Programme: M. Sc. Part-II (Chemistry)
Title of the Course: Nanoscience: Concepts and Applications
Course Code: PCO-506
Number of Credits:03 **Effective from AY: 2019-20**

Prerequisites for the course:	Should have studied the courses PCC-401, PCC-402 and PCO-401. Should have basic knowledge of Physical Chemistry.	No. of lectures/hours
Course Objectives:	1. Introduction of various concepts for nanoscience. 2. Introduction of various synthesis methods of nanomaterials. 3. Introduction of various characterisation techniques and application study of nanomaterials	
Course Outcomes:	Students will learn different techniques of synthesis and characterisation of nanomaterials. Students should be in a position to understand magnetic, electrical, optical and catalytic properties of materials at nanoscale level. Students should be in a position to apply the knowledge of subject for their dissertation and research work.	
Content:	**1. Essential concepts and definitions** Nanoscale, interdisciplinary nature of nanoscience, quantum effects, colours from colloidal gold, Surface to volume ratio of nanoparticles, surface effects and surface energy on nanoparticle surface. **2. Electronic and Electrical properties** Chemistry of solid surfaces, Zero dimensional systems: nanoparticles One dimensional systems:nanowires and nanorods Metallic nanowires and quantum conductance. **3. Fabrication of nanoscale materials: top-down vs bottom-up approach** **i.** Physical nanofabrication methods for the two dimensional nanostructures such as Thin film deposition of metallic copper, aluminium, tungsten and semiconducting silicon and Gallium arsenide films; Epitaxial growth; chemical vapour deposition and molecular beam epitaxial methods for the synthesis of semiconducting thin films, **ii.** Plasma Lithographic, photolithography, e-beam lithographic techniques for the transfer of circuit and nanopatterns on thin films. Positive and negative photoresists, different etching methods for the final pattern transfer on thin films. **iii.** Synthesis of colloidal metallic nanoparticles using different stabilizing and complexing agents such as citric acid and use of surfactants. iv. Discussion of Self assembly growth modes for thin films and colloidal nanoparticles : Stransky-Krastinova and Ostwald ripening	5 hr 5 hr 8 hr

	4. Investigation of important nanomaterials: Silica: discussion of sol-gel and liquid crystal synthesis method, self assembly of colloidal silica particles, photoluminescence property of opals, different surface functionalization methods and application study Gold: Different colloidal synthesis methods, self assembly methods, surface Plasmon resonance (SPR) of colloidal gold nanoparticles surface functionalization strategies and application study CdSe: Different synthesis methods, synthesis of coreshell particles, Sudy of CdSe excitons and CdSe quantum dots, functionalization and application study. Iron oxide, Different synthesis methods Superparamagnetism property of nanoparticles, Hysteresis and magnetisation of Fe_3O_4 nanomaterial, catalytic and Biomedical applications. Carbon: synthesis methods for carbon nanotubes, Graphene and Buckminster fullerene, structural study of these materials, electrical property study of these materials, surface functionalization statergies and application study **5. Characterisation of nanomaterials** **i.** Beam probe methods: Instrumentation, physical principle and different modes of operations in electron microscopic techniques such as Transmission electron microscope Scanning electron microscope and *Energy-dispersive* X-ray *spectroscopy*. **ii**. Electron and Scanning probe methods: Instrumentation, physical principle and different modes of operations in scanning tunnelling microscopy (STM) and Atomic force microscop.y **iii.** Optical Microscopes: Instrumentation, physical principle and different modes of operations in *Stimulated emission depletion* (STED) *microscopy* STED, Single molecule microscopy and *Dynamic light scattering* (*DLS*) is a *technique*. **6. Applications of nanomaterials** Polymer vesicles for drug delivery, interaction of nanoparticles with DNA, Biosensors, Heterogeneous catalysts for the synthesis of fine chemicals, use of nano TiO_2 and ZnO for water and air pollution control.	10 hr 4 hr 4 hr
Pedagogy:	Mainly lectures / tutorials. Seminars/assignments/ presentations/ self-studyor a combination of some of these could also be used to some extent. Sessions shall be interactive in nature to enable peer group learning.	

Text Books/ Reference Books	1. L. Cademartiri and G.A.Ozin, Concepts of Nanochemistry, Wiley-VCH, 2009. 2. C.N.R. Rao and A. Govindaraj, *Nanotubes and nanowires,*Royal society of Chemistry, *2005*. 3. G. Cao, *Nanostructures and Nanomaterials,*Imperial College Press, *2004.* *4.* J. M. Tour, *Molecular Electronics*, Imperial College Press, 2004 5. H. S. Nalwa (Ed),*Encyclopedia of Nanoscience and Nanotechnology,*American Scientific Publishers, Los Angeles, 2004. 6. E.Roduner, Nanoscopic Materials Size-Dependent Phenomena, RSC, Publishing, Cambridge, 2006. 7. G.A. Ozin and A.C. Arsenault, Nanochemistry: A Chemical Approach to Nanomaterials, RSC Publishing, Cambridge, 2005. 8. C.P. Poole and F.J. Owens, Introduction to Nanotechnology, John Wiley and Sons, Singapore, 2003.	