

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Materials Research Centre

Course Code : 21MST501

Course Name : Design of Materials

Credits : 3 L - 3 T - 0 P - 0

Course Type : Core

Prerequisites : None

Course Contents

Unit I: Introduction to material science, classification of materials. Atomic structure and Interatomic bonding, Crystalline and amorphous structure identification, Various crystal systems, plane direction representation.

Unit II: Imperfection in solids, point defects, line defects, planar defects and surface defects. Diffusion mechanisms. Mechanical response of a material-dislocation.

Unit III: Phase diagram-illustration using Iron-Carbon system. Phase transformation-with reference with microstructure and property changes. Various processing routes for metal alloys

Unit IV: Material Systems- Ceramics, Polymer and composites- their structure, properties and processing.

Unit V: Design and Materials selection Examples: Cutting tools, Combustion Engine, Thermoelectric modules, Solar Cells, Electronic Devices.

Recommended Readings

1. Text book-
 - (i) Interdisciplinary Engineering Sciences: Concepts and Applications to Materials Science; AK Dubey, A Mukhopadhyay, B Basu.
 - (ii) Materials Science and Engineering: An Introduction; W. D. Callister, D. G. Rethwisch.
 - (iii) The Science and Engineering of Materials; D.R. Askeland et al.
2. Reference book-
 - (i) Introduction to Materials Science for Engineers; James Shackelford.
 - (ii) Materials Science and Engineering; V. Raghavan.

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Materials Research Centre

Course Code : 21MST822

Course Name : Nanomaterials Technology

Credits : 3 L - 3 T - 0 P - 0

Course Type : Open Elective

Prerequisites : Basic knowledge of chemistry, physics and biology

Course Contents

Unit I: Introduction to nanomaterials, Surface area to volume ratio, stabilizers, Synthesis of nanomaterials, General properties of nanomaterials. History of nanomaterials.

Unit II: Metallic nanoparticles: Surface plasmon resonance, Synthesis of metal nanoparticles by wet chemical methods, Ostwald ripening and sintering, Anisotropic nanoparticles. Metal nanoclusters, Bimetallic nanoparticles. Quantum Dots: Quantum confinement, Band gap tuning and properties of quantum dots. Surface defects and Doping in Quantum dots. Carbon nanomaterials: Preparation and properties of graphene oxide, graphene, fullerenes, carbon nanotubes and carbon dots. Composites of carbon nanomaterials.

Unit III: Nanomaterials for catalysis, optical sensing and as artificial enzymes; Catalysis: Types of catalysis, Metallic nanoparticles and nanoclusters as catalyst, metal oxide and carbon nanostructures for photocatalysis; Optical Sensing: Principles of optical sensing, Fluorescence and Quenching mechanisms, Metal nanoparticles and fluorescent nanostructures as optical sensors for heavy metal ions, important biomolecules and explosives with examples of paper and film based sensing devices; Artificial enzymes: Enzymes, Importance of nanozymes; Metallic, oxide, carbon and hybrid nanoscale materials as artificial enzymes.

Unit IV: Nanomaterials for Energy and Environmental Protection; Nanomaterials for solar cells, Dye and QD-sensitized solar cells, Organic-inorganic hybrid solar cells, Current status and future prospects. Nano technology processes – Nano Engineering materials for Pollution Prevention, Green Chemistry, Energy efficient resources and materials, Nanomaterials for clean water & air.

Unit V: Nanotechnology for Medical Diagnostics and Therapy: Disease diagnostics: Quantum dot conjugation strategies with DNA-aptamer, Protein and Antibody and FRET based assays for disease diagnostics. Drug delivery: Lipid and polymeric nanoparticles as drug delivery vehicles; Polymeric, peptide and metal-organic gels for drug delivery, nanoparticle induced Gene delivery for gene therapy. Nanotechnology for therapy: Metallic nanostructures and nanoscale metal-organic frameworks for Phototherapy of cancer; Magnetic nanoparticles as MRI contrast agents.

Recommended Readings

1. Text book-
 - (i) Nanoscience & Nanotechnology: Fundamentals of Frontiers; M. S. Ramachandra Rao, S. Singh.
 - (ii) Nanoparticles: From Theory to Application; G. Schmid.
 - (iii) Nanomaterials for Medical Diagnostics and Therapy; Challa Kumar.

2. Reference book-
 - (i) Nanostructures and Nanomaterials: Synthesis, Properties, and Application; G. Cao, Y. Wang.

3. Online Resources-
 - (i) Updated research and review articles