

## 4. NANOSCIENCE AND NANOTECHNOLOGY

### Module I (10 hours)

Introduction to Nanomaterials: Features of nanosystems, characteristic length scales of materials. Quantum Size Effect: Electron confinement in infinitely deep square well, electron confinement in one dimensional well, Classification of low dimensional materials: 3D structure (bulk), 2D (quantum well) structure, 1D (quantum wires) structure, 0D (quantum dots) structure.

Physical and chemical properties of nano materials, Size-dependent properties of nanoparticles including mechanical, optical, magnetic, thermal and spintronic

### Module II (16 hours)

Several methods of Synthesis and Characterization of Nano scale materials (e.g. Nanoparticles, thin films, nanowires, nanocrystals and glass composites) - Top down and bottom up approach: Ball milling technique, Chemical method, Electrochemical method, Sol-gel, VLS and SLS method, Chemical vapor deposition method, Physical vapor deposition method, Cluster beam evaporation, ion beam deposition method, chemical bath deposition with capping techniques, cluster assembly and mechanical attrition. Determination of particle size from increase in width of XRD peaks of nanoparticles, shift in photoluminescence peaks, electron microscope, Raman microscopy, and surface analysis.

### Module III (10 hours)

Nanostructured Materials: Fullerenes, nanotubes and nano structured carbon coatings, nano structured materials-nano particles, nano materials nanocoatings and nano composites, thin film. Applications: Photonic crystals, smart materials, fuel and solar cells and optoelectronic devices, application in catalysis, chemical sensors, gas sensors, vapour sensors and biosensors

### Text and Reference Books:

1. Introduction to Nanotechnology by Charles P. Poole, Jr. Frank J. Owens, Wiley publication
2. The Physics and Chemistry of Nano Solids-Frank J Owens, Charles P Poole, Wiley publication
3. Nano Materials Synthesis And Characterisation, by V. Rajendran 2013
4. Nanotechnology An Introduction to Synthesis Properties and Applications of Nanomaterials by Thomas Varghese and K. M. Balkrishna, Atlantic publisher
5. Nanostructure and Nanomaterials : Synthesis, Properties and Applications , Guozhnong Cao, 2<sup>nd</sup> edition, World Scientific
6. Nanomaterials and Devices by Donglu Shi, William Andrew publishing, 2014
7. Nanomaterials: Synthesis, Characterization, and Applications by A. K. Hagi, Ajesh K. Zachariah, Nandakumar Kalarikkal, CRC Press, ISBN 9781926895192 - CAT# N10703