ECE3450 Course Syllabus

ECE3450

Semiconductor Devices (3-0-0-3)

CMPE Degree
This course is Elective for the CMPE degree.

EE Degree
This course is Elective for the EE degree.

Lab Hours
0 supervised lab hours and 0 unsupervised lab hours

Course Coordinator
Shen,Shyh-Chiang

Prerequisites
ECE 3040 [min C]

Corequisites
None

Catalog Description
Properties of semiconductor devices. Applications in current and future computers, fiber optic and wireless communication systems. Future needs of high frequency, GHz-range, device operation.

Textbook(s)
Anderson & Anderson, *Fundamentals of Semiconductor Devices* (2 edition), McGraw-Hill. ISBN 9780073529561 (required)

Course Outcomes
Upon successful completion of this course, students should be able to:
1. Analyze semiconductor quantum wells and quantum mechanical structures qualitatively and quantitatively.
2. Describe the interactions of photons, phonons, and electrons in semiconductors.
3. Describe heterojunctions in semiconductor systems: metal-semiconductor junction and semiconductor heterojunctions.
4. Analyze switching characteristics of rectifiers using PN diodes as an example.
5. Analyze short channel effect and the frequency response of field-effect transistors.
6. Analyze d.c. operation and the frequency response of bipolar transistors.
7. Describe operating principles of semiconductor-based light sources and photodetectors

Student Outcomes
In the parentheses for each Student Outcome:
"P" for primary indicates the outcome is a major focus of the entire course.
“M” for moderate indicates the outcome is the focus of at least one component of the course, but not majority of course material.
“LN” for “little to none” indicates that the course does not contribute significantly to this

outcome.

1. (P) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. (P) An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. (M) An ability to communicate effectively with a range of audiences
4. (LN) An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. (LN) An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. (LN) An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. (P) An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Topical Outline

1. System Application Background
   a. Current and future computer systems
   b. Current and future fiber optic and wireless communication sys
2. General Limits/Capabilities of Existing Technologies
   a. Silicon device characterisgtics
   b. More-than-Moore device technologies
3. Review of Semiconductor Device Basics
   a. Quantum mechanical phenomena for electrons
   b. Quantum well theory (ideal quantum wells)
   c. Band structures
   d. Doping and impurities
4. Specific Devices for Computers, Wireless and Fiber:
   a. p-n junctions: steady-state characteristics, a.c. responses,
   b. FETs - Silicon MOSEFT's (MOS Capacitor, threshold voltage, ca
5. Bipolar junction transistors (BJTs) and Heterojunction bipo
   a. Basic-device operation
   b. Silicon BJTs (DC characteristics)
   c. HBTs (DC characteristics, RF characteristics)
6. Optoelectronic device technologies : photon emitters
   a. LEDs, (e.g, color, electron-hole annihiliation, generation/re
   b. Basic Semiconductor Lasers theory: Fabry Perot lasers
7. Optoelectronic device technologies: photodetectors
   a. Photodiodes (optical absorption, minority carrier injection,
   b. Avalanche photodiodes (carrier multiplication, noise, superla