Course Syllabus **EECS 4600 – Solid State Devices**

Credits & Contact hours 4 credit hours &three3 50-minute lecture plus 150 minutes of lab contact hours

Coordinator Dr. Daniel Georgiev

Textbook B.G. Streetman, S.K. Banerjee "Solid State Electronic Devices", 7th edition, Pearson (2015)

Course Information Semiconductor materials and semiconductor technology basics. Crystals and semiconductor fabrication. Electrical transport in metals and semiconductors. Theory and operation of diodes, field-effect transistors and bipolar junction transistors. Laboratory involves experimentation with the semiconductor devices covered in the lectures.

Prerequisite: EECS 3400 Electronics I

Required course for EE program

Students Learning Objectives Students will be able to

1. understand the differences between metals, insulators, and semiconductors and origin of their properties based on the crystal structures of materials.
2. understand intrinsic and extrinsic semiconductors and role of doping in engineering the properties of semiconductor structures.
3. understand the fabrication process of silicon wafers, starting from silica.
4. understand generation and recombination of charge carriers in semiconductors under electrical, optical and thermal excitation, and transport of these carriers under an electric field.
5. understand formation of p-n junctions, p-n junction devices, fabrication, electrical characteristics, and their wide range of applications as diodes, LEDs, and solar cells.
6. understand metal-semiconductor contacts resulting in ohmic vs. Schottky (rectifying) junctions.
7. understand bipolar junction transistors (BJT) and their characteristics.
8. understand field-effect transistors (FET) fundamental working principles, fabrication, and applications.

9. understand Moore's Law, scaling of MOSFET and its impact in revolutionizing the electronic market including high speed processors and consumer electronic products.
10. set up an experiment to measure the switching speed and switching energy loss of a standard Metal Oxide Semiconductor Field Effect Transistor in the laboratory.
11. discuss the design of a solar cell in terms of appropriate selection of materials, device geometry, and fabrication methods with the objective to understand the
12. trade-offs between the efficiency, cost-effectiveness, sustainability, and environmental impact of the technology.
13. identify the global, economic and environmental impact of energy harvesting technologies (e.g., solar, wind, vibration, thermoelectric etc.) given a specific application context such as hand-held devices, wireless sensor networks, etc.

Topics

1. Introduction
2. Crystal properties and growth of semiconductors
3. Atoms and electrons
4. Energy band and charge carriers in semiconductors
5. Excess carriers in semiconductors
6. Junctions
7. Field effect transistor
8. Bipolar junction transistors
9. Selected topics