

## **XE-C: Materials Science**

### Section 1: Processing of Materials:

Powder synthesis, sintering, chemical methods, crystal growth techniques, zone refining, preparation of nanoparticles and thin films

### Section 2: Characterisation Techniques:

X-ray diffraction, spectroscopic techniques like UV-vis, IR, Raman. Optical and Electron microscopy

### Section 3: Structure and Imperfections:

Crystal symmetry, point groups, space groups, indices of planes, close packing in solids, bonding in materials, coordination and radius ratio concepts, point defects, dislocations, grain boundaries, surface energy and equilibrium shapes of crystals

### Section 4: Thermodynamics and Kinetics:

Phase rule, phase diagrams, solid solutions, invariant reactions, lever rule, basic heat treatment of metals, solidification and phase transformations, Fick's laws of diffusion, mechanisms of diffusion, temperature dependence of diffusivity

### Section 5: Properties of Materials:

**Mechanical Properties:** Stress-strain response of metallic, ceramic and polymer materials, yield strength, tensile strength and modulus of elasticity, toughness, plastic deformation, fatigue, creep and fracture

**Electronic Properties:** Free electron theory, Fermi energy, density of states, elements of band theory, semiconductors, Hall effect, dielectric behaviour, piezo, ferro, pyroelectric materials

**Magnetic Properties:** Origin of magnetism in metallic and ceramic materials, paramagnetism, diamagnetism, ferro and ferrimagnetism

**Thermal Properties:** Specific heat, thermal conductivity and thermal expansion, thermoelectricity

**Optical Properties:** Refractive index, absorption and transmission of electromagnetic radiation in solids, electrooptic and magneto-optic materials, spontaneous and stimulated emission, gas and solid state lasers

### Section 6: Material types

Concept of amorphous, single crystals and polycrystalline materials, crystallinity and its effect on physical properties, metal, ceramic, polymers, classification of polymers, polymerization, structure and properties, additives for polymer products, processing and applications, effect of environment on materials, composites

### Section 7: Environmental Degradation

Corrosion, oxidation and prevention

### Section 8: Elements of Quantum Mechanics and Mathematics

Basics of quantum mechanics, quantum mechanical treatment of electrical, optical and thermal properties of materials, analytical solid geometry, differentiation and integration, differential equations, vectors and tensors, matrices, Fourier series, complex analysis, probability and statistics