# NANO TECHNOLOGY
## (OPEN ELECTIVE-I)

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| **Course code** | 23ME2503 | **Year** | III | **Semester** | I |
| **Course category** | Open Elective-I | **Branch** | ME | **Course Type** | Theory |
| **Credits** | 3 | **L-T-P** | 3-0-0 | **Pre requisites** | Material Scienceand Metallurgy, Manufacturing Processes |
| **Continuous Internal Evaluation:** | 30 | **Semester End Evaluation:** | 70 | **Total Marks:** | 100 |

| **Course Outcomes** | | |
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| **At the end of the course students will be able to** | | **Blooms Level** |
| **CO1** | Fundamental Knowledge of Nanoscience and Engineering | **L2** |
| **CO2** | Understand the unique properties of nano materials | **L3** |
| **CO3** | Proficiency in Nanomaterial Synthesis and Characterization | **L3** |
| **CO4** | Application of Nanotechnology Across Industries | **L3** |

**Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations(H:High (3), M:Medium (2), L:Low (1))**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | 1 | 1 | | | | | 1 | 1 | 3 | 2 |
| **CO2** | 3 | 3 | 2 | 2 | 2 | | 1 | 1 | | 1 | 1 | 3 | 2 |
| **CO3** | 3 | 3 | 3 | 3 | 3 | | 1 | 1 | 1 | 2 | 2 | 3 | 2 |
| **CO4** | 2 | 3 | 3 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 3 | 3 | 2 |

**SYLLABUS**

| Unit | Contents | CO |
|---|---|---|
| **I** | **INTRODUCTION**: History and Scope, Classification of Nano structured Materials, Fascinating Nanostructures, and applications of nano-materials, challenges and future prospects. | **CO1** |
| **II** | **UNIQUE PROPERTIES OF NANO MATERIALS:** Microstructure and Defects in Nano crystalline Materials: Dislocations, Twins, stacking faults and voids, Grain Boundaries, triple and disclinations. Effect of Nano-dimensions on Materials Behavior: Elastic properties, Melting Point, Diffusivity, Grain growth characteristics, enhanced solid solubility. Magnetic Properties: Soft magnetic nanocrystalline alloy, Permanent magnetic nanocrystalline materials, Giant Magnetic Resonance, Electrical Properties, Optical Properties, Thermal Properties and Mechanical Properties. | **CO1,CO2** |
| **III** | **SYNTHESIS ROUTES**: Bottom-up approaches: Physical Vapor Deposition, Inert Gas Condensation, Laser Ablation, Chemical Vapor Deposition, Molecular Beam Epitaxy, Sol-gel method, Self-assembly.Top-down approaches: Mechanical alloying, Nano-lithography. Consolidation of Nano powders: Shock wave consolidation, Hot iso-static pressing and Cold iso-static pressing, Spark plasma sintering. | **CO1,CO3** |

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| **IV** | **TOOLS TO CHARACTERIZE NANOMATERIALS**: X-Ray Diffraction (XRD), Small Angle X-ray scattering, Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Atomic Force Microscopy (AFM), Scanning Tunneling Microscope (STM), Field Ion Microscope (FEM), Three-dimensional Atom Probe (3DAP), Nano indentation. | **CO1,CO3** |
| **V** | **APPLICATIONS OF NANO MATERIALS**: Nano-electronics, Micro- and Nano-electromechanical systems (MEMS/NEMS),Nano sensors, Nano catalysts, Food and Agricultural Industry, Cosmetic and Consumer Goods, Structure and Engineering, Automotive Industry, Water- Treatment and the environment, Nano-medical applications, Textiles, Paints, Energy, Defense and Space Applications, Concerns and challenges of Nanotechnology | **CO1, CO4** |

**Learning Resource**

**TEXT BOOKS:**

1. Introduction to Nano Technology by Charles. P. Poole Jr& Frank J. Owens.Wiley India Pvt. Ltd.
2. Nano Materials- A.K.Bandyopadhyay/ New Age Publishers.
3. Nano Essentials- T.Pradeep/TMH

**Referencebooks**

1. 1. Solid State physics by Pillai, Wiley Eastern Ltd.
2. Introduction to solid state physics 7th edition by Kittel. John Wiley & sons (Asia) Pvt Ltd.

**E-Resources & otherdigitalMaterial:**

4. **nanoyou.eu.**
5. Nanotechnology, Science and Applications - Course
6. Coursera - Nanotechnology
7. MIT xPRO | Nanotechnology: Applications and Opportunities