arrays and application specific integrated circuits Security threats have become a significant issue since most embedded systems lack security even more than personal computers Many embedded systems hacking tools are readily available on the internet Hacking in the PDAs and modems is a pervasive example of embedded systems hacking This book explores the designs of

VLSI circuits and embedded systems These two vast topics are divided into four parts In the book s first part the Decision Diagrams DD have been covered DDs have extensively used Computer Aided Design CAD software to synthesize circuits and formal verification The book s second part mainly covers the design architectures of Multiple Valued Logic MVL Circuits MVL circuits offer several potential opportunities to improve present VLSI circuit designs The book s third part deals with Programmable Logic Devices PLD PLDs can be programmed to incorporate a complex logic function within a single IC for VLSI circuits and Embedded Systems The fourth part of the book concentrates on the design architectures of Complex Digital Circuits of Embedded Systems As a whole from this book core researchers academicians and students will get the complete picture of VLSI Circuits and Embedded Systems and their applications

**Decision Diagram Techniques for Micro- and Nanoelectronic Design Handbook** Svetlana N. Yanushkevich,D. Michael Miller,Vlad P. Shmerko,Radomir S. Stankovic,2018-10-03

Decision diagram DD techniques are very popular in the electronic design automation EDA of integrated circuits and for good reason They can accurately simulate logic design can show where to make reductions in complexity and can be easily modified to model different scenarios Presenting DD techniques from an applied perspective Decision Diagram Techniques for Micro and Nanoelectronic Design Handbook provides a comprehensive up to date collection of DD techniques Experts with more than forty years of combined experience in both industrial and academic settings demonstrate how to apply the techniques to full advantage with more than 400 examples and illustrations Beginning with the fundamental theory data structures and logic underlying DD techniques they explore a breadth of topics from arithmetic and word level representations to spectral techniques and event driven analysis The book also includes abundant references to more detailed information and additional applications Decision Diagram Techniques for Micro and Nanoelectronic Design Handbook collects the theory methods and practical knowledge necessary to design more advanced circuits and places it at your fingertips in a single concise reference

**Systems, Controls, Embedded Systems, Energy, and Machines** Richard C. Dorf,2017-12-19 In two editions spanning more than a decade The Electrical Engineering Handbook stands as the definitive reference to the multidisciplinary field of electrical engineering Our knowledge continues to grow and so does the Handbook For the third edition it has expanded into a set of six books carefully focused on a specialized area or field of study Each book represents a concise yet definitive collection of key concepts models and equations in its respective domain thoughtfully gathered for convenient access Systems Controls Embedded Systems Energy and Machines explores in detail the fields of energy devices machines and systems as well as control systems It provides all of the fundamental concepts needed for thorough in depth understanding of each area and devotes special attention to the emerging area of embedded systems Each article includes defining terms references and sources of further information Encompassing the work of the world s foremost experts in their respective specialties Systems Controls Embedded Systems Energy and Machines features the latest developments the broadest scope of coverage and new material on human computer

interaction      **Design Automation and Applications for Emerging Reconfigurable Nanotechnologies** Shubham Rai,Akash Kumar,2023-09-11 This book is a single source solution for anyone who is interested in exploring emerging reconfigurable nanotechnology at the circuit level It lays down a solid foundation for circuits based on this technology having considered both manual as well as automated design flows The authors discuss the entire design flow consisting of both logic and physical synthesis for reconfigurable nanotechnology based circuits The authors describe how transistor reconfigurable properties can be exploited at the logic level to have a more efficient circuit design flow as compared to conventional design flows suited for CMOS Further the book provides insights into hardware security features that can be intrinsically developed using the runtime reconfigurable features of this nanotechnology      **Applied Automata Theory** Julius T. Tou,2013-10-22 Applied Automata Theory provides an engineering style of presentation of some of the applied work in the field of automata theory Topics covered range from algebraic foundations and recursive functions to regular expressions threshold logic and switching circuits Coding problems and stochastic processes are also discussed along with content addressable memories probabilistic reliability and Turing machines Much emphasis is placed on engineering applications Comprised of nine chapters this book first deals with the algebraic foundations of automata theory focusing on concepts such as semigroups groups and homomorphisms and partially ordered sets and lattices as well as congruences and other relations The reader is then introduced to regular expressions stochastic automata and discrete systems theory and switching networks as models of discrete stochastic processes Subsequent chapters explore applications of automata theory in coding content addressable and distributed logic memories recursive functions and switching circuit theory and synthesis of a cellular computer The book concludes with an assessment of the fundamentals of threshold logic This monograph is intended for graduates or advanced undergraduates taking a course in information science or a course on discrete systems in modern engineering curriculum      **Index Generation Functions** Tsutomu Sasao,2022-05-31 Index generation functions are binary input integer valued functions They represent functions of content addressable memories CAMs Applications include IP address tables terminal controllers URL lists computer virus scanning circuits memory patch circuits list of English words code converters and pattern matching circuits This book shows memory based realization of index generation functions It shows 1 methods to implement index generation functions by look up table LUT cascades and index generation units IGU 2 methods to reduce the number of variables using linear transformations and 3 methods to estimate the sizes of memories with many illustrations tables examples exercises and their solutions      **Representations of Discrete Functions** Tsutomu Sasao,Masahira Fujita,2012-12-06 Representations of Discrete Functions is an edited volume containing 13 chapter contributions from leading researchers with a focus on the latest research results The first three chapters are introductions and contain many illustrations to clarify concepts presented in the text It is recommended that these chapters are read first The book then deals with the following topics binary decision diagrams BDDs multi terminal binary decision diagrams

MTBDDs edge valued binary decision diagrams EVBDDs functional decision diagrams FDDs Kronecker decision diagrams KDDs binary moment diagrams BMDs spectral transform decision diagrams STDDs ternary decision diagrams TDDs spectral transformation of logic functions other transformations of logic functions EXOR based two level expressions FPRM minimization with TDDs and MTBDDs complexity theories on FDDs multi level logic synthesis and complexity of three level logic networks Representations of Discrete Functions is designed for CAD researchers and engineers and will also be of interest to computer scientists who are interested in combinatorial problems Exercises prepared by the editors help make this book useful as a graduate level textbook

*Bent Functions and Permutation Methods* Radomir S. Stanković, Milena Stanković, Claudio Moraga, Jaakko Astola, 2024-02-20 This book discusses in a uniform way binary ternary and quaternary bent functions while most of the existing books on bent functions refer to just binary bent functions The authors describe the differences between binary and multiple valued cases and the construction methods for bent functions are focused on the application of two types of permutation matrices These matrices are derived from a class of differential operators on finite groups and Fast Fourier transform algorithms respectively The approach presented is based on the observation that given certain bent functions many other bent functions can be constructed by manipulating them Permutations are possible manipulations that are easy to implement These permutations perform spectral invariant operations which ensure that they preserve bentness

**Advances in Computers**, 1991-07-15 **Advances in Computers** **VLSI-SoC: Research Trends in VLSI and Systems on Chip** Giovanni De Micheli, Salvador Mir, Ricardo Reis, 2010-08-23 This book contains extended and revised versions of the best papers presented during the fourteenth IFIP TC 10 WG 10 5 International Conference on Very Large Scale Integration This conference provides a forum to exchange ideas and show industrial and academic research results in microelectronics design The current trend toward increasing chip integration and technology process advancements brings about stimulating new challenges both at the physical and system design levels

**Spectral Interpretation of Decision Diagrams** Radomir Stankovic, Jaakko T. Astola, 2006-04-28 Anyone who can interpret decision diagrams using the spectral approach can advance both the utility and understanding of classical DD techniques This approach also provides a framework for developing advanced solutions for digital design and a host of other applications Scientists computer science and engineering professionals and researchers with an interest in the spectral methods of representing discrete functions as well as the foundations of logic design will find the book a clearly explained well organized and essential resource

*Recent Developments in Switching Theory* Amar Mukhopadhyay, 2013-10-22 Electrical Science Series Recent Developments in Switching Theory covers the progress in the study of the switching theory The book discusses the simplified proof of Post's theorem on completeness of logic primitives the role of feedback in combinational switching circuits and the systematic procedure for the design of Lupanov decoding networks The text also describes the classical results on counting theorems and their application to the classification of switching functions under different notions of



equivalence including linear and affine equivalences The development of abstract harmonic analysis of combinational switching functions the theory of universal logic modules methods of their construction and upper bounds on the input terminals and cellular logic are also considered The book further tackles the systematic techniques for the realization of multi output logic function by means of multirail cellular cascades the programmable cellular logic and the logical design of programmable arrays Electrical engineers electronics engineers computer professionals and student taking related courses will find the book invaluable

*Design of Digital Systems and Devices* Marian Adamski,Alexander Barkalov,Marek Wegrzyn,2011-02-04 Logic design of digital devices is a very important part of the Computer Science It deals with design and testing of logic circuits for both data path and control unit of a digital system Design methods depend strongly on logic elements using for implementation of logic circuits Different programmable logic devices are wide used for implementation of logic circuits Nowadays we witness the rapid growth of new and new chips but there is a strong lack of new design methods This book includes a variety of design and test methods targeted on different digital devices It covers methods of digital system design the development of theoretical base for construction and designing of the PLD based devices application of UML for digital design A considerable part of the book is devoted to design methods oriented on implementing control units using FPGA and CPLD chips Such important issues as design of reliable FSMs automatic design of concurrent logic controllers the models and methods for creating infrastructure IP services for the SoCs are also presented The editors of the book hope that it will be interesting and useful for experts in Computer Science and Electronics as well as for students who are viewed as designers of future digital devices and systems

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