EEE 352 Properties of Electronic Materials (4) [F, S, SS]

Course (Catalog) Description:
Schrodinger's wave equation, potential barrier problems, bonds of crystals, the band theory of solids, semiconductors, p-n junctions, MOSFETs, bipolar transistors, other transistors, superconductor, dielectric, and magnetic properties.
Lecture. Required for all engineering majors.

Prerequisites:
CHM 114 (or 116); MAT 274; PHY 241.

Textbook:
Donald A. Neamen, Semiconductor Physics and Devices, McGraw-Hill, 2003.

Supplemental Materials:
C. Kittel, *Introduction to Solid State and Semiconductor Physics*. J. McKelvey, *Solid State and Semiconductor Physics*, 1982. S. Brandt and H. Dahmen, *The Picture Book of Quantum Mechanics*. L. Solymar and D. Walsh, *Lectures on the Electrical Properties of Materials*, 5th edition, Oxford University Press, New York, 1988.

Coordinator:
David Ferry, Regents' Professor

Prerequisites by Topic:
1. Basic knowledge of atomic structure, chemical bonding, and kinetic theory
2. Knowledge of classical mechanics, including Newton's laws of motion
3. Knowledge of classical electromagnetics, especially electrostatics
4. Ability to manipulate complex numbers and solve ordinary linear differential equations with constant coefficients

Course Objective:
1. Students will be introduced to the electronic properties of materials and will learn semiconductor physics and the qualitative principles of solid-state devices.

Course Outcomes:
1. Students become proficient in applying the basic principles of quantum mechanics.
2. Students develop an appreciation of the microscopic properties of electronic materials.
3. Students understand semiconductor physics and the operation of solid-state devices.

Course Topics:
1. Atomic structure of crystals
2. Classical waves; quantization; wave-particle duality
3. Elementary quantum mechanics of the electron
4. Chemical bonding and the periodic table
5. The free electron theory of metals*
6. Band theory of solids

7. Semiconductors: Doping, holes, statistics, transport, and excess carriers
8. p-n junctions
9. MOSFETs
10. Other transistors
11. Dielectric properties of materials*
12. Magnetic properties of materials*
13. Superconducting properties of materials*

*Coverage varies by instructor; not all starred topics usually covered in one semester

Computer Usage:
Students will be assigned HW problems involving plotting functions, solving nonlinear equations numerically, or doing some type of simulation on a PC, including using available simulators at e.g. Nanohub.org.

Laboratory Experiments: None.

Course Contribution to Engineering Science and Design:
This course contributes primarily to engineering science (close to 100%). It provides the basic knowledge of quantum mechanics, electronic materials properties, and semiconductor physics and qualitative device principles needed to support detailed instruction in the analysis and design of semiconductor devices covered in EEE 436. It provides practice in applying math and science skills to engineering applications and gives substantial practice in formulating and solving engineering-related problems involving electronic materials and quantum mechanics.

Course Relationship to Program Outcomes:
a: This course support is fundamental since quantum mechanics and properties of electronic materials are basic to understanding current semiconductor device and VLSI technology. It contributes to the students' technical competence because it strengthens their skills in mathematics and physics through use and application of those skills, provides basic knowledge about electronic materials and devices, and gives some practice in developing models, defining problems, and recognizing appropriate solutions, through solution of problems related to electronic materials.
i: Quantum mechanics is particularly important to understanding future technologies (e.g. 10 years after graduation). It will help our graduates succeed in an environment where technical innovation is important because these modern fundamentals should aid in such innovation.

People preparing this description and date of preparation: Brian Skromme, David Ferry, Nongjian Tao, and Ying-Cheng Lai, March 2008, K. Tsakalis, June 2015.