# *Nanoelectronic Circuit Design*

Three-dimensional (3D) integration is identified as a possible avenue for continuous performance growth in integrated circuits (IC) as the conventional scaling approach is faced with unprecedented challenges in fundamental and economic limits. Wafer level 3D IC can take several forms, and they usually include a stack of several thinned IC layers that are vertically bonded and interconnected by through silicon via TSV. There is a long string of benefits that one can derive from 3D IC implementation such as form factor, density multiplication, improved delay and power, enhanced bandwidth, and heterogeneous integration. This book presents contributions by key researchers in this field, covering motivations, technology platforms, applications, and other design issues.

This peer-reviewed book explores the methodologies that are used for effective research, design and innovation in the vast field of millimeter-wave circuits, and describes how these have to be modified to fit the uniqueness of high-frequency nanoelectronics design. Each chapter focuses on a specific research challenge related to either small form factors or higher operating frequencies. The book first examines nanodevice scaling and the emerging electronic design automation tools that can be used in millimeter-wave research, as well as the singular challenges of combining deep-submicron and millimeter-wave design. It also demonstrates the importance of considering, in the millimeter-wave context, system-level design leading to differing packaging options. Further, it presents integrated circuit design methodologies for all major transceiver blocks typically employed at millimeter-wave frequencies, as these methodologies are normally fundamentally different from the traditional design methodologies used in analogue and lower-frequency electronics. Lastly, the book discusses the methodologies of millimeter-wave research and design for extreme or harsh environments, rebooting electronics, the additional opportunities for terahertz research, and the main differences between the approaches taken in millimeter-wave research and terahertz research.

Focussing on micro- and nanoelectronics design and technology, this book provides thorough analysis and demonstration, starting from semiconductor devices to VLSI fabrication, designing (analog and digital), on-chip interconnect modeling culminating with emerging non-silicon/ nano devices. It gives detailed description of both theoretical as well as industry standard HSPICE, Verilog, Cadence simulation based real-time modeling approach with focus on fabrication of bulk and nano-devices. Each chapter of this proposed title starts with a brief introduction of the presented topic and ends with a summary indicating the futuristic aspect including practice questions. Aimed at researchers and senior undergraduate/graduate students in electrical and electronics engineering, microelectronics, nanoelectronics and nanotechnology, this book: Provides broad and comprehensive coverage from Microelectronics to Nanoelectronics including design in analog and digital electronics. Includes HDL, and VLSI design going into the nanoelectronics arena. Discusses devices, circuit analysis, design methodology, and real-time simulation based on industry standard HSPICE tool. Explores emerging devices such as FinFETs, Tunnel FETs (TFETs) and CNTFETs including their circuit co-designing. Covers real time illustration using industry standard Verilog, Cadence and Synopsys simulations.

Offering first-hand insights by top scientists and industry experts at the forefront of R&D into nanoelectronics, this book neatly links the underlying technological principles with present and future applications. A brief introduction is followed by an overview of present and emerging logic devices, memories and power technologies. Specific chapters are dedicated to the enabling factors, such as new materials, characterization techniques, smart manufacturing and advanced circuit design. The second part of the book provides detailed coverage of the current state and showcases real future applications in a wide range of fields: safety, transport, medicine, environment, manufacturing, and social life, including an analysis of emerging trends in the internet of things and cyber-physical systems. A survey of main economic factors and trends concludes the book. Highlighting the importance of nanoelectronics in the core fields of communication and information technology, this is essential reading for materials scientists, electronics and electrical engineers, as well as those working in the semiconductor and sensor industries.

This book considers the design and development of nanoelectronic computing circuits, systems and architectures focusing particularly on memristors, which represent one of today’s latest technology breakthroughs in nanoelectronics. The book studies, explores, and addresses the related challenges and proposes solutions for the smooth transition from conventional circuit technologies to emerging computing memristive nanotechnologies. Its content spans from fundamental device modeling to emerging storage system architectures and novel circuit design methodologies, targeting advanced non-conventional analog/digital massively parallel computational structures. Several new results on memristor modeling, memristive interconnections, logic circuit design, memory circuit architectures, computer arithmetic systems, simulation software tools, and applications of memristors in computing are presented. High-density memristive data storage combined with memristive circuit-design paradigms and computational tools applied to solve NP-hard artificial intelligence problems, as well as memristive arithmetic-logic units, certainly pave the way for a very promising memristive era in future electronic systems. Furthermore, these graph-based NP-hard problems are solved on memristive networks, and coupled with Cellular Automata (CA)-inspired computational schemes that enable computation within memory. All chapters are written in an accessible manner and are lavishly illustrated. The book constitutes an informative cornerstone for young scientists and a comprehensive reference to the experienced reader, hoping to stimulate further research on memristive devices, circuits, and systems.

Nanoelectronic Device Applications Handbook gives a comprehensive snapshot of the state of the art in nanodevices for nanoelectronics applications. Combining breadth and depth, the book includes 68 chapters on topics that range from nano-scaled complementary metal-oxide-semiconductor (CMOS) devices through recent developments in nano capacitors and AlGaAs/GaAs devices. The contributors are world-renowned experts from academia and industry from around the globe. The handbook explores current research into potentially disruptive technologies for a post-CMOS world. These include: Nanoscale advances in current MOSFET/CMOS technology Nano capacitors for applications such as electronics packaging and humidity sensors Single electron transistors and other electron tunneling devices Quantum cellular automata and nanomagnetic logic Memristors as switching devices and for memory Graphene preparation, properties, and devices Carbon nanotubes (CNTs), both single CNT and random network Other CNT applications such as terahertz, sensors, interconnects, and capacitors Nano system architectures for reliability Nanowire device fabrication and applications Nanowire transistors Nanodevices for spintronics The book closes with a call for a new generation of simulation tools to handle nanoscale mechanisms in realistic nanodevice geometries. This timely handbook offers a wealth of insights into the application of nanoelectronics. It is an invaluable reference and source of ideas for anyone working in the rapidly expanding field of nanoelectronics.

This book examines single-electron circuits as an introduction to the rapidly expanding field of nanoelectronics. It discusses both the analysis and synthesis of circuits with the nanoelectronic metallic single-electron tunneling (SET) junction device. The basic physical phenomena under consideration are the quantum mechanical tunneling of electrons through a small insulating gap between two metal leads, the Coulomb blockade and Coulomb oscillations — the last two resulting from the quantization of charge. The author employs an unconventional approach in explaining the operation and design of single-electron circuits.

Devices and Modelling
Advanced Nanoelectronics
Emerging Nanoelectronic Devices
Nanoelectronics
Nanoelectronic Device Modeling for Robust Circuit Design and Analysis
3D Integration for VLSI Systems
Transistors and Interconnects at the Nanoscale
From Materials to Circuits
Memristor-Based Nanoelectronic Computing Circuits and Architectures
Analog Circuits and Design

In-depth coverage of integrated circuit design on the nanoscale level Written by international experts in industry and academia, CMOS Nanoelectronics addresses the state of the art in integrated circuit design in the context of emerging systems. New, exciting opportunities in body area networks, wireless communications, data networking, and optical imaging are discussed. This cutting-edge guide explores emerging design concepts for very low power and describes design approaches for RF transceivers, high-speed serial links, PLL/DLL, and ADC/DAC converters. CMOS Nanoelectronics covers: Portable high-efficiency polar transmitters All-digital RF signal generation Frequency multiplier design Tunable CMOS RF filters GaAs HBT linear power amplifier design High-speed serial I/O design CDMA-based crosstalk cancellation Delta-sigma fractional-N PLL Delay locked loops Digital clock generators Analog design in deep submicron CMOS technologies 1/f noise reduction for linear analog CMOS ICs Broadband high-resolution bandpass sigma-delta modulators Analog/digital conversion specifications for power line communication systems Digital-to-analog converters for LCDs Sub-1-V CMOS bandgap reference design And much more

This book gathers a collection of papers by international experts that were presented at the International Conference on NextGen Electronic Technologies (ICNETS2-2016). ICNETS2 encompassed six symposia covering all aspects of the electronics and communications domains, including relevant nano/micro materials and devices. Highlighting the latest research on nanoelectronic materials and devices, the book offers a valuable guide for researchers, practitioners and students working in the core areas of functional electronics nanomaterials, nanocomposites for energy application, sensing and high strength materials and simulation of novel device design structures for ultra-low power applications.

Covering both the classical and emerging nanoelectronic technologies being used in mixed-signal design, this book addresses digital, analog, and memory components. Winner of the Association of American Publishers' 2016 PROSE Award in the Textbook/Physical Sciences & Mathematics category. Nanoelectronic Mixed-Signal System Design offers professionals and students a unified perspective on the science, engineering, and technology behind nanoelectronics system design. Written by the director of the NanoSystem Design Laboratory at the University of North Texas, this comprehensive guide provides a large-scale picture of the design and manufacturing aspects of nanoelectronic-based systems. It features dual coverage of mixed-signal circuit and system design, rather than just digital or analog-only. Key topics such as process variations, power dissipation, and security aspects of electronic system design are discussed. Top-down analysis of all stages--from design to manufacturing Coverage of current and developing nanoelectronic technologies--not just nano-CMOS Describes the basics of nanoelectronic technology and the structure of popular electronic systems Reveals the techniques required for design excellence and manufacturability

The first book devoted to quantum-dot cellular automata (QCA), this groundbreaking resource provides a comprehensive view of QCA, showing practitioners how to work with this cutting-edge technology.

Graphene has emerged as a potential candidate to replace traditional CMOS for a number of electronic applications; this book presents the latest advances in graphene nanoelectronics and the potential benefits of using graphene in a wide variety of electronic applications. The book also provides details on various methods to grow graphene, including epitaxial, CVD, and chemical methods. This book serves as a spring-board for anyone trying to start working on graphene. The book is also suitable to experts who wish to update themselves with the latest findings in the field.

A comprehensive and in-depth review of analog circuitlayout, schematic architecture, device, power network and ESDdesign This book will provide a balanced overview of analog circuitdesign layout, analog circuit schematic development,architecture of chips, and ESD design. It will start atan introductory level and will bring the reader right up to thestate-of-the-art. Two critical design aspects for analog and powerintegrated circuits are combined. The first design aspect coversanalog circuit design techniques to achieve the desired circuitperformance. The second and main aspect presents the additionalchallenges associated with the design of adequate and effective ESDprotection elements and schemes. A comprehensive list of practicalapplication examples is used to demonstrate the successfulcombination of both techniques and any potential designtrade-offs. Chapter One looks at analog design discipline, including layoutand analog matching and analog layout design practices. Chapter Twodiscusses analog design with circuits, examining: singletransistor amplifiers; multi-transistor amplifiers; active loadsand more. The third chapter covers analog design layout (alsoMOSFET layout), before Chapters Four and Five discuss analog designsynthesis. The next chapters introduce the reader to analog-digitalmixed signal design synthesis, analog signal pin ESD networks, andanalog ESD power clamps. Chapter Nine, the last chapter, covers ESDdesign in analog applications. Clearly describes analog design fundamentals (circuitfundamentals) as well as outlining the various ESDimplications Covers a large breadth of subjects and technologies, such asCMOS, LDMOS, BCD, SOI, and thick body SOI Establishes an “ESD analog design” discipline thatdistinguishes itself from the alternative ESD digital designfocus Focuses on circuit and circuit design applications Assessible, with the artwork and tutorial style of the ESD bookseries PowerPoint slides are available for university facultymembers Even in the world of digital circuits, analog and power circuitsare two very important but under-addressed topics, especially fromthe ESD aspect. Dr. Voldman’s new book will serve as anessential and practical guide to the greater IC community. Withhigh practical and academic values this book is a“bible” for professionals, graduate students, deviceand circuit designers for investigating the physics of ESD and forproduct designs and testing.

Nanoelectronic Circuit DesignSpringer Science & Business Media
Methodologies for Research, Design and Innovation
Nanoelectronics and Materials Development
Carbon-Based Electronics
Nano-CMOS Circuit and Physical Design
Introduction to Nanoelectronic Single-Electron Circuit Design, Second Edition
Millimeter-Wave Integrated Circuits
Devices, Circuits and Systems
Nanoelectronic Device Applications Handbook
Science, Technology, and Applications
Decision Diagram Techniques for Micro- and Nanoelectronic Design Handbook

*The demand for ever smaller and portable electronic devices has driven metal oxide semiconductor-based (CMOS) technology to its physical limit with the smallest possible feature sizes. This presents various size-related problems such as high power leakage, low-reliability, and thermal effects, and is a limit on further miniaturization. To enable even smaller electronics, various nanodevices including carbon nanotube transistors, graphene transistors, tunnel transistors and memristors (collectively called post-CMOS devices) are emerging that could replace the traditional and ubiquitous silicon transistor. This book explores these nanoelectronics at the device level including modelling and design. Topics covered include high-k dielectrics; high mobility n and p channels on gallium arsenide and silicon substrates using interfacial misfit dislocation arrays; anodic metal-insulator-metal (MIM) capacitors; graphene transistors; junction and doping free transistors; nanoscale gigh-k/metal-gate CMOS and FinFET based logic libraries; multiple-independent-gate nanowire transistors; carbon nanotubes for efficient power delivery; timing driven buffer insertion for carbon nanotube interconnects; memristor modeling; and neuromorphic devices and circuits. This book is essential reading for researchers, research-focused industry designers/developers, and advanced students working on next-generation electronic devices and circuits.*

*Nanoelectronics and Photonics provides a fundamental description of the core elements and problems of advanced and future information technology. The authoritative book collects a series of tutorial chapters from leaders in the field covering fundamental topics from materials to devices and system architecture, and bridges the fundamental laws of physics and chemistry of materials at the atomic scale with device and circuit design and performance requirements.*

*While theories based on classical physics have been very successful in helping experimentalists design microelectronic devices, new approaches based on quantum mechanics are required to accurately model nanoscale transistors and to predict their characteristics even before they are fabricated. Advanced Nanoelectronics provides research information on advanced nanoelectronics concepts, with a focus on modeling and simulation. Featuring contributions by researchers actively engaged in nanoelectronics research, it develops and applies analytical formulations to investigate nanoscale devices. The book begins by introducing the basic ideas related to quantum theory that are needed to better understand nanoscale structures found in nanoelectronics, including graphenes, carbon nanotubes, and quantum wells, dots, and wires. It goes on to highlight some of the key concepts required to understand nanotransistors. These concepts are then applied to the carbon nanotube field effect transistor (CNTFET). Several chapters cover graphene, an unzipped form of CNT that is the recently discovered allotrope of carbon that has gained a tremendous amount of scientific and technological interest. The book discusses the development of the graphene nanoribbon field effect transistor (GNRFET) and its use as a possible replacement to overcome the CNT chirality challenge. It also examines silicon nanowire (SiNW) as a new candidate for achieving the downscaling of devices. The text describes the modeling and fabrication of SiNW, including a new top-down fabrication technique. Strained technology, which changes the properties of device materials rather than changing the device geometry, is also discussed. The book ends with a look at the technical and economic challenges that face the commercialization of nanoelectronics and what universities, industries, and government can do to lower the barriers. A useful resource for professionals, researchers, and scientists, this work brings together state-of-the-art technical and scientific information on important topics in advanced nanoelectronics.*

*Predictive Technology Model for Robust Nanoelectronic Design explains many of the technical mysteries behind the Predictive Technology Model (PTM) that has been adopted worldwide in explorative design research. Through physical derivation and technology extrapolation, PTM is the de-factor device model used in electronic design. This work explains the systematic model development and provides a guide to robust design practice in the presence of variability and reliability issues. Having interacted with multiple leading semiconductor companies and university research teams, the author brings a state-of-the-art perspective on technology scaling to this work and shares insights gained in the practices of device modeling.*

*Nanoelectronics: Devices, Circuits and Systems explores current and emerging trends in the field of nanoelectronics, from both a devices-to-circuits and circuits-to-systems perspective. It covers a wide spectrum and detailed discussion on the field of nanoelectronic devices, circuits and systems. This book presents an in-depth analysis and description of electron transport phenomenon at nanoscale dimensions. Both qualitative and analytical approaches are taken to explore the devices, circuit functionalities and their system applications at deep submicron and nanoscale levels. Recent devices, including FinFET, Tunnel FET, and emerging materials, including graphene, and its applications are discussed. In addition, a chapter on advanced VLSI interconnects gives clear insight to the importance of these nano-transmission lines in determining the overall IC performance. The importance of integration of optics with electronics is elucidated in the optoelectronics and photonic integrated circuit sections of this book. This book provides valuable resource materials for scientists and electrical engineers who want to learn more about nanoscale electronic materials and how they are used. Shows how electronic transport works at the nanoscale level Demonstrates how nanotechnology can help engineers create more effective circuits and systems Assesses the most commonly used nanoelectronic devices, explaining which is best for different situations*

*Emerging Nanoelectronic Devices focuses on the future direction of semiconductor and emerging nanoscale device technology. As the dimensional scaling of CMOS approaches its limits, alternate information processing devices and microarchitectures are being explored to sustain increasing functionality at decreasing cost into the indefinite future. This is driving new paradigms of information processing enabled by innovative new devices, circuits, and architectures, necessary to support an increasingly interconnected world through a rapidly evolving internet. This original title provides a fresh perspective on emerging research devices in 26 up to date chapters written by the leading researchers in their respective areas. It supplements and extends the work performed by the Emerging Research Devices working group of the International Technology Roadmap for Semiconductors (ITRS). Key features: Serves as an authoritative tutorial on innovative devices and architectures that populate the dynamic world of “Beyond CMOS” technologies. Provides a realistic assessment of the strengths, weaknesses and key unknowns associated with each technology. Suggests guidelines for the directions of future development of each technology. Emphasizes physical concepts over mathematical development. Provides an essential resource for students, researchers and practicing engineers.*

*Based on the authors' expansive collection of notes taken over the years, Nano-CMOS Circuit and Physical Design bridges the gap between physical and circuit design and fabrication processing, manufacturability, and yield. This innovative book covers: process technology, including sub-wavelength optical lithography; impact of process scaling on circuit and physical implementation and low power with leaky transistors; and DFM, yield, and the impact of physical implementation.*

*Predictive Technology Model for Robust Nanoelectronic Design*
*CMOS Nanoelectronics*
*Nano-cmos and Post-cmos Electronics*
*Nanoelectronics and Photonics*
*ESD*
*Select Proceedings of ICNETS2, Volume III*
*Nanoelectronic Circuit Design*
*Materials, Devices, Applications, 2 Volumes*
*Nanoelectronic Devices*
*Introduction to Microelectronics to Nanoelectronics*

This book features selected papers presented at Third International Conference on Nanoelectronics, Circuits and Communication Systems (NCCS 2017). Covering topics such as MEMS and nanoelectronics, wireless communications, optical communication, instrumentation, signal processing, Internet of Things, image processing, bioengineering, green energy, hybrid vehicles, environmental science, weather forecasting, cloud computing, renewable energy, RFID, CMOS sensors, actuators, transducers, telemetry systems, embedded systems, and sensor network applications in mines, it is a valuable resource for young scholars, researchers, and academics.

This book describes the computational challenges posed by the progression toward nanoscale electronic devices and increasingly short design cycles in the microelectronics industry, and proposes methods of model reduction which facilitate circuit and device simulation for specific tasks in the design cycle. The goal is to develop and compare methods for system reduction in the design of high dimensional nanoelectronic ICs, and to test these methods in the practice of semiconductor development. Six chapters describe the challenges for numerical simulation of nanoelectronic circuits and suggest model reduction methods for constituting equations. These include linear and nonlinear differential equations tailored to circuit equations and drift diffusion equations for semiconductor devices. The performance of these methods is illustrated with numerical experiments using real-world data. Readers will benefit from an up-to-date overview of the latest model reduction methods in computational nanoelectronics.

The latest advances in nanoelectronics This definitive volume addresses the state of the art in nanoelectronics, covering nanowires, molecular electronics, and nanodevices. Written by global experts in the field, Nanoelectronics discusses cutting-edge techniques and emerging materials, such as carbon nanotubes and quantum dots. This pioneering work offers a comprehensive survey of nanofabrication options for use in next-generation technologies. Nanoelectronics covers: Electrical properties of metallic nanowires Electromigration defect nucleation in damascene copper interconnect lines Carbon nanotube interconnects in CMOS integrated circuits Printed organic electronics One-dimensional nanostructure-enabled chemical sensing Cross-section fabrication and analysis of nanoscale device structures and complex organic electronics Microfabrication and applications of nanoparticle-doped conductive polymers Single-electron conductivity in organic nanostructures for transistors and memories Synthesis of molecular bioelectronic nanostructures Nanostructured electrode materials for advanced Li-ion batteries Quantum-dot devices based on carbon nanotubes Carbon nanotubes as electromechanical actuators Low-level nanoscale electrical measurements and ESD Nanopackaging

This book covers one of the most important device architectures that have been widely researched to extend the transistor scaling: FinFET. Starting with theory, the book discusses the advantages and the integration challenges of this device architecture. It addresses in detail the topics such as high-density fin patterning, gate stack design, and source/drain engineering, which have been considered challenges for the integration of FinFETs. The book also addresses circuit-related aspects, including the impact of variability on SRAM design, ESD design, and high-T operation. It discusses a new device concept: the junctionless nanowire FET.

This book provides readers with the knowledge in fundamentals of nanoelectronic devices. The authors build the principles of nanoelectronic devices based on those of microelectronic devices wherever possible and introduce the inherently nanoelectronic principles gradually. They briefly review quantum mechanics and solid-state physics that can form

Discovery of one-dimensional material carbon nanotubes in 1991 by the Japanese physicist Dr. Sumio Iijima has resulted in voluminous research in the field of carbon nanotubes for numerous applications, including possible replacement of silicon used in the fabrication of CMOS chips. One interesting feature of carbon nanotubes is that these can be metallic or semiconducting with a bandgap depending on their diameter. In search of non-classical devices and related technologies, both carbon nanotube-based field-effect transistors and metallic carbon nanotube interconnects are being explored extensively for emerging logic devices and very large-scale integration. Although various models for carbon nanotube-based transistors and interconnects have been proposed in the literature, an integrated approach to make them compatible with the present simulators is yet to be achieved. This book makes an attempt in this direction for the carbon-based electronics through fundamentals of solid-state physics and devices.

The current edited book presents some of the most advanced research findings in the field of nanotechnology and its application in materials development in a very concise form. The main focus of the book is dragged toward those materials where electronic properties are manipulated for development of advanced materials. We have discussed about the extensive usage of nanotechnology and its impact on various facets of the chip-making practice from materials to devices such as basic memory, quantum dots, nanotubes, nanowires, graphene-like 2D materials, and CIGS thin-film solar cells as energy-harvesting devices. Researchers as well as students can gain valuable insights into the different processing of nanomaterials, characterization procedures of the materials in nanoscale, and their different functional properties and applications.

Introduction to Nanoelectronic Single-Electron Circuit Design
Nanoelectronic Circuit Design and Test
Nanoelectronics, Circuits and Communication Systems
VLSI Micro- and Nanophotonics
Nanoelectronics: Nanowires, Molecular Electronics, and Nanodevices
Innovative Devices, Architectures, and Applications
Proceeding of NCCS 2017
Nanoelectronic Materials and Devices
Nanoelectronics and Nanosystems
Machine Learning Techniques for Resource Prediction in Nanoelectronic Circuit Design

**An accessible introduction for electronic engineers, computer scientists and physicists. The overview covers all aspects from underlying technologies to circuits and systems. The challenge of nanoelectronics is not only to manufacture minute structures but also to develop innovative systems for effective integration of the billions of devices. On the system level, various architectures are presented and important features of systems, such as design strategies, processing power, and reliability are discussed. Many specific technologies are presented, including molecular devices, quantum electronic devices, resonant tunnelling devices, single electron devices, superconducting devices, and even devices for DNA and quantum computing. The book also compares these devices with current silicon technologies and discusses limits of electronics and the future of nanosystems.**

**This book is about large-scale electronic circuits design driven by nanotechnology, where nanotechnology is broadly defined as building circuits using nanoscale devices that are either implemented with nanomaterials (e.g., nanotubes or nanowires) or following an unconventional method (e.g., FinFET or III/V compound-based devices). These nanoscale devices have significant potential to revolutionize the fabrication and integration of electronic systems and scale beyond the perceived scaling limitations of traditional CMOS. While innovations in nanotechnology originate at the individual device level, realizing the true impact of electronic systems demands that these device-level capabilities be translated into system-level benefits. This is the first book to focus on nanoscale circuits and their design issues, bridging the existing gap between nanodevice research and nanosystem design.**

**Addressing the growing demand for larger capacity in information technology, VLSI Micro- and Nanophotonics: Science, Technology, and Applications explores issues of science and technology of micro/nano-scale photonics and integration for broad-scale and chip-scale Very Large Scale Integration photonics. This book is a game-changer in the sense that it is quite possibly the first to focus on "VLSI Photonics". Very little effort has been made to develop integration technologies for micro/nanoscale photonic devices and applications, so this reference is an important and necessary early-stage perspective on this field. New demand for VLSI photonics brings into play various technological and scientific issues, as well as evolutionary and revolutionary challenges—all of which are discussed in this book. These include topics such as miniaturization, interconnection, and integration of photonic devices at micron, submicron, and nanometer scales. With its "disruptive creativity" and unparalleled coverage of the photonics revolution in information technology, this book should greatly impact the future of micro/nano-photonics and IT as a whole. It offers a comprehensive overview of the science and engineering of micro/nanophotonics and photonic integration. Many books on micro/nanophotonics focus on understanding the properties of individual devices and their related characteristics. However, this book offers a full perspective from the point of view of integration, covering all aspects of benefits and advantages of VLSI-scale photonic integration—the key technical concept in developing a platform to make individual devices and components useful and practical for various applications.**

**Today, the concepts of single-electron tunneling (SET) are used to understand and model single-atom and single-molecule nanoelectronics. The characteristics of nanoelectronic devices, especially SET transistors, can be understood on the basis of the physics of nanoelectronic devices and circuit models. A circuit theory approach is necessary for considering possible integration with current microelectronic circuitry. To explain the properties and possibilities of SET devices, this book follows an approach to modeling these devices using electronic circuit theory. All models and equivalent circuits are derived from the first principles of circuit theory. Based on energy conservation, the circuit model of SET is an impulsive current source, and modeling distinguishes between bounded and unbounded currents. The Coulomb blockade is explained as a property of a single junction. In addition, this edition differs from the previous one by elaborating on the section on spice simulations and providing a spice simulation on the SET electron box circuit, including the spice netlist. Also, a complete, new proof of the two-capacitor problem in circuit theory is presented; the importance of this proof in understanding energy conservation in SET circuits cannot be underestimated. This book will be very useful for advanced undergraduate- and graduate-level students of electrical engineering and nanoelectronics and researchers in nanotechnology, nanoelectronic device physics, and computer science. Only book modeling both single-electron tunneling and many electron tunneling from the points of view of electronics; starting from experiments, via a physics description, working towards a circuit description; and based on energy conservation, in electrical circuits, developing the impulse circuit model for single-electron tunneling.**

**This master's thesis is about the use of machine learning techniques in the field of nanoelectronic circuit design. It has been developed in collaboration with eSilicon Corporation, which is a company specialized in designing and producing Application-specific integrated circuit (ASIC). While specific integrated circuits require several resources to be designed. Most of them can be classified as expenses from non-recurring engineering. This includes all costs used only once related to the final product. For example, in our project, they mean computational resources, such as CPU usage and memory utilization, but also hours worked by specialized designers. All of them have tremendous costs, which can not be reused for future designs. The study done in this thesis inverts the current situation, gathering data from the design process to produce valuable information for upcoming designs. This information is related to time, memory and specific attributes of the design. In order to achieve this goal, some of the most successful and helpful machine learning algorithms are used. Their purpose is to predict key aspects of the design and its computation before any execution is done. For example, if a designer is aware of that the result of an execution in terms of leakage or area utilization, will not satisfy their expectations, then he would be able to decide whether it is worth or not the execution. This implies saving time and computational resources. These machine learning techniques are fed with data obtained from designs. This data, though, may present us certain drawbacks like missing values, unreliable data due to bugs, errors during the execution and a long list of possible sources of noise and incorrect data. Thus, it is important to preprocess all that information to obtain a trustworthy and stable source of data. The final outcome of this project can be seen as the combination of data preprocess and machine learning use. This applied to the field of nanoelectronic circuit design, to get predictions of: runtime, CPU time, RAM memory, leakage and area utilization. This can lead to an improvement in productivity by reducing the total cost of computational resources and time spend on them by designers.**

**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.**

**From Atoms to Materials, Devices, and Architectures**
**Design and Test of Digital Circuits by Quantum-dot Cellular Automata**
**Design and Technology**
**From Transistors to Molecular and Quantum Devices**
**System Reduction for Nanoscale IC Design**
**Graphene Nanoelectronics**
**Foreword by Leon Chua**

**CMOS Nanoelectronics: Analog and RF VLSI Circuits**
**Nanoelectronic Mixed-Signal System Design**