BMS COLLEGE OF ENGINEERING, BANGALORE

Autonomous Institute, Affiliated to VTU

INSTITUTIONAL ELECTIVE OFFERED BY THE DEPARTMENT OF CHEMISTRY

Course Name	Nanomaterials - Synthesis, Characterization And Applications	**Course Code**	**17CY7IENMA**
Credits	**03**	**L-T-P-S**	**3- 0 -0-0**
Contact hours	**36**	**Faculty Handling**	**Dr. M. S. DHARMAPRAKASH**

Course Objectives: The basic objectives course is to make students aware of Nano scale materials and structures, their properties, size effects. To make students learn some methods of synthesis of Nano materials their characterization by XRD, SEM and TEM. Some important Industrial applications of Nano materials is also dealt with.

CO NO.	COURSE OUTCOMES: *AT THE END OF THE COURSE THE STUDENT WILL HAVE*
CO1	AN ABILITY TO UNDERSTAND AND EXPLAIN NANOSCALE MATERIALS AND PROPERTIES,VAROIUS METHODS OF SYNTHESIS,CHARACTERIZATION
CO2	AN ABILITY TO APPLY THE LEARNT KNOWLEDGE AND CHOOSE APPROPRIATE METHOD TO SYNTHESIZE AND CHARACTERIZE NANOMATERIALS.
CO3	AN ABILITY TO APPLICATION OF NANOMATERIALS

UNIT-I. INTRODUCTION: 6 Hrs

Definition and Classification of Nanostructures -Nano Particles, Nano crystalline Materials, Nanocrystalline Ceramics, Semiconductor Nanoparticles, Metal Nanoparticles, Nanotubes and Nano -Scale Architectures.

Unit-II. SYNTHESIS: 8 Hrs

Top down approaches and bottom up approaches.

Chemical methods: sol-gel synthesis, Co-precipitation, CVD, CVS, and combustion synthesis. Microwave Synthesis of Metallic nano Particles (Ag, Au, pt) and Nanoparticles of Metal Oxides (ZrO_2, ZnO,Al_2O_3 TiO_2). Carbon Nanotubes -Synthesis Multi-Walled Nanotubes Aligned Carbon Nanotube Bundles Single-Walled Carbon Nanotubes.

Physical methods: Vapor deposition and different types of epitaxial growth techniques- pulsed laser deposition, Magnetron sputtering - Micro lithography (photolithography, soft lithography, micromachining.

Unit-III. PROPERTIES: 6 Hrs

Effects of nanometer length scale on Physical and Chemical Properties of Materials. Size Effects – Fraction of Surface Atoms – specific Surface Energy and Surface Stress – Effect on the Lattice Parameter – Phonon Density of States. Chemical properties- catalysis.

Unit-IV. CHARACTERIZATION: 8 Hrs

XRD-X-ray powder diffraction – Bragg's law - Instrumentation. Determination of lattice parameters - particle size analysis using Scherer formula.

SEM-Working Principle of Specimen Preparation – Modes of operation– Backscattered electrons – secondary electrons- X-rays – typical forms of contrast– Resolution and contrast – enhancement – Analyses of SEM images.
TEM-Basic principles - Modes of operation – Specimen preparation – Diffraction in imperfect crystals and dislocations – Structure of Grain boundaries and interfaces- HRTEM.

Unit-V. APPLICATIONS **6 Hrs**

Renewable energy, solar energy, fuel cells. Materials manufacturing and automobile industry. Biomedical Science, Medicine, Diagnostics. Biotechnology. Computers, Electronics and communication. Chemical analysis, Pharmacy Environmental sciences, Sport sector, Printing, Optics. Agriculture, Food, Textile, Cosmetics. Defense, Aerospace and Marine Nanotechnology.

Text book:

1. C. N. R. Rao, A. Mu¨ller, A. K. Cheetham, *The Chemistry of Nanomaterials :Synthesis, Properties and Applications*, Volume 1, Wiley-VCH, Verlag GmbH, Germany (2004).

References:

1. G.A. Ozin and A.C. Arsenault, “Nanochemistry : A chemical approach to nanomaterials”, Royal Society of Chemistry, 2005.
2. Charles P.Poole Jr. “*Introduction to Nanotechnology*”, John Willey & Sons , 2003. T. Pradeep
3. “*NANO The Essential , understanding Nanoscience and Nanotechnology”*. Tata McGraw-Hill
4. Nano scale Science and Technology Robert Kelsall, Ian Hamley, and Mark Geoghegan (Editors) John-Wiley