ELEC4510 Semiconductor Materials and Devices

Course Description

This course covers fundamental semiconductor physics relevant to modern electronics and provides a physical understanding of advanced solid-state devices. Topics include quantum mechanics of electrons in solids, crystalline structures, band theory of semiconductors, electron statistics and dynamics in energy bands, carrier transport, semiconductor heterostructures, heterojunction bipolar transistors, and high-electron-mobility transistors. *Prerequisite(s):* ELEC 3500

List of Topics

1. Basic quantum mechanics and solid-state physics pertinent to modern (opto)electronic technologies
2. Electrons in semiconductors, density of states, group velocity
3. Band structure, Brillouin zone
4. Semiconductor doping
5. Carrier transport
6. Heterostructures
7. Heterojunction bipolar transistors
8. Heterojunction field-effect transistors

Statement of Objectives/Outcomes:

On successful completion of this course, students will be able to:

CO1 - understand the formation and properties of semiconductor crystals.

CO2 - interpret the electronic band structure of semiconductor crystals.

CO3 - associate the electronic band structure to the properties of semiconductor materials and devices.

CO4 - analyze carrier dynamics and transport in semiconductors.

CO5 - construct energy band diagrams of semiconductor heterostructures.

CO6 - understand the physics and operation of advanced semiconductor devices such as heterojunction bipolar transistors and heterojunction field-effect transistors.

Textbook(s):

1. Lecture notes
2. Ben G. Streetman and Sanjay K. Banerjee, *Solid State Electronic Devices* (7^{th} Edition), Pearson

Reference Books:

1. Debdeep Jena, *Quantum Physics of Semiconductor Materials and Devices*, Oxford University Press
2. E. F. Schubert, *Doping in III-V Semiconductors* (1st Edition), Cambridge University Press
3. David J. Griffiths and Darrell F. Schroeter, *Introduction to Quantum Mechanics* (3rd Edition), Cambridge University Press
4. Umesh Mishra and Jasprit Singh, *Semiconductor Device Physics and Design* (1st Edition), Springer
5. Yuan Taur and Tak H. Ning, *Fundamentals of Modern VLSI Devices* (3rd Edition), Cambridge University Press
6. Richard S. Muller and Theodore I. Kamins, *Device Electronics for Integrated Circuits* (3rd Edition), Wiley
7. Simon M. Sze, Yiming Li, Kwok K. Ng, *Physics of Semiconductor Devices* (4th Edition), Wiley

Relationship of Course to Program Outcomes:

Please refer to the Report Section 4.3.2 (iii).

Grading Scheme

Homework Assignments	15% (2.5% × 6)
Midterm Examination	30%
Final Examination	55%