

Mosfet Device Modeling And Simulation

Practicing designers, students, and educators in the semiconductor field face an ever expanding portfolio of MOSFET models. In *Compact MOSFET Models for VLSI Design*, A.B. Bhattacharyya presents a unified perspective on the topic, allowing the practitioner to view and interpret device phenomena concurrently using different modeling strategies. Readers will learn to link device physics with model parameters, helping to close the gap between device understanding and its use for optimal circuit performance. Bhattacharyya also lays bare the core physical concepts that will drive the future of VLSI development, allowing readers to stay ahead of the curve, despite the relentless evolution of new models. Adopts a unified approach to guide students through the confusing array of MOSFET models Links MOS physics to device models to prepare practitioners for real-world design activities Helps fabless designers bridge the gap with off-site foundries Features rich coverage of: quantum mechanical related phenomena Si-Ge strained-Silicon substrate non-classical structures such as Double Gate MOSFETs Presents topics that will prepare readers for long-term developments in the field Includes solutions in every chapter Can be tailored for use among students and professionals of many levels Comes with MATLAB code downloads for independent practice and advanced study This book is essential for students specializing in VLSI Design and indispensable for design professionals in the microelectronics and VLSI industries. Written to serve a number of experience levels, it can be used either as a course textbook or practitioner's reference. Access the MATLAB code, solution manual, and lecture materials at the companion website: www.wiley.com/go/bhattacharyya

To push MOSFETs to their scaling limits and to explore devices that may complement or even replace them at molecular scale, a clear understanding of device physics at nanometer scale is necessary. *Nanoscale Transistors* provides a description on the recent development of theory, modeling, and simulation of nanotransistors for electrical engineers, physicists, and chemists working on nanoscale devices. Simple physical pictures and semi-analytical models, which were validated by detailed numerical simulations, are provided for both evolutionary and revolutionary nanotransistors. After basic concepts are reviewed, the text summarizes the essentials of traditional semiconductor devices, digital circuits, and systems to supply a baseline against which new devices can be assessed. A nontraditional view of the MOSFET using concepts that are valid at nanoscale is developed and then applied to nanotube FET as an example of how to extend the concepts to revolutionary nanotransistors. This practical guide then explore the limits of devices by discussing conduction in single molecules

Metal Oxide Semiconductor (MOS) transistors are the basic building block of MOS integrated circuits (IC). Very Large Scale Integrated (VLSI) circuits using MOS technology have emerged as the dominant technology in the semiconductor industry. Over the past decade, the complexity of MOS IC's has increased at an astonishing rate. This is realized mainly through the reduction of MOS transistor dimensions in addition to the improvements in processing. Today VLSI circuits with over 3 million transistors on a chip, with effective or electrical channel lengths of 0.5 microns, are in volume production. Designing such complex chips is virtually impossible without simulation tools which help to predict circuit behavior before actual circuits are fabricated. However, the utility of simulators as a tool for the design and analysis of circuits depends on the adequacy of the device models used in the simulator. This problem is further aggravated by the technology trend towards smaller and smaller device dimensions which increases the complexity of the models. There is extensive literature available on modeling these short channel devices. However, there is a lot of confusion too. Often it is not clear what model to use and which model parameter values are important and how to determine them. After working over 15 years in the field of semiconductor device modeling, I have felt the need for a book which can fill the gap between the theory and the practice of MOS transistor modeling. This book is an attempt in that direction.

An expert guide to understanding and making optimum use of BSIM Used by more chip designers worldwide than any other comparable model, the Berkeley Short-Channel IGFET Model (BSIM) has, over the past few years, established itself as the de facto standard MOSFET SPICE model for circuit simulation and CMOS technology development. Yet, until now, there have been no independent expert guides or tutorials to supplement the various BSIM manuals currently available. Written by a noted expert in the field, this book fills that gap in the literature by providing a comprehensive guide to understanding and making optimal use of BSIM3 and BSIM4. Drawing upon his extensive experience designing with BSIM, William Liu provides a brief history of the model, discusses the various advantages of BSIM over other models, and explores the reasons why BSIM3 has been adopted by the majority of circuit manufacturers. He then provides engineers with the detailed practical information and guidance they need to master all of BSIM's features. He: Summarizes key BSIM3 components Represents the BSIM3 model with equivalent circuits for various operating conditions Provides a comprehensive glossary of modeling terminology Lists alphabetically BSIM3 parameters along with their meanings and relevant equations Explores BSIM3's flaws and provides improvement suggestions Describes all of BSIM4's improvements and new features Provides useful SPICE files, which are available online at the Wiley ftp site

Modeling, Simulation, and Parameter Extraction

Analysis and Design of MOSFETs

BSIM4 and MOSFET Modeling For IC Simulation

Using the BSIM-CMG Standard

MOSFET Modeling for Circuit Analysis and Design

FET Modeling for Circuit Simulation

This book presents the art of advanced MOSFET modeling for integrated circuit simulation and design. It provides the essential mathematical and physical analyses of a mechanical and thermal effects in MOS transistors relevant to the operation of integrated circuits. Particular emphasis is placed on how the BSIM model evolved into a standard SPICE MOSFET model for circuit simulation and CMOS technology development. The discussion covers the theory and methodology of how a MOSFET model, or device models in general, can be implemented to be robust and efficient, turning device physics theory into a production-worthy SPICE simulation model. Special attention is given to MOSFET characterization and model parameter extraction methodologies, making the book particularly useful for those interested or already engaged in work in the area of devices, compact modeling for SPICE simulation, and integrated circuit design.

This book is a useful reference for practicing electrical engineers as well as a textbook for a junior/senior or graduate level course in electrical engineering. The author covers subjects: device modeling and circuit simulation - by providing a large number of well-prepared examples of circuit simulations immediately following the description of Compact Models for Integrated Circuit Design: Conventional Transistors and Beyond provides a modern treatise on compact models for circuit computer-aided design (CAD). The author with more than 25 years of industry experience in semiconductor processes, devices, and circuit CAD, and more than 10 years of academic experience in teaching courses, this first-of-its-kind book on compact SPICE models for very-large-scale-integrated (VLSI) chip design offers a balanced presentation of compact modeling crucial to current modeling challenges and understanding new models for emerging devices. Starting from basic semiconductor physics and covering state-of-the-art device regimes from micron to nanometer, this text: Presents industry standard models for bipolar-junction transistors (BJTs), metal-oxide-semiconductor (MOS) field-effect-transistors (FETs), tunnel field-effect transistors (TFETs), along with statistical MOS models Discusses the major issue of process variability, which severely impacts device and circuit performance in modern technologies and requires statistical compact models Promotes further research of the evolution and development of compact models for VLSI circuit design and analysis Provides fundamental and practical knowledge necessary for efficient integrated circuit (IC) design using nanoscale devices Includes exercise problems at the end of each chapter and references at the end of the book Compact Models for Integrated Circuit Design: Conventional Transistors and Beyond is intended for senior undergraduate and graduate students in electrical and electronics engineering as well as for researchers and practitioners working in the area of electron devices. However, even those unfamiliar with semiconductor devices will gain a solid grasp of compact modeling concepts from this book. The Open Access version of this book, available at <https://doi.org/10.1201/b19117>, has been made available under a Creative Commons Attribution-Non Commercial-No Derivatives 4.0 license.

During the first decade following the invention of the transistor, progress in semiconductor device technology advanced rapidly due to an effective synergy of technological innovation and physical understanding. Through physical reasoning, a feeling for the right assumption and the correct interpretation of experimental findings, a small group of pioneers developed analytic design equations, which are currently to be found in numerous textbooks. Naturally with the growth of specific applications, the description of some characteristics became more complicated. For instance, in integrated circuits this was due in part to the use of a wider bias range, the addition of inherent parasitic elements and the occurrence of three-dimensional effects in smaller devices. Since powerful computing aids became available at the same time, complicated situations in complex configurations could be analyzed using numerical techniques. Despite the resulting progress in device optimization, the above approach fails to provide a required compact set of device design and process control parameters for a compact circuit model for the analysis of large-scale electronic designs. This book therefore takes up the original thread to some extent. Taking into account new physical insights, introducing useful but correct simplifying assumptions, the previous concepts of analytic device models have been extended to describe the characteristics of modern devices. This has been made possible by making extensive use of exact numerical results to gain insight into complicated situations of transistor operation.

Bipolar transistor and MOSFET device models
Technology Computer Aided Design
Junctionless Field-Effect Transistors
Surface-Potential Model Hisim
Compact Modeling
The EKV Model for Low-Power and RF IC Design

A comprehensive one-volume reference on current JLFET methods, techniques, and research Advancements in transistor technology have driven the modern smart-device revolution—many cell phones, watches, home appliances, and numerous other devices of everyday usage now surpass the performance of the room-filling supercomputers of the past. Electronic devices are continuing to become more mobile, powerful, and versatile in this era of internet-of-things (IoT) due in large part to the scaling of metal-oxide semiconductor field-effect transistors (MOSFETs). Incessant scaling of the conventional MOSFETs to cater to consumer needs without incurring performance degradation requires costly and complex fabrication process owing to the presence of metallurgical junctions. Unlike conventional MOSFETs, junctionless field-effect transistors (JLFETs) contain no metallurgical junctions, so they are simpler to process and less costly to manufacture. JLFETs utilize a gated semiconductor film to control its resistance and the current flowing through it. Junctionless Field-Effect Transistors: Design, Modeling, and Simulation is an inclusive, one-stop reference on the study and research on JLFETs This timely book covers the fundamental physics underlying JLFET operation, emerging architectures, modeling and simulation methods, comparative analyses of JLFET performance metrics, and several other interesting facts related to JLFETs. A calibrated simulation framework, including guidance on Sentaurus TCAD software, enables researchers to investigate JLFETs, develop new architectures, and improve performance. This valuable resource: Addresses the design and architecture challenges faced by JLFET as a replacement for MOSFET Examines various approaches for analytical and compact modeling of JLFETs in circuit design and simulation Explains how to use Technology Computer-Aided Design software (TCAD) to produce numerical simulations of JLFETs Suggests research directions and potential applications of JLFETs Junctionless Field-Effect Transistors: Design,

Modeling, and Simulation is an essential resource for CMOS device design researchers and advanced students in the field of physics and semiconductor devices.

Responding to recent developments and a growing VLSI circuit manufacturing market, Technology Computer Aided Design: Simulation for VLSI MOSFET examines advanced MOSFET processes and devices through TCAD numerical simulations. The book provides a balanced summary of TCAD and MOSFET basic concepts, equations, physics, and new technologies related to TCAD and MOSFET. A firm grasp of these concepts allows for the design of better models, thus streamlining the design process, saving time and money. This book places emphasis on the importance of modeling and simulations of VLSI MOS transistors and TCAD software. Providing background concepts involved in the TCAD simulation of MOSFET devices, it presents concepts in a simplified manner, frequently using comparisons to everyday-life experiences. The book then explains concepts in depth, with required mathematics and program code. This book also details the classical semiconductor physics for understanding the principle of operations for VLSI MOS transistors, illustrates recent developments in the area of MOSFET and other electronic devices, and analyzes the evolution of the role of modeling and simulation of MOSFET. It also provides exposure to the two most commercially popular TCAD simulation tools Silvaco and Sentaurus. • Emphasizes the need for TCAD simulation to be included within VLSI design flow for nano-scale integrated circuits • Introduces the advantages of TCAD simulations for device and process technology characterization • Presents the fundamental physics and mathematics incorporated in the TCAD tools • Includes popular commercial TCAD simulation tools (Silvaco and Sentaurus) • Provides characterization of performances of VLSI MOSFETs through TCAD tools • Offers familiarization to compact modeling for VLSI circuit simulation R&D cost and time for electronic product development is drastically reduced by taking advantage of TCAD tools, making it indispensable for modern VLSI device technologies. They provide a means to characterize the MOS transistors and improve the VLSI circuit simulation procedure. The comprehensive information and systematic approach to design, characterization, fabrication, and computation of VLSI MOS transistor through TCAD tools presented in this book provides a thorough foundation for the development of models that simplify the design verification process and make it cost effective.

Circuit simulation is widely used for the design of circuits, both discrete and integrated. Device modeling is an important aspect of circuit simulation since it is the link between the physical device and the simulated device. Currently available circuit simulation programs provide a variety of built-in models. Many circuit designers use these built-in models whereas some incorporate new models in the circuit simulation programs. Understanding device modeling with particular emphasis on circuit simulation will be helpful in utilizing the built-in models more efficiently as well as in implementing new models. SPICE is used as a vehicle since it is the most widely used circuit simulation program. However, some issues are addressed which are not directly applicable to SPICE but are applicable to circuit simulation in general. These discussions are useful for modifying SPICE and for understanding other simulation programs. The generic version 2G. 6 is used as a reference for SPICE, although numerous different versions exist with different modifications. This book describes field effect transistor models commonly used in a variety of circuit simulation programs. Understanding of the basic device physics and some familiarity with device modeling is assumed. Derivation of the model equations is not included. (SPICE is a circuit simulation program available from EECS Industrial Support Office, 461 Cory Hall, University of California, Berkeley, CA 94720.) Acknowledgements I wish to express my gratitude to Valid Logic Systems, Inc.

Most of the recent texts on compact modeling are limited to a particular class of semiconductor devices and do not provide comprehensive coverage of the field. Having a single comprehensive reference for the compact models of most commonly used semiconductor devices (both active and passive) represents a significant advantage for the reader. Indeed, several kinds of semiconductor devices are routinely encountered in a single IC design or in a single modeling support group. Compact Modeling includes mostly the material that after several years of IC design applications has been found both theoretically sound and practically significant. Assigning the individual chapters to the groups responsible for the definitive work on the subject assures the highest possible degree of expertise on each of the covered models.

3D TCAD Simulation for Semiconductor Processes, Devices and Optoelectronics

Device Modeling for Analog and RF CMOS Circuit Design

Design, Modeling and Simulation

BSIM4 and MOSFET Modeling for IC Simulation

Selected Problems

The Physics and Modeling of Mosfets

This comprehensive new resource presents a detailed look at the modeling and simulation of microwave semiconductor control devices and circuits. Fundamental PIN, MOSFET, and MESFET nonlinear device modeling are discussed, including the analysis of transient and harmonic behavior. Considering various control circuit topologies, the book analyzes a wide range of models, from simple approximations, to sophisticated analytical approaches. Readers find clear examples that provide guidance in how to use specific modeling techniques for their challenging projects in the field. Numerous illustrations help practitioners better understand important device and circuit behavior, revealing the relationship between key parameters and results. This authoritative volume covers basic and complex mathematical models for the most common semiconductor control elements used in today's microwave and RF circuits and systems.

Microelectronics is one of the most rapidly changing scientific fields today. The tendency to shrink devices as far as possible results in extremely small devices which can no longer be described using simple analytical models. This book covers various aspects of advanced device modeling and simulation. As such it presents extensive reviews and original research by outstanding scientists. The bulk of the book is concerned with the theory of classical and quantum-mechanical transport modeling, based on macroscopic, spherical harmonics and Monte Carlo methods.

The primary goal of this book is to provide a sound understanding of wide bandgap Silicon Carbide (SiC) power semiconductor device simulation using Silvaco® ATLAS Technology Computer Aided Design (TCAD) software. Physics-based TCAD modeling of SiC power devices can be extremely challenging due to the wide bandgap of the semiconductor material. The material presented in this book aims to shorten the learning curve required to start successful SiC device simulation by providing a detailed explanation of simulation code and the impact of various modeling and simulation parameters on the simulation results. Non-isothermal simulation to predict heat dissipation and lattice temperature rise in a SiC device structure under switching condition has been explained in detail. Key pointers including runtime error messages, code debugging, implications of using certain models and parameter values, and other factors beneficial to device simulation are provided based on the authors' experience while simulating SiC device structures. This book is useful for students, researchers, and semiconductor professionals working in the area of SiC semiconductor technology. Readers will be provided with the source code of several fully functional simulation programs that illustrate the use of Silvaco® ATLAS to simulate SiC power device structure, as well as supplementary material for download.

Analysis and Design of MOSFETs: Modeling, Simulation, and Parameter Extraction is the first book devoted entirely to a broad spectrum of analysis and design issues related to the semiconductor device called metal-oxide semiconductor field-effect transistor (MOSFET). These issues include MOSFET device physics, modeling, numerical simulation, and parameter extraction. The discussion of the application of device simulation to the extraction of MOSFET parameters, such as the threshold voltage, effective channel lengths, and series resistances, is of particular interest to all readers and provides a valuable learning and reference tool for students, researchers and engineers. Analysis and Design of MOSFETs: Modeling, Simulation, and Parameter Extraction, extensively referenced, and containing more than 180 illustrations, is an innovative and integral new book on MOSFETs design technology.

Nanoscale Transistors

MOSFET Models for VLSI Circuit Simulation

Nonlinear Circuit Simulation and Modeling

A Unified MOS Device Model for Circuit Simulation

Including BSIM3v3 and BSIM4

Modeling and Simulation in Engineering

This volume provides a timely description of the latest compact MOS transistor models for circuit simulation. The first generation BSIM3 and BSIM4 models that have dominated circuit simulation in the last decade are no longer capable of characterizing all the important features of modern sub-100nm MOS transistors. This book discusses the second generation MOS transistor models that are now in urgent demand and being brought into the initial phase of manufacturing applications. It considers how the models are to include the complete drift-diffusion theory using the surface potential variable in the MOS transistor channel in order to give one characterization equation.

Continuous efforts to develop new semiconductor devices enable device manufacturers to make significant improvements in the information technology sector.

Bipolar transistors and MOSFETS are two special electronic device components that are used to construct very large scale integrated (VLSI) circuits, allowing engineers to create powerful machines that are power efficient. VLSI device characterization depends largely on semiconductor device modeling which is based on physical and electronic principles. Bipolar transistor and MOSFET device models is a textbook that describes basic functions and characterization models of these two types of transistors. Readers will learn about the processes employed to derive these models which will help them understand the modeling process. Chapters in this text cover the fundamentals of semiconductor devices, the pn junction, high and low injection region models for bipolar transistors, and different MOSFET models such as channel doping models and gated SOI models. Key features of this book include: - step by step, easy to understand presentation of model information on innovative semiconductor devices - an overview of model derivation, assumptions, approximations and limitations - novel experimental information on semiconductor parameters such as gate fringe capacitance, silicided source/drain resistance, and threshold voltage shift Bipolar transistor and MOSFET device models is an essential learning resource for advanced students and professional engineers involved in semiconductor device modeling and fabrication divisions.

Microelectronics is one of the most rapidly changing scientific fields today. The tendency to shrink devices as far as possible results in extremely small devices which can no longer be described using simple analytical models. This book covers various aspects of advanced device modeling and simulation. As such it presents extensive reviews and original research by outstanding scientists. The bulk of the book is concerned with the theory of classical and quantum-mechanical transport modeling, based on macroscopic, spherical harmonics and Monte Carlo methods. Contents: Modeling Electron Transport in MOSFET Devices: Evolution and State of the Art (A Abramo) Particle Models for Device Simulation (H Kosina & M Nedjalkov) Effective Potentials and Quantum Fluid Models: A Thermodynamic Approach (C Ringhofer et al.) Self-Consistent Modeling of MOSFET Quantum Effects by Solving the Schrödinger and Boltzmann System of Equations (N Goldsman & C-K Huang) Hydrodynamic Modeling of RF Noise for Silicon-Based Devices (C Jungemann et al.) Carbon Nanotubes as a Perfectly Conducting Cylinder (T Ando) Hot Carrier Effects Within Macroscopic Transport Models (T Grassler et al.) Readership: Upper level undergraduates, graduate students, academics/lecturers, researchers and industrialists in microelectronics and semiconductor science. Keywords: Device Simulation; Monte Carlo Method; Wigner-Boltzmann Equation; Spherical Harmonics; Carbon Nanotubes; Quantum Effects

Circuit simulation is essential in integrated circuit design, and the accuracy of circuit simulation depends on the accuracy of the transistor model. BSIM3v3 (BSIM for Berkeley Short-channel IGFET Model) has been selected as the first MOSFET model for standardization by the Compact Model Council, a consortium of leading companies in semiconductor and design tools. In the next few years, many fabless and integrated semiconductor companies are expected to switch from dozens of other MOSFET models to BSIM3. This will require many device engineers and most circuit designers to learn the basics of BSIM3. MOSFET Modeling & BSIM3 User's Guide explains the detailed physical effects that are important in modeling MOSFETs, and presents the derivations of compact model expressions so that users can understand the physical meaning of the model equations and parameters. It is the first book devoted to BSIM3. It treats the BSIM3 model in detail as used in digital, analog and RF circuit design. It covers the complete set of models, i.e., I-V model, capacitance model, noise model, parasitics model, substrate current model,

temperature effect model and non quasi-static model. MOSFET Modeling & BSIM3 User's Guide not only addresses the device modeling issues but also provides a user's guide to the device or circuit design engineers who use the BSIM3 model in digital/analog circuit design, RF modeling, statistical modeling, and technology prediction. This book is written for circuit designers and device engineers, as well as device scientists worldwide. It is also suitable as a reference for graduate courses and courses in circuit design or device modelling. Furthermore, it can be used as a textbook for industry courses devoted to BSIM3. MOSFET Modeling & BSIM3 User's Guide is comprehensive and practical. It is balanced between the background information and advanced discussion of BSIM3. It is helpful to experts and students alike.

*FinFET Modeling for IC Simulation and Design
Introduction to Semiconductor Device Modelling
MOSFET Modeling & BSIM3 User's Guide
MOSFET Models for SPICE Simulation
Conventional Transistors and Beyond
Simulation for VLSI MOSFET*

This is the first book dedicated to the next generation of MOSFET models. Addressed to circuit designers with an in-depth treatment that appeals to device specialists, the book presents a fresh view of compact modeling, having completely abandoned the regional modeling approach. Both an overview of the basic physics theory required to build compact MOSFET models and a unified treatment of inversion-charge and surface-potential models are provided. The needs of digital, analog and RF designers as regards the availability of simple equations for circuit designs are taken into account. Compact expressions for hand analysis or for automatic synthesis, valid in all operating regions, are presented throughout the book. All the main expressions for computer simulation used in the new generation compact models are derived. Since designers in advanced technologies are increasingly concerned with fluctuations, the modeling of fluctuations is strongly emphasized. A unified approach for both space (matching) and time (noise) fluctuations is introduced.

A practical, tutorial guide to the nonlinear methods and techniques needed to design real-world microwave circuits.

Helps readers understand the physics behind MOS devices for low-voltage and low-energy applications • Based on timely published and unpublished work written by expert authors • Discusses various promising MOS devices applicable to low-energy environmental and biomedical uses • Describes the physical effects (quantum, tunneling) of MOS devices • Demonstrates the performance of devices, helping readers to choose right devices applicable to an industrial or consumer environment • Addresses some Ge-based devices and other compound-material-based devices for high-frequency applications and future development of high performance devices. 'Seemingly innocuous everyday devices such as smartphones, tablets and services such as on-line gaming or internet keyword searches consume vast amounts of energy. Even when in standby mode, all these devices consume energy. The upcoming "Internet of Things" (IoT) is expected to deploy 60 billion electronic devices spread out in our homes, cars and cities. Britain is already consuming up to 16 per cent of all its power through internet use and this rate is doubling every four years. According to The UK's Daily Mail May (2015), if usage rates continue, all of Britain's power supply could be consumed by internet use in just 20 years. In 2013, U.S. data centers consumed an estimated 91 billion kilowatt-hours of electricity, corresponding to the power generated by seventeen 1000-megawatt nuclear power plants. Data center electricity consumption is projected to increase to roughly 140 billion kilowatt-hours annually by 2020, the equivalent annual output of 50 nuclear power plants. (Natural Resources Defense Council, USA, Feb. 2015) All these examples stress the urgent need for developing electronic devices that consume as little energy as possible. The book "MOS Devices for Low-Voltage and Low-Energy Applications" explores the different transistor options that can be utilized to achieve that goal. It describes in detail the physics and performance of transistors that can be operated at low voltage and consume little power, such as subthreshold operation in bulk transistors, fully depleted SOI devices, tunnel FETs, multigate and gate-all-around MOSFETs. Examples of low-energy circuits making use of these devices are given as well. The book "MOS Devices for Low-Voltage and Low-Energy Applications" is a good reference for graduate students, researchers, semiconductor and electrical engineers who will design the electronic systems of tomorrow.' --- Dr. Jean-Pierre Colinge, Taiwan Semiconductor Manufacturing Company (TSMC) "The authors present a creative way to show how different MOS devices can be used for low-voltage and low-power applications. They start with Bulk MOSFET, following with SOI MOSFET, FinFET, gate-all-around MOSFET, Tunnel-FET and others. It is presented the physics behind the devices, models, simulations, experimental results and applications. This book is interesting for researchers, graduate and undergraduate students. The low-energy field is an important topic for integrated circuits in the future and none can stay out of this." --- Prof. Joao A. Martino, University of Sao Paulo, Brazil

This book deals mainly with physical device models which are developed from the carrier transport physics and device geometry considerations. The text concentrates on silicon and gallium arsenide devices and includes models of silicon bipolar junction transistors, junction field effect transistors (JFETs), MESFETs, silicon and GaAs MESFETs, transferred electron devices, pn junction diodes and Schottky varactor diodes. The modelling techniques of more recent devices such as the heterojunction bipolar transistors (HBT) and the high electron mobility transistors are discussed. This book contains details of models for both equilibrium and non-equilibrium transport conditions. The modelling Technique of Small-scale devices is discussed and techniques applicable to submicron-dimensioned devices are included. A section on modern quantum transport analysis techniques is included. Details of essential numerical schemes are given and a variety of device models are used to illustrate the application of these techniques in various fields.

Introduction to Device Modeling and Circuit Simulation

POWER/HVMOS Devices Compact Modeling

Statistical Modeling for Computer-Aided Design of MOS VLSI Circuits

Microwave and RF Semiconductor Control Device Modeling

Principles, Techniques and Applications

Technology computer-aided design, or TCAD, is critical to today's semiconductor technology and anybody working in this industry needs to know something about TCAD. This book is about how to use computer software to manufacture and test virtually semiconductor devices in 3D. It brings to life the topic of semiconductor device physics, with a hands-on, tutorial approach that de-emphasizes abstract physics and equations and emphasizes real practice and extensive illustrations. Coverage includes a comprehensive library of devices, representing the state of the art technology, such as Superjunction LDMOS, GaN LED devices, etc.

A reprint of the classic text, this book popularized compact modeling of electronic and semiconductor devices and components for college and graduate-school classrooms, and manufacturing engineering, over a decade ago. The first comprehensive book on MOS transistor compact modeling, it was the most cited among similar books in the area and remains the most frequently cited today. The coverage is device-physics based and continues to be relevant to the latest advances in MOS transistor modeling. This is also the only book that discusses in detail how to measure device model parameters required for circuit simulations. The book deals with the MOS Field Effect Transistor (MOSFET) models that are derived from basic semiconductor theory. Various models are developed, ranging from simple to more sophisticated models that take into account new physical effects observed in submicron transistors used in today's (1993) MOS VLSI technology. The assumptions used to arrive at the models are emphasized so that the accuracy of the models in describing the device characteristics are clearly understood. Due to the importance of designing reliable circuits, device reliability models are also covered. Understanding these models is essential when designing circuits for state-of-the-art MOS ICs.

This book is the first to explain FinFET modeling for IC simulation and the industry standard - BSIM-CMG - describing the rush in demand for advancing the technology from planar to 3D architecture, as now enabled by the approved industry standard. The book gives a strong foundation on the physics and operation of FinFET, details aspects of the BSIM-CMG model such as surface potential, charge and current calculations, and includes a dedicated chapter on parameter extraction procedures, providing a step-by-step approach for the efficient extraction of model parameters. With this book you will learn: Why you should use FinFET The physics and operation of FinFET Details of the FinFET standard model (BSIM-CMG) Parameter extraction in BSIM-CMG FinFET circuit design and simulation Authored by the lead inventor and developer of FinFET, and developers of the BSIM-CM standard model, providing an experts' insight into the specifications of the standard The first book on the industry-standard FinFET model - BSIM-CMG

Bridges the gap between device modelling and analog circuit design. Includes dedicated software enabling actual circuit design. Covers the three significant models: BSIM3, Model 9 &, and EKV. Presents practical guidance on device development and circuit implementation. The authors offer a combination of extensive academic and industrial experience.

Applications from Engineering with MATLAB Concepts

Mosfet Modeling for VLSI Simulation

Advanced Nanoelectronics

Theory and Practice

Fundamentals for Microwave Design

Compact Models for Integrated Circuit Design (Open Access)

As MOS devices are scaled to meet increasingly demanding circuit specifications, process variations have a greater effect on the reliability of circuit performance. For this reason, statistical techniques are required to design integrated circuits with maximum yield. Statistical Modeling for Computer-Aided Design of MOS VLSI Circuits describes a statistical circuit simulation and optimization environment for VLSI circuit designers. The first step toward accomplishing statistical circuit design and optimization is the development of an accurate CAD tool capable of performing statistical simulation. This tool must be based on a statistical model which comprehends the effect of device and circuit characteristics, such as device size, bias, and circuit layout, which are under the control of the circuit designer on the variability of circuit performance. The distinctive feature of the CAD tool described in this book is its ability to accurately model and simulate the effect in both intra- and inter-die process variability on analog/digital circuits, accounting for the effects of the aforementioned device and circuit characteristics. Statistical Modeling for Computer-Aided Design of MOS VLSI Circuits serves as an excellent reference for those working in the field, and may be used as the text for an advanced course on the subject.

The book presents a collection of MATLAB-based chapters of various engineering background. Instead of giving exhausting amount of technical details, authors were rather advised to explain relations of their problems to actual MATLAB concepts. So, whenever possible, download links to functioning MATLAB codes were added and a potential reader can do own testing. Authors are typically scientists with interests in modeling in MATLAB. Chapters include image and signal processing, mechanics and dynamics, models and data identification in biology, fuzzy logic, discrete event systems and data acquisition systems.

The general aim of this book is to present selected chapters of the following types: chapters with more focus on modeling with some necessary simulation details and chapters with less focus on modeling but with more simulation details. This book contains eleven chapters divided into two sections: Modeling in Continuum Mechanics and Modeling in Electronics and Engineering. We hope our book entitled "Modeling and Simulation in Engineering - Selected Problems" will serve as a useful reference to students, scientists, and engineers.

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.

Design, Modeling, and Simulation

Mosfet Models for VLSI Circuit Simulation

Compact Transistor Modelling for Circuit Design

Compact MOSFET Models for VLSI Design

MOS Devices for Low-Voltage and Low-Energy Applications

Advanced Device Modeling and Simulation

Semiconductor power electronics plays a dominant role due its increased efficiency and high reliability in various domains including the medium and high electrical drives, automotive and aircraft applications, electrical power conversion, etc. Power/HVMOS Devices Compact Modeling will cover very extensive range of topics related to the development and characterization power/high voltage (HV) semiconductor technologies as well as modeling and simulations of the power/HV devices and smart power integrated circuits (ICs). Emphasis is placed on the practical applications of the advanced semiconductor technologies and the device level compact/spice modeling. This book is intended to provide reference information by selected, leading authorities in their domain of expertise. They are representing both academia and industry. All of them have been chosen because of their intimate knowledge of their subjects as well as their ability to present them in an easily understandable manner.

Modern, large-scale analog integrated circuits (ICs) are essentially composed of metal-oxide semiconductor (MOS) transistors and their interconnections. As technology scales down to deep sub-micron dimensions and supply voltage decreases to reduce power consumption, these complex analog circuits are even more dependent on the exact behavior of each transistor. High-performance analog circuit design requires a very detailed model of the transistor, describing accurately its static and dynamic behaviors, its noise and matching limitations and its temperature variations. The charge-based EKV (Enz-Krummenacher-Vittoz) MOS transistor model for IC design has been developed to provide a clear understanding of the device properties, without the use of complicated equations. All the static, dynamic, noise, non-quasi-static models are completely described in terms of the inversion charge at the source and at the drain taking advantage of the symmetry of the device. Thanks to its hierarchical structure, the model offers several coherent description levels, from basic hand calculation equations to complete computer simulation model. It is also compact, with a minimum number of process-dependant device parameters. Written by its developers, this book provides a comprehensive treatment of the EKV charge-based model of the MOS transistor for the

design and simulation of low-power analog and RF ICs. Clearly split into three parts, the authors systematically examine: the basic long-channel intrinsic charge-based model, including all the fundamental aspects of the EKV MOST model such as the basic large-signal static model, the noise model, and a discussion of temperature effects and matching properties; the extended charge-based model, presenting important information for understanding the operation of deep-submicron devices; the high-frequency model, setting out a complete MOS transistor model required for designing RF CMOS integrated circuits. Practising engineers and circuit designers in the semiconductor device and electronics systems industry will find this book a valuable guide to the modelling of MOS transistors for integrated circuits. It is also a useful reference for advanced students in electrical and computer engineering.

Surface-Potential Model HiSIM

Modeling And Electrothermal Simulation Of Sic Power Devices: Using Silvaco® Atlas

Charge-Based MOS Transistor Modeling

Mosfet Modeling for Circuit Analysis and Design

Device Physics, Modeling and Simulation