

Course Content for Semiconductor Device Modeling (EE5132)

Concentration and motion of carriers in Semiconductor bulk - equilibrium concentration in intrinsic and extrinsic semiconductors, excess carriers, drift and diffusion transport, continuity equation.

Concentration and motion of carriers at the interface - surface recombination, surface mobility etc.

Device modeling - basic equations for device analysis, approximation to these equations for deriving analytical expressions.

PN homojunction - ideal static I-V characteristics and deviations including breakdown, ac small signal equivalent circuit, switching characteristics.

MIS Junction/capacitor - ideal C-V characteristics and deviations due to interface states/charges and work function differences, threshold voltage.

BJT - transistor action, static characteristics, ac small signal equivalent circuit, switching characteristics.

FETs - field effect, types of transistors (JFET, MESFET, MISFET), static characteristics of MISFET, small signal equivalent circuit, difference between BJT and FETS.

Reference Books for Semiconductor Device Modeling (EE5132)

Other than the following reference books, one can find lots of other text books on semiconductor devices in the market. A number of them are available in the Central Library of IIT Madras. Students can also use them as their reference books if they cover the learning outcomes of this course.

1. **B. G. Streetman and S. Banerjee, Solid State Electronic Devices, PHI.** This is the text book that we recommend the students to have with them while taking this course. The course structure more or less follows this text book. Available in IITM Central Library.
2. **S. M. Sze, Physics of Semiconductor Devices, John Wiley & Sons.** This is one of the best reference books available. The M. Tech. students should check this one if they are interested to pursue a project or higher study in Semiconductor Devices area. Available in IITM Central Library.
3. **S. M. Sze, Semiconductor Devices: Physics and Technology, John Wiley & Sons.** This book is a shorter version of the previous reference, however, with a better introduction on the technology aspect. This is also a useful reference. Available in IITM Central Library.
4. **Michael Shur, Physics of Semiconductor Devices, PHI.** This book presents lots of simulation results yielding a feeling on the current transport mechanisms within semiconductor devices. This is also a well-known reference in the area of semiconductor devices.
5. **Nandita DasGupta and Amitava DasGupta, Semiconductor Devices, PHI.** This is also a well-written text book. Both the authors of this book are involved in teaching and research at IIT Madras for around two decades and this book is an outcome of the vast experiences. A very useful feature of this book is that lots of common questions, which came from students year after year, were compiled and answered to the point as special “help-desk” in each chapter.
6. **C. T. Sah, Fundamentals of Solid State Electronics, World Scientific.** This is a pioneering work on documenting the fundamentals, technology, modeling and applications of semiconductor devices. Those who are pursuing the research or interested to pursue research projects in Semiconductor Devices areas are encouraged to use this book as a ready reference. In this thick book, you can “mostly” find answers to “all” of your doubts as far as fundamentals on solid state devices are concerned. Available in IITM Central Library.

7. **Karl Hess, Advanced Theory of Semiconductor Devices, IEEE Press.** This is a brilliant reference that presents the advanced theory of semiconductor devices. The book is very much useful for those who are working on the fundamental theory of the semiconductor devices. Those who are interested to work on the simulation and modeling of semiconductor devices are encouraged to have a look at this book.
8. **J. Lindmayer and C. Y. Wringley, Fundamentals of Semiconductor Devices, Affiliated East-West Press Pvt. Ltd.** This is an old classic which covers lots of fundamental issues on various effects in semiconductor devices. If you plan to research on devices area, you may like to have a look into it.
9. **N. W. Ashcroft and N. D. Mermin, Solid State Physics, Brooks/Cole Cengage Learning.** This is the classic reference book which is still used by the researchers working in the area of solid state physics. This book is very much popular among the physicists. Available in IITM Central Library.
10. **Charles Kittel, Introduction to Solid State Physics, Wiley.** This is an excellently written classic on solid state physics. The theory of band-gap in semiconductor is nicely exposed. Those who are interested to pursue a theoretical work on the solid state physics are encouraged to read this book.