ECE 430 - Fundamentals of Semiconductor Devices

2013 Catalog Data: ECE 430: Fundamentals of Semiconductor Devices. Credit 3.
The goals of this course are to give the student an understanding of the physical and operational principles behind important electronic devices such as transistors and solar cells. Semiconductor electron and hole concentrations, carrier transport, and carrier generation and recombination are discussed. P-N junction operation and its application to diodes, solar cells, and LEDs are developed. The field-effect transistor (FET) and bipolar junction transistor (BJT) are then discussed and their terminal operation developed. Application of transistors to bipolar and CMOS analog and digital circuits is introduced. Prerequisites: ECE 311 (with min. grade of D). (3-0-3)

Enrollment: Elective course for EE and PHY majors (ECE523 for graduate students only).

Textbook: Solid State Electronic Devices, 7th Edition, by Ben Streetman and Sanjay Banerjee, ISBN-13: 978-0133356038, Prentice Hall (2014)

Coordinator: Z. J. Shen, Professor of ECE

Course goals:
After completing this course, the student should be able to do the following:

1. Explain basic crystal properties and growth of semiconductors.
2. Explain baisc concepts of atoms and electrons of semiconductors.
3. Intepret fundamental concepts of energy bands, chemical bonds, electrons and holes, generation and recombination, carrier lifetime, and charge carrier transport.
4. Analyze operation principles of PN and metal-semiconductor junctions.
5. Analyze operation principles of bipolar junction transistors.
6. Analyze operation principles of field effect transistors.
7. Intepret fabrication and physics of CMOS integrated circuits.
8. Analyze operation principles and applications of other devices.
9. Explain contemporary issues associated with microelectronics.

Prerequisites by topic:

1. Basic knowledge of voltage, current, power, and energy.
2. Basic knowledge of amplifier and logic circuits.
3. Basic knowledge of general physics.
4. Basic skills in mathmetics and calculus.

Lecture schedule: Two 75-minute sessions per week
Laboratory schedule: None

Relationship of ECE 430 Course Goals to Student Outcomes:

	Student Outcomes	Course Goals
1	An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	1-8
2	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	An ability to communicate effectively with a range of audiences	8
4	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	8,9
5	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	An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions	
7	An ability to acquire and apply new knowledge as needed, using appropriate learning strategies	

Topics:

- Introduction and semiconductor materials (1 week)
- Atoms and electrons (1 week)
- Energy bands and charge carriers (1 week)
- Excess carriers (1 weeks)
- Junctions (3 week)
- Field effect transistors (2 week)
- Bipolar junction transistors (1.5 week)
- CMOS integrated circuits (2.5 week)
- Other solid state electronic devices and their applications (1 week)
- Final Exams (1 weeks)

Computer usage: Students use internet search for subject related information.

Laboratory topics: None

Prepared by: Z. J. Shen **Date:** Feb 28, 2020