

Practice Problems- Band Theory of solids and Semiconductors

1. Refer to the class notes on band structure of solid. In the case of periodically placed delta function potential, show that the wave function for a particle in the periodic delta function potential can be written in the form

$$\psi(x) = C[\sin(kx) + e^{-iKa} \sin(k(a-x))], \quad 0 \leq x \leq a.$$

2. Find the energy at the top of the first allowed band, for the case $\beta = 5$, correct to three significant digits. For the sake of argument, assume $a/a = 1$.
3. Find the Fermi energy of copper metal. The electron density in copper is $8.5 \times 10^{28} \text{electrons/m}^3$.

[Ans. 7.04 eV]

4. An electron beam strikes a crystal of cadmium sulfide (CdS). Electrons scattered by the crystal move at a velocity of $4.4 \times 10^5 \text{ m/s}$. Calculate the energy of the incident beam. Express your result in eV. CdS is a semiconductor with a band gap, E_g , of 2.45 eV.
(Hint: $E_{\text{incident}} = E_{\text{emitted}} + E_{\text{scattered}}$).

5. The number of electron-hole pairs in intrinsic germanium (Ge) is given by:

$$n_i = 9.7 \times 10^{15} \times T^{3/2} \times e^{\frac{-E_g}{2kT}} \text{ cm}^{-3}$$

($E_g = 0.72 \text{ eV}$)

- (a) What is the density of pairs at $T = 20 \text{ deg-C}$?
 - (b) Will undoped Ge be a good conductor at 200 deg-C ? If so, why?
6. If no electron-hole pairs were produced in germanium (Ge) until the temperature reached the value corresponding to the energy gap, at what temperature would Ge become conductive? ($E_{\text{gap}} = 3/2kT$)
 7. Given $\mu_p = 470 \text{ cm}^2/\text{V.s}$ for Si, what is the hole drift velocity at $\mathcal{E} = 10^3 \text{ V/cm}$. What is τ_{avg} and what is the average distance traveled between collisions, i.e., the mean free path ? (Ans. mean free path = 22nm).
 8. What is the hole diffusion constant in a piece of silicon doped with $3 \times 10^{15} \text{ cm}^{-3}$ of donors and $7 \times 10^{15} \text{ cm}^{-3}$ of acceptors at 300 K? at 400 K? [Ans. $7.6 \text{ cm}^2/\text{V.s}$]

Semiconductors Their Theory Practice

Narain Arora



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Semiconductors W.M. Jr. Coughran, Julian Cole, Peter Lloyd, Jacob K. White, 2012-12-06 Semiconductor and integrated circuit modeling are an important part of the high technology chip industry whose high performance low cost microprocessors and high density memory designs form the basis for supercomputers engineering workstations laptop computers and other modern information appliances There are a variety of differential equation problems that must be solved to facilitate such modeling This two volume set covers three topic areas process modeling and circuit simulation in Volume I and device modeling in Volume II Process modeling provides the geometry and impurity doping characteristics that are prerequisites for device modeling device modeling in turn provides static current and transient charge characteristics needed to specify the so called compact models employed by circuit simulators The goal of these books is to bring together scientists and mathematicians to discuss open problems algorithms to solve such and to form bridges between the diverse disciplines involved

Semiconductors and Semimetals , 1981-09-02 Semiconductors and Semimetals

Making a Semiconductor Superpower Dong-Won Kim, 2023-09-29 This book provides real stories about the South Korean semiconductor community It explores the lives and careers of six influential semiconductor engineers who all studied at Korea Advanced Institute of Science and Technology KAIST under the mentorship of Dr Kim Choong Ki the most influential semiconductor professor in South Korea during the last quarter of the twentieth century Kim s

students became known as Kim's Mafia because of the important positions they went on to hold in industry government and academia This book will be of interest to semiconductor engineers and electronics engineers historians of science and technology and scholars and students of East Asian studies They were called Kim's Mafia Kim Choong Ki himself wouldn't have put it that way But it was true what semiconductor engineers in South Korea whispered about his former students They were everywhere Kim was the first professor in South Korea to systematically teach semiconductor engineering From 1975 when the nation had barely begun producing its first transistors to 2008 when he retired from teaching Kim trained more than 100 students effectively creating the first two generations of South Korean semiconductor experts Source IEEE Spectrum October 2022

Mosfet Modeling For Vlsi Simulation: Theory And Practice Narain Arora, 2007-02-14 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 *Compact Models for Integrated Circuit Design* Samar K. Saha, 2018-09-03 Compact Models for Integrated Circuit Design Conventional Transistors and Beyond provides a modern treatise on compact models for circuit computer aided design CAD Written by an 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 compact modeling 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 for addressing current modeling challenges and understanding new models for emerging devices Starting from basic semiconductor physics and covering state of the art device regimes from conventional micron to nanometer this text Presents industry standard models for bipolar junction transistors BJTs metal oxide semiconductor MOS field effect transistors FETs FinFETs and 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 advanced technologies and requires statistical compact models Promotes further research of the evolution and development of compact models for VLSI circuit design and analysis Supplies fundamental and practical

knowledge necessary for efficient integrated circuit IC design using nanoscale devices Includes exercise problems at the end of each chapter and extensive references at the end of the book Compact Models for Integrated Circuit Design Conventional Transistors and Beyond is intended for senior undergraduate and graduate courses 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 physics gain a solid grasp of compact modeling concepts from this book **Semiconductor Microchips and Fabrication**

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Janina Morska, Alan Rogerson, 2023-06-14 This volume contains the papers presented at the International Symposium Innovative Teaching Practices held on August 14 18 2023 in The Queen's College Oxford University The Symposium was organized by The Mathematics Education for the Future Project an international philanthropic project

founded in 1986 and dedicated to innovation in mathematics science computer and statistics education *NBS Special Publication*, 1974 *FinFET Devices for VLSI Circuits and Systems* Samar K. Saha, 2020-07-15 To surmount the continuous scaling challenges of MOSFET devices FinFETs have emerged as the real alternative for use as the next generation device for IC fabrication technology The objective of this book is to provide the basic theory and operating principles of FinFET devices and technology an overview of FinFET device architecture and manufacturing processes and detailed formulation of FinFET electrostatic and dynamic device characteristics for IC design and manufacturing Thus this book caters to practicing engineers transitioning to FinFET technology and prepares the next generation of device engineers and academic experts on mainstream device technology at the nanometer nodes *Publications of the National Bureau of Standards ... Catalog* United States. National Bureau of Standards, 1978 *Invention of Integrated Circuits* Arjun N. Saxena, 2009 This book is the first to give an authoritative and comprehensive account of the invention of Integrated Circuits ICs from an insider who had participated and contributed from the beginning of their invention and advancement to the Ultra Large Scale ICs ULSICs of today It reads like a mystery novel to engross the reader but it is not based on fiction it gives documented facts of the invention of ICs analyzes the patents and highlights additional details and clarifications of their history **Foundations of Computer Science and Frontiers in Education: Computer Science and Computer Engineering** Hamid R. Arabnia, Leonidas Deligiannidis, Soheyla Amirian, Farid Ghareh Mohammadi, Farzan Shenavarmasouleh, 2025-05-24 This book constitutes the proceedings of the 20th International Conference on Foundations of Computer Science FCS 2024 and the 20th International Conference on Frontiers in Education FECS 2024 held as part of the 2024 World Congress in Computer Science Computer Engineering and Applied Computing in Las Vegas USA during July 22 to July 25 2024 The 10 FECS 2024 papers included were carefully reviewed and selected from 43 submissions FCS 2024 received 172 submissions and accepted 31 papers for inclusion in the proceedings The papers have been organized in topical sections as follows Foundations of computer science frontiers in education novel studies and assessment results frontiers in education's tools frontiers in education student retention teaching and learning methods curriculum design and related issues and poster position papers *Publications* United States. National Bureau of Standards, 1975 *Catalog of National Bureau of Standards Publications, 1966-1976: Citations and abstracts* United States. National Bureau of Standards. Technical Information and Publications Division, 1978 [Catalog of National Bureau of Standards Publications, 1966-1976](#) United States. National Bureau of Standards, 1978 *Electrician (Theory) - II* Mr. Rohit Manglik, 2024-05-18 EduGorilla Publication is a trusted name in the education sector committed to empowering learners with high quality study materials and resources Specializing in competitive exams and academic support EduGorilla provides comprehensive and well structured content tailored to meet the needs of students across various streams and levels

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