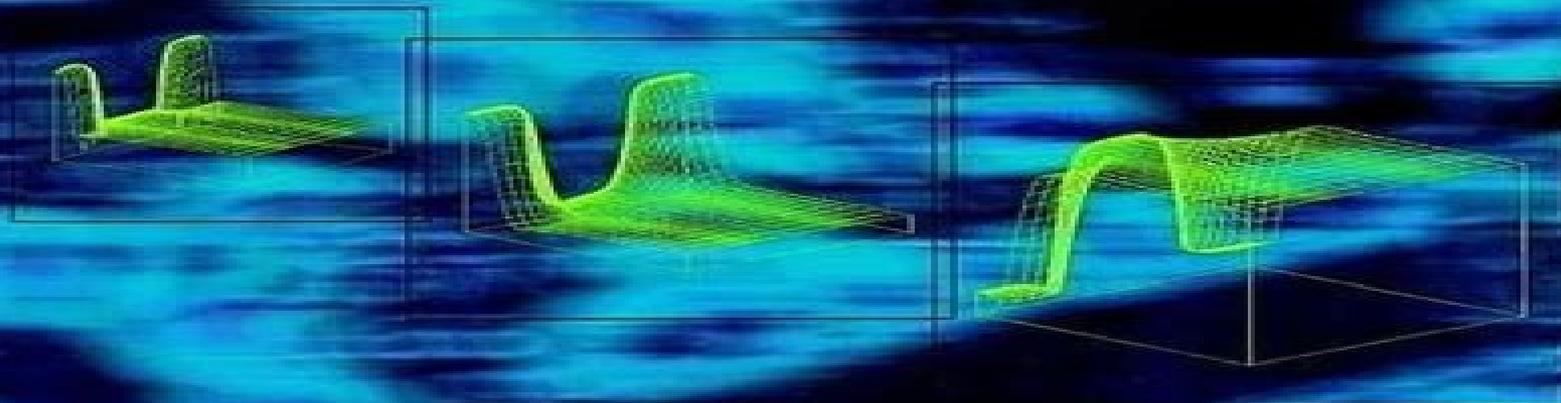
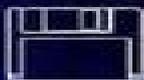


# Semiconductor Devices Explained

using active simulation



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# Semiconductor Devices Explained Using Active Simulation

**Abdul Al-Azzawi**



## **Semiconductor Devices Explained Using Active Simulation:**

Semiconductor Devices Explained Ton J. Mouta, 1999 Offers an innovative and accessible new approach to the teaching of the fundamentals of semiconductor components by exploiting simulation to explain the mechanisms behind current in semiconductor structures Simulation is a popular tool used by engineers and scientists in device and process research and the accompanying two dimensional process and device simulation software MicroTec enables students to make their own devices and allows the recreation of real performance under varying parameters There is also an accompanying ftp site containing ICECREAM software Integrated Circuits and Electronics group Computerized Remedial Education And Mastering which improves understanding of the physics involved and covers semiconductor physics junction diodes silicon bipolar and MOS transistors and photonic devices like LEDs and lasers Features include MicroTec diskette containing a two dimensional process and device simulator on which the many simulation exercises mentioned in the text can be performed thereby facilitating learning through experimentation Computer aided education software accessible via ftp featuring question and answer games which enables students to enhance their understanding of the physics involved and allows lecturers to set assignments Broad coverage spanning the common devices pn junctions metal semiconductor junctions photocells lasers bipolar transistors and MOS transistors Discussion of fundamental concepts and technological principles offering the student a valuable grounding in semiconductor physics Examination of the implications of recent research on small dimensions reliability problems and breakdown mechanisms Semiconductor Devices Explained offers a comprehensive new approach to teaching the fundamentals of semiconductor components based on the use of the accompanying process and device simulation software Simulation is a popular tool used by engineers and scientists in device and process research It supports the understanding of basic phenomena by linking the theory to hands on applications and real world problems with semiconductor devices Throughout the text students are encouraged to augment their understanding by undertaking simulations and creating their own devices The ICECREAM programme Integrated Circuits and Electronics group Computerized Remedial Education And Mastering question and answer game leads students through the concepts of common devices and makes learning fun There is also a self test element in which a data bank generates questions on the fundamentals of semiconductor junctions enabling students to assess their progress Larger projects suitable for use as examination assignments are also incorporated The test package is freely available to lecturers from the author on request The remedial component of ICECREAM is available from the Wiley ftp site MicroTec comes on a disk in the back of the book

Fiber Optics Abdul Al-Azzawi, 2017-05-23 This book provides a step by step discussion through each topic of fiber optics Each chapter explores theoretical concepts of principles and then applies them by using experimental cases with numerous illustrations The book works systematically through fiber optic cables advanced fiber optic cables light attenuation in optical components fiber optic cable types and installations fiber optic connectors passive fiber optic devices wavelength division

multiplexing optical amplifiers optical receivers opto mechanical switches and optical fiber communications It includes important chapters in fiber optic lighting fiber optics testing and laboratory safety *Voltage Regulators for Next Generation Microprocessors* Toni López,Reinhold Elferich,Eduard Alarcón,2010-12-01 This book deals with energy delivery challenges of the power processing unit of modern computer microprocessors It describes in detail the consequences of current trends in miniaturization and clock frequency increase upon the power delivery unit referred to as voltage regulator This is an invaluable reference for anybody needing to understand the key performance limitations and opportunities for improvement from both a circuit and systems perspective of state of the art power solutions for next generation CPUs

**Photonics** Abdul Al-Azzawi,2017-12-19 Since the invention of the laser our fascination with the photon has led to one of the most dynamic and rapidly growing fields of technology An explosion of new materials devices and applications makes it more important than ever to stay current with the latest advances Surveying the field from fundamental concepts to state of the art developments *Photonics Principles and Practices* builds a comprehensive understanding of the theoretical and practical aspects of photonics from the basics of light waves to fiber optics and lasers Providing self contained coverage and using a consistent approach the author leads you step by step through each topic Each skillfully crafted chapter first explores the theoretical concepts of each topic and then demonstrates how these principles apply to real world applications by guiding you through experimental cases illuminated with numerous illustrations Coverage is divided into six broad sections systematically working through light optics waves and diffraction optical fibers fiber optics testing and laboratory safety A complete glossary useful appendices and a thorough list of references round out the presentation The text also includes a 16 page insert containing 28 full color illustrations Containing several topics presented for the first time in book form *Photonics Principles and Practices* is simply the most modern comprehensive and hands on text in the field *Introduction to Simulations of Semiconductor Lasers* Marek Wartak,2024-03-21 Simulations play an increasingly important role not only in scientific research but also in engineering developments *Introduction to Simulations of Semiconductor Lasers* introduces senior undergraduates to the design of semiconductor lasers and their simulations The book begins with explaining the physics and fundamental characteristics behind semiconductor lasers and their applications It presumes little prior knowledge such that only a familiarity with the basics of electromagnetism and quantum mechanics is required The book transitions from textbook explanations equations and formulas to ready to run numeric codes that enable the visualization of concepts and simulation studies Multiple chapters are supported by MATLAB code which can be accessed by the students These are ready to run but they can be modified to simulate other structures if desired Providing a unified treatment of the fundamental principles and physics of semiconductors and semiconductor lasers *Introduction to Simulations of Semiconductor Lasers* is an accessible practical guide for advanced undergraduate students of Physics particularly for courses in laser physics **Key Features** A unified treatment of fundamental principles Explanations of the fundamental physics

of semiconductor Explanations of the operation of semiconductor lasers An historical overview of the subject Physics of Semiconductor Devices V. K. Jain, Abhishek Verma, 2013-11-27 The purpose of this workshop is to spread the vast amount of information available on semiconductor physics to every possible field throughout the scientific community As a result the latest findings research and discoveries can be quickly disseminated This workshop provides all participating research groups with an excellent platform for interaction and collaboration with other members of their respective scientific community This workshop s technical sessions include various current and significant topics for applications and scientific developments including Optoelectronics VLSI ULSI Technology Photovoltaics MEMS Sensors Device Modeling and Simulation High Frequency Power Devices Nanotechnology and Emerging Areas Organic Electronics Displays and Lighting Many eminent scientists from various national and international organizations are actively participating with their latest research works and also equally supporting this mega event by joining the various organizing committees **Analysis and**

**Design of Power Converter Topologies for Application in Future More Electric Aircraft** Amit Kumar Singh, 2018-04-20 This thesis proposes new power converter topologies suitable for aircraft systems It also proposes both AC DC and DC DC types of converters for different electrical loads to improve the performance these systems To increase fuel efficiency and reduce environmental impacts less efficient non electrical aircraft systems are being replaced by electrical systems However more electrical systems requires more electrical power to be generated in the aircraft The increased consumption of electrical power in both civil and military aircrafts has necessitated the use of more efficient electrical power conversion technologies This book presents a comprehensive mathematical analysis and the design and digital simulation of the power converters Subsequently it discusses the construction of the hardware prototypes of each converter and the experimental tests carried out to verify the benefits of the proposed solutions in comparison to the existing solutions

**Computer Simulation of Electronic Circuits** R. Raghuram, 1989 This Book On A Very Topical Subject Is Aimed At Engineers Who Either Use Or Develop Cad Tools For Circuit Design Be It At The Discrete Device Level Or At The Lsi Vlsi Level The Book Is Unique In The Sense That It Covers Analog Circuit Simulation Device Models Logic Simulation And Fault Simulation These Topics Traditionally Belong To Different Areas Of Electrical Engineering And Are Therefore Not Covered In One Book However A Person Doing Circuit Design On A Computer Today Needs To Know All Aspects Of The Simulation This Book Attempts To Satisfy This Need Many Examples Of Programs As Well As Applications Are Given Every Chapter Contains Solved As Well As Unsolved Problems In Addition Programming Assignments Are Included Mathematics Has Been Kept To A Minimum And An Intuitive Approach Has Been Taken The Background Required Is That Of Final Year Undergraduate In Electrical Engineering It Is Expected That Much Of This Material Would Percolate Down To More Basic Courses In Future Years *Modeling And Parameter Extraction Techniques Of Silicon-based Radio Frequency Devices* Ao Zhang, Jianjun Gao, 2023-03-21 This comprehensive compendium describes the basic modeling techniques for silicon based semiconductor

devices introduces the basic concepts of silicon based passive and active devices and provides its state of the art modeling and equivalent circuit parameter extraction methods The unique reference text benefits practicing engineers technicians senior undergraduate and first year graduate students working in the areas of RF microwave and solid state device and integrated circuit design *Analysis and Simulation of Heterostructure Devices* Vassil Palankovski, Rüdiger Quay, 2012-12-06 Communication and information systems are subject to rapid and highly sophisticated changes Currently semiconductor heterostructure devices such as Heterojunction Bipolar Transistors HBTs and High Electron Mobility Transistors HEMTs are among the fastest and most advanced high frequency devices They satisfy the requirements for low power consumption medium integration low cost in large quantities and high speed operation capabilities in circuits In the very high frequency range cut off frequencies up to 500 GHz 557 have been reported on the device level HEMTs and HBTs are very suitable for high efficiency power amplifiers at 900 MHz as well as for data rates higher than 100 Gbit/s for long range communication and thus cover a broad range of applications To cope with explosive development costs and the competition of today's semiconductor industry Technology Computer Aided Design TCAD methodologies are used extensively in development and production As of 2003 III V semiconductor HEMT and HBT micrometer and millimeter wave integrated circuits MICs and MMICs are available on six inch GaAs wafers SiGe HBT circuits as part of the CMOS technology on eight inch wafers are in volume production Simulation tools for technology devices and circuits reduce expensive technological efforts This book focuses on the application of simulation software to heterostructure devices with respect to industrial applications In particular a detailed discussion of physical modeling for a great variety of materials is presented *Silicon And Beyond: Advanced Device Models And Circuit Simulators* Tor A Fjeldly, Michael S Shur, 2000-04-20 The steady downscaling of device feature size combined with a rapid increase in circuit complexity as well as the introduction of new device concepts based on non silicon material systems poses great challenges for device and circuit designers One of the major tasks is the development of new and improved device models needed for accurate device and circuit design Another task is the development of new circuit simulation tools to handle very large and complex circuits This book addresses both these issues with up to date reviews written by leading experts in the field The first three chapters of the book discuss advanced device models both for existing technologies and for new emerging technologies Among the topics covered are models for MOSFETs thin film transistors TFTs and compound semiconductor devices including GaAs HEMTs and HFETs heterodimensional devices quantum tunneling devices as well as wide bandgap devices Chapters 4 and 5 discuss advanced circuit simulators that hold promise for handling circuits of much higher complexity than what is possible for typical state of the art circuit simulators today **Latchup** Steven H. Voldman, 2008-04-15 Interest in latchup is being renewed with the evolution of complementary metal oxide semiconductor CMOS technology metal oxide semiconductor field effect transistor MOSFET scaling and high level system on chip SOC integration Clear methodologies that grant protection from latchup with

insight into the physics technology and circuit issues involved are in increasing demand This book describes CMOS and BiCMOS semiconductor technology and their sensitivity to present day latchup phenomena from basic over voltage and over current conditions single event latchup SEL and cable discharge events CDE to latchup domino phenomena It contains chapters focusing on bipolar physics latchup theory latchup and guard ring characterization structures characterization testing product level test systems product level testing and experimental results Discussions on state of the art semiconductor processes design layout and circuit level and system level latchup solutions are also included as well as latchup semiconductor process solutions for both CMOS to BiCMOS such as shallow trench deep trench retrograde wells connecting implants sub collectors heavily doped buried layers and buried grids from single to triple well CMOS practical latchup design methods automated and bench level latchup testing methods and techniques latchup theory of logarithm resistance space generalized alpha a space beta b space new latchup design methods connecting the theoretical to the practical analysis and examples of latchup computer aided design CAD methodologies from design rule checking DRC and logical to physical design to new latchup CAD methodologies that address latchup for internal and external latchup on a local as well as global design level Latchup acts as a companion text to the author s series of books on ESD electrostatic discharge protection serving as an invaluable reference for the professional semiconductor chip and system level ESD engineer Semiconductor device process and circuit designers and quality reliability and failure analysis engineers will find it informative on the issues that confront modern CMOS technology Practitioners in the automotive and aerospace industries will also find it useful In addition its academic treatment will appeal to both senior and graduate students with interests in semiconductor process device physics computer aided design and design integration

### **Noise in Semiconductor Devices**

Fabrizio Bonani, Giovanni Ghione, 2013-03-09 The design and optimization of electronic systems often requires appraisal an of the electrical noise generated by active devices and at a technological level the ability to properly design active elements in order to minimize when possible their noise Examples of critical applications are of course receiver front ends in RF and optoelectronic transmission systems but also front end stages in sensors and in a completely different context nonlinear circuits such as oscillators mixers and frequency multipliers The rapid development of silicon RF applications has recently fostered the interest toward low noise silicon devices for the lower microwave band such as low noise MOS transistors at the same time the RF and microwave ranges are becoming increasingly important in fast optical communication systems Thus high frequency noise modeling and simulation of both silicon and compound semiconductor based bipolar and field effect transistors can be considered as an important and timely topic This does not exclude of course low frequency noise which is relevant also in the RF and microwave ranges when ever it is up converted within a nonlinear system either autonomous as an oscillator or non autonomous as a mixer or frequency multiplier The aim of the present book is to provide a thorough introduction to the physics based numerical modeling of semiconductor devices operating both in small signal and in large

signal conditions In the latter instance only the non autonomous case was considered and thus the present treatment does not directly extend to oscillators

*Advanced Multilevel Converters and Applications in Grid Integration* Ali Iftekhar Maswood, Hossein Dehghani Tafti, 2018-10-15 A comprehensive survey of advanced multilevel converter design control operation and grid connected applications *Advanced Multilevel Converters and Applications in Grid Integration* presents a comprehensive review of the core principles of advanced multilevel converters which require fewer components and provide higher power conversion efficiency and output power quality The authors noted experts in the field explain in detail the operation principles and control strategies and present the mathematical expressions and design procedures of their components The text examines the advantages and disadvantages compared to the classical multilevel and two level power converters The authors also include examples of the industrial applications of the advanced multilevel converters and offer thoughtful explanations on their control strategies *Advanced Multilevel Converters and Applications in Grid Integration* provides a clear understanding of the gap difference between research conducted and the current industrial needs This important guide Puts the focus on the new challenges and topics in related areas such as modulation methods harmonic analysis voltage balancing and balanced current injection Makes a strong link between the fundamental concepts of power converters and advances multilevel converter topologies and examines their control strategies together with practical engineering considerations Provides a valid reference for further developments in the multilevel converters design issue Contains simulations files for further study Written for university students in electrical engineering researchers in areas of multilevel converters high power converters and engineers and operators in power industry *Advanced Multilevel Converters and Applications in Grid Integration* offers a comprehensive review of the core principles of advanced multilevel converters with contributions from noted experts in the field

*Simulation Methods for ESD Protection Development* Harald Gossner, Kai Esmark, Wolfgang Stadler, 2003-10-16 *Simulation Methods for ESD Protection Development* looks at the integration of new techniques into a comprehensive development flow which is now available due advances made in the field during the recent years These findings allow for an early stable ESD concept at a very early stage of the technology development which is essential now development cycles have been reduced The book also offers ways of increasing the optimization and control of the technology concerning performance thus making the process more cost effective and increasingly efficient This title provides a guide through the latest research and technology presenting the ESD protection development methodology This is based on a combination of process device and circuit stimulation and addresses the optimization of the industry critical issue reduced development cycles Written to address the needs of the ESD engineer this text is required reading by all industry practitioners and researchers and students within this field The FIRST Extensive overview on the subject of ESD simulation Addresses the industry critical issue of reduced development cycles and provides solutions Presents the latest research in the field with high practical relevance and its results

*Plasmonic Nanoelectronics*

*and Sensing* Er-Ping Li, Hong-Son Chu, 2014-02-13 A comprehensive overview from fundamental theory and numerical methods to the design of real plasmonic structures for nanoelectronic and sensing applications

**Physical Optics** Abdul Al-Azzawi, 2018-10-03 Since the invention of the laser our fascination with the photon has led to one of the most dynamic and rapidly growing fields of technology As the reality of all optical systems comes into focus it is more important than ever to stay current with the latest advances in the optics and components that enable photonics technology Comprising chapters drawn from the author's highly anticipated book *Photonics Principles and Practices* **Physical Optics Principles and Practices** offers a detailed and focused treatment for anyone in need of authoritative information on this critical area underlying photonics Using a consistent approach the author leads you step by step through each topic Each skillfully crafted chapter first explores the theoretical concepts of each topic and then demonstrates how these principles apply to real world applications by guiding you through experimental cases illuminated with numerous illustrations The book works systematically through the principles of waves diffraction interference diffraction gratings interferometers spectrometers and several aspects of laser technology to build a thorough understanding of how to study and manipulate the behavior of light for various applications In addition it includes a four page insert containing several full color illustrations as well as a chapter on laboratory safety Containing several topics presented for the first time in book form **Physical Optics Principles and Practices** is simply the most modern detailed and hands on text in the field

**Scientific and Technical Aerospace Reports**, 1992 *Physical Limitations of Semiconductor Devices* Vladislav A. Vashchenko, V. F. Sinkevitch, 2008-03-22 Since the beginning of semiconductor era in microelectronics the methodology of reliability assessment became a well established area In most cases the reliability assessment involves statistical methods for safe operating area and long term reliability parameters at the development of semiconductor processes components and systems At the same time in case of catastrophic failures at any development phase the major practical method is failure analysis FA However FA is mainly dealing with detection of consequences of some irreversible event that already happened This book is focused on the most important and the less summarized reliability aspects Among them catastrophic failures impact of local structural inhomogeneities major principles of physical limitation of safe operating area SOA physical mechanisms of the current instability filamentation and conductivity modulation in particular device types and architectures Specifically the similar principles and regularities are discussed for electrostatic discharge ESD protection devices treating them as a particular case of pulsed power devices Thus both the most intriguing applications and reliability problems in case of the discrete and the integrated components are covered in this book

[Single-Event Effects, from Space to Accelerator Environments](#) Ygor Quadros de Aguiar, Frédéric Wrobel, Jean-Luc Autran, Rubén García Alía, 2024-10-17 This book describes the fundamental concepts underlying radiation induced failure mechanisms in electronic components operating in harsh environments such as in space missions or in particle accelerators In addition to providing an extensive overview of the dynamics and composition of different radiation

environments the authors discuss the failure mechanisms known as single event effects SEEs and dedicated failure modeling and prediction methodologies Additionally novel radiation hardening by design RHBD techniques at physical layout and circuit levels are described Readers who are newcomers to this field will learn the fundamental concepts of particle interaction physics and electronics hardening design starting from the composition and dynamics of radiation environments and their effects on electronics to the qualification and hardening of components Experienced readers will enjoy the comprehensive discussion of the state of the art in modeling simulation and analysis of radiation effects developed in the recent years especially the outcome of the recent European project RADSAGA Describes both the fundamental concepts underlying radiation effects in electronics and state of the art hardening methodologies Addresses failure mechanisms known as single event effects SEEs and dedicated failure modeling and prediction methodologies Reveals novel radiation hardening by design RHBD techniques at physical layout and circuit levels Offers readers the first book in which particle accelerator applications will be extensively included in the radiation effects context This is an open access book

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