

Syllabus for Ph.D Entrance test
Centre for Materials Science and Nanotechnology,
Sikkim Manipal Institute of Technology

Structure: Atomic structure and bonding in materials. Crystal structure of materials, crystal systems, unit cells and space lattices, determination of structures of simple crystals by x-ray diffraction, miller indices of planes and directions, packing geometry in metallic, ionic and covalent solids. Concept of amorphous, single and polycrystalline structures and their effect on properties of materials.

Diffusion: Fick's laws and application of diffusion in sintering, doping of semiconductors

Mechanical Properties: stress-strain diagrams of metallic, ceramic and polymeric materials.

Thermal Properties: Heat capacity, thermal conductivity, thermal expansion of materials.

Electronic Properties: Concept of energy band diagram for materials - conductors, semiconductors and insulators, electrical conductivity – effect of temperature on conductivity, intrinsic and extrinsic semiconductors, dielectric properties.

Optical Properties: Reflection, refraction, absorption and transmission of electromagnetic radiation in solids.

Magnetic Properties: Origin of magnetism in metallic and ceramic materials, para-magnetism, dia-magnetism, antiferro-magnetism, ferromagnetism, ferri-magnetism, magnetic hysteresis, Hall Effect in semiconductors.

Environmental Degradation: Corrosion and oxidation of materials, prevention.

Chemistry of high polymers: Monomers, functionality, degree of polymerizations, classification of polymers, glass transition, melting transition.

Introduction to Nanoscience and Nanotechnology: History, background scope and interdisciplinary nature of nanoscience and nanotechnology, scientific revolutions, nanosized effects surface to volume ratio.

Nanomaterials synthesis: Synthesis and nanofabrication, Bottom-Up and Top-Down approach with examples. Chemical precipitation methods, sol-gel method, chemical reduction, Sono-chemical synthesis, Hydrothermal, Solvo-thermal, Chemical vapor deposition (CVD), Spray pyrolysis, hot-wall reactor, LASER vaporization. Self-assembly techniques.

Nanomaterials Characterization: XRD, X-ray photoelectron spectroscopy, HRTEM, SAED pattern analysis, SEM, UV-vis spectroscopy, Surface probe microscopy: AFM/STM, Photoluminescence Spectroscopy.