PHY 3101: Electrical Engineering Materials
Academic Session: 2024-2025

3 Hours/week, 3 Credits | Examination Duration: 3 Hours

1. **Elementary Quantum Physics:** Introduction to quantum mechanics, Wave nature of electrons, Schrodinger's equation, one-dimensional quantum problems- infinite quantum well, potential step and potential barrier; Heisenbergs's uncertainty principle and quantum box.

2. **Elementary Materials Science Concepts:** Crystal structures, Types of crystals, lattice and basis, Bravais lattice and Miller indices.

3. **Electrical and Thermal Conduction in Solids:** Classical theory of electrical and thermal conduction, Scattering, mobility and resistivity, temperature dependence of metal resistivity, Mathiessen's rule, Hall effect and thermal conductivity.

4. **Modern Theory of Solids:** Band theory of solids, Band theory from molecular orbital, Bloch theorem, Kronig-Penny model, effective mass, density-of-states. Carrier statistics: Maxwell-Boltzmann and Fermi-Dirac distributions, Fermi energy. Modern theory of metals: Determination of Fermi energy and average energy of electrons, classical and quantum mechanical calculation of specific heat.

5. **Dielectric Materials and Insulation:** Dielectric properties of materials, Dielectric constant, polarization- electronic, ionic and orientational; internal field, Clausius-Mosotti equation, spontaneous polarization, frequency dependence of dielectric constant, dielectric loss and piezoelectricity.

6. **Magnetic Properties and Superconductivity:** Magnetic properties of materials, Magnetic moment, magnetization and relative permitivity, different types of magnetic materials, origin of ferromagnetism and magnetic domains. Introduction to superconductivity, Zero resistance and Meissner effect, Type I and Type II superconductors and critical current density.

Books Recommended:

Bransden BH, Joachain CJ	Quantum Mechanics
Zettili N	Quantum Mechanics: Concepts and Applications
A. J. Dekker	Electrical Engineering Materials
Charles Kittel	Introduction to Solid State Physics
N. Ashcroft and N. D. Mermin	Solid State Physics
R.G. Sharma	Superconductivity: Basics and Applications to Magnets