MANGALORE UNIVERSITY

Department of Materials Science

MSc Materials Science

MSS 506: **NANOSCIENCE AND NANOTECHNOLOGY – I** (3 Credits)

Objectives: This course offers an opportunity for the interested student to get a basic knowledge about nanoscience and associated technology - one of the most researched topic in the past decade. It serves as an introductory course in the topic and is designed so that any student having just a basic knowledge of science is able to understand the fundamentals involved in synthesis and characterization of nanostructures.

Expected course outcomes: The student acquires information the about the physics behind why nanomaterials exhibit properties different from that of the bulk. The chemistry involved in their synthesis equips them with knowledge of how matter can be manipulated to give materials with new properties.

Unit I

Introduction. – Nanostructured materials, nanoparticles, nanorods, nanotubes etc. Brief survey of metals, insulators and semiconductors, Free electron and band theory, Low dimentional structures, Particles in a box, Strong and weak confinements, Excitons.

Colloid Chemistry: Introduction. Kinetic properties- Sedimentation rate, Brownian motion. Surface energy, Surface potential and Zeta potential and their consequences. Thermodynamics of surfaces. Coagulation- Kinetics of coagulation. Stability of colloids.

14 hours

Unit II

Chemical Synthesis of Nanoparticles: Bottom up approach. Chemical reduction. Microwave synthesis, Sol-gel technique, Reverse miscelle methods. Functionalized nanoparticles in different medium. Size control. Self assembly. Nanoparticle arrays. Porous nanoparticles, Nanocoatings.

Physical Methods of Nanostructure Fabrication: Top down approach. High energy ball milling, Vapour condensation, Laser ablation, MBE, MOCVD, LPE.

Nanopatterning- Lithography- Optical, X-ray and Electron beam lithography. Ion- beam lithography, SPM, Dip pen lithography. 14 hours

Unit III

Analysis of Nanostructures: Atomic Force Miscroscope, Scanning Tunneling Microscope, High Resolution Transmission Electron Microscope, Field Emission Scanning Electron Microscope, X-ray Diffraction, Small angle X-ray diffraction, UV-Vis-NIR spectroscopy, Photoluminiscence, IR spectroscopy, Raman spectroscopy. Zeta potential measurements. Micro SQUID Magnetometry. 14 hours

References:

1. The Science and Engineering of Micro electronic Fabrication -S. A. Campbell (Oxford,1996).
2. Nanoscale Materials - (Ed) L.M. Liz-Marzan and P.V.Kamat, (Kluwer, 2003)
3. Nanostructured Materials and Nanotechnology - (Ed) H.S.Nalwa, (Academic, 2002).
4. Colloidal and Surface Chemistry - M Satake, Y Hayashi, Y Mido, S A Iqbal, M S Sethi (Discovery, 1996)
5. Colloid Chemistry – S Voyutsky (MIR, 1978)
6. Introduction to Nanotechnology – C P Poole and F J Owens (Wiley- Intersci., 2006)
7. Nanotechnology and Nanoelectronics – W R Fahrner (ed) (Springer, N Delhi, 2006)
8. Quantum Dots - L.Jacak, P Hawrylak, A Wojs, (Springer, 1997)
9. Physics of Low Dimensional Structures, J H Davis, (Cambridge, 1998)
10. Sol-Gel Science, Scherrer and Brinker