EEE.3.2. ELECTROTECNHIC MATERIALS

THEORETICAL PART OF THE COURSE

- Introduction to Materials Technology. Classification and selection of materials.
- Structure and properties of materials. Atomic structure. Quantum numbers and atomic orbits. Periodicity of the properties of the elements. Reactivity of elements. Ionization energy - electronegativity. Chemical bonds: Covalent bonds (bond energy, bond length, dipole moments, polar molecules), ionic, metallic bonds. Secondary chemical bonds (Van der Waals). Mixed bonds.
- Oxidation/reduction of elements. Standard electrode potentials. Half-cells. Galvanic cells.
- Physical states of matter. Solid state. Crystalline state, crystal structure, space lattices. Crystal lattice defects. Allotropy, polymorphism. Amorphous solids.
- Metals: Solidification and solidification defects. Alloys: phase diagram showing three-phase equilibrium. Solid solutions. Binary eutectic alloys.
- Ceramics: Ionic crystals
- Polymers: covalent bonds, characteristics, applications and processing of polymers.
- Complex materials.
- Corrosion and wear of materials.
- Mechanical properties of materials: stress, deformation, Young's modulus of elasticity, hardness.
- Electrical properties of materials: electrical conductivity and resistivity in solids and electrolytes.
- Conducting Materials: Electrical conductivity. Mobility and resistivity. Factors effecting resistivity. Thermal conductivity, Wiedemann-Franz law. Resistors, heating resistors. Electric contacts.
- Insulating Materials: Dielectrics, dielectric constant, polarizability, temperature dependence and frequency response of polarization. Conductivity of dielectrics. Electrical breakdown. Insulating materials. Piezoelectricity. Pyroelectricity, Ferroelectricity – materials and applications.
- Semiconductors: Crystal structure of semiconductors. Electron-hole pairs. Energy level diagrams. Intrinsic and Extrinsic semiconductors. n-type and p-type semiconductors. Conduction due to “carrier drift”. Conduction due to “carrier diffusion”. Semiconductor materials.
- Magnetic Materials: Basic concepts of magnetism, Diamagnetism. Paramagnetism. Ferromagnetism, ferromagnetic materials and applications. Amorphous materials and applications. Power losses in magnetic materials. Ferrimagnetic materials and applications.
- Superconducting materials: Superconductivity-Theory, materials and technological applications.
- Optical properties of materials.
- Thermal properties of materials.
- Modern and smart materials in engineering.
- Material selection criteria for specific engineering applications.

LABORATORY PART OF THE COURSE

- Optical microscopy for obtaining information concerning the structural state of materials. Grain structures of metallic materials. Grain size determination.
- Thermoelectric effect. Seebeck potential – thermocouples. Standardization of thermocouples. Operation, calibration and testing.
- Temperature dependence of electrical resistance of metallic materials
- Temperature and concentration dependence of electrical conductivity of electrolytes. Validity of Ohm's law on electrolytes
- Redox potentials. Reactivity of metals.
- Galvanic metal corrosion and cathodic protection.
- Magnetic properties of ferromagnetic materials. Evaluation of characteristic magnetic parameters and energy loss from the hysteresis loop of a magnetic material.