PONTIFICIA UNIVERSIDAD CATÓLICA DE CHILE
COLLEGE OF ENGINEERING
DEPARTMENT OF ELECTRICAL ENGINEERING
ABET COURSE SYLLABI

IEE1133 ELECTRICAL PROPERTIES OF MATERIALS

Credits and contact hours: 10 UC credits/10 hours (3 Lecture hours per week ; 1.5 problem session hours per week and 5.5 hours of Independent learning experience per week)

Instructor's name: Roberto Rodríguez

Course coordinator's name: To be defined

Textbook: Livingston, James D. Electronic Properties of Engineering Materials. New York, Wiley, 1999.

Course Catalog Description: The solid state electronic technology has experienced a revolution in the last decades. Today, several semiconductors coexist with silicon, the most notable of which are gallium-arsenide and gallium-indium, but many others have flourished. This development has driven important changes in areas such as lithography, optics, solar energy, communications, power electronics and the laser industry. This course focuses on the study of solid-state electric devices, involving three essential ingredients: i) Semiconductor Physics; ii) Semiconductor-based electronic devices, and iii) Dielectric, magnetic and conductive characteristics of electric materials.

Prerequisite Courses: FISG1533 Electricity Magnetism

Co-requisite Courses: None

Status in the Curriculum: Required

Course Learning Outcomes:

1. To describe the basics about the nature of light. (Wave-particle properties and the correspondence between them, particularly the Einstein relation between energy and frequency, and between momentum and wavelength).
2. To express the De Broglie relations for electrons. To understand the meaning of the Schrödinger equation as the wave equation describing the electron behavior, as well as the probabilistic meaning of the equation solution.
3. To describe the basic spectral properties associated to the Schrödinger equation (energy levels of an electron within different potentials) and the relation between energy jumps and emitted photons.
4. To explain the band structure for periodic potentials modeling crystal structures. To explain, using Pauli's principle, concepts such as: Fermi level, energy level occupancy, properties of conductors and insulators,

electron density, etc. In simple cases, to compute the macroscopic properties of charge transport in different situations and the macroscopic properties of electrons and energy levels.

5. To distinguish the role of impurities in semiconductors, the concept of hole, and their consequences: in producing different types of semiconductors, their properties and their applications.
6. Using the concept of electron density and of Fermi level, to derive the properties of solids in contact, including thermal properties of junctions and their applications (Peltier, Seebeck and other effects).
7. To describe the origin of the magnetic properties of materials and their relationship with the macroscopic properties of matter.
8. To derive the basic properties of different types of magnetic media, identifying their applications.
9. To describe the Hall Effect and its applications.
10. To describe the relationship between optical properties of different types of solids and their microscopic structure.
11. To distinguish the basic principles characterizing lasers and their applications.

Relation of Course to ABET Criteria:

a. Knowledge of mathematics, science and engineering
e. Identify, formulate, and solve engineering problems
j. Knowledge of contemporary issues
k. Techniques, skills, and modern tools for engineering practice.

Topics covered:

1. Fundamentals of the Electronic Theory of Materials.
   - 1.1 Wave-Particle Duality
   - 1.2 Schrödinger Equation
   - 1.3 Schrödinger Equation Solution
   - 1.4 Energy Bands in Crystals
   - 1.5 Electrons in Crystals
2. Electrical Properties of Materials
   - 2.1 Electrical Conduction in Metals and Alloys
   - 2.2 Semiconductors
   - 2.3 Electrical Properties of Polymers, Ceramics, Dielectrics and Amorphous Materials
3. Magnetic Properties of Materials
   - 3.1 Fundamentals of Magnetism
   - 3.2 Classic Treatment of Magnetic Phenomena
   - 3.3 Quantum Considerations of Magnetic Phenomena
   - 3.4 Applications
4. Optical Properties of Materials
   - 4.1 Optical Constants
   - 4.2 Atomic Theory of Optical Properties
   - 4.3 Quantum Treatment of Optical Properties
   - 4.4 Applications