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Basics of Semiconductor Devices and Technology

Instructor

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Department: Department of Electronic Systems Engineering

Course Time: Tue., Thu., 11:30 - 01:00 PM

Lecture venue: DESE Auditorium

Detailed Course Page:

Announcements

Brief description of the course

The course covers fundamentals of quantum mechanics and electrical transport, which are necessary to investigate and understand any semiconductor device. The course will give a detailed description of quantum mechanics, with focus on its impact on electrical properties of semiconductors. It will serve as a launching pad for students planning to build a career in semiconductors/microelectronics/VLSI.

Prerequisites

None

Syllabus

Introduction to semiconductor device physics: Review of quantum mechanics and quantum chemistry, electrons in periodic lattices, atomic orbital overlap theory and basics of hybridization, E-k diagrams, quasiparticles (electrons, holes and phonons) in semiconductors.

Carrier statics and dynamics: Carrier transport under low electric and magnetic fields, mobility and diffusivity; carrier statistics; continuity equation, Poisson's equation and their solution.

Semiconductor Junctions: Schottky, p-n junction and hetero-junctions and related physics.

High field effects: Velocity saturation, hot carriers and avalanche breakdown.

Ideal and non-ideal MOS capacitor: Band diagrams and CVs; Effects of oxide charges, defects and interface states; Characterization of MOS capacitors: HF and LF CVs.

MOSFETs: Physics of transistors and basics of semiconductor processing.

Course outcomes

The course will enable students to understand and appreciate the synergy between quantum mechanics and semiconductor materials, which will eventually lead to a general framework of concepts applicable across a variety of semiconductor devices. The students will be able to comprehend the drift and diffusion mode of electrical transport through semiconductor devices. The course will empower students to use quantum mechanics and transport theory to investigate complex and novel electrical devices.

Grading policy

15% for Assignment

15% for Quiz

20% for mid-sem exam

50% for end-sem exam

Assignments

One assignment on each module

Resources

S. M. Sze, Physics of Semiconductor Devices, John Wiley.

Donald Neamen, Semiconductor Physics and Devices, 3rd Edition