Programme: M. Sc. (Physics)
Course Code:PHO-315 **Title of the Course:** Nanoscience and Technology
Number of Credits: 4
Effective from AY: 2018-19

Prerequisites for the course:	Basic knowledge of Solid State Physics / Solid State Chemistry	
Objective:	This course is designed to familiarize students with general and specific aspects of magnetic interaction in condensed matter and methods of magnetic measurements.	
Content:	**1. Nanostructures and Nanomaterials** Introduction to Nanoscience, Physics and Chemistry of solid surfaces, Size effect on thermal, electrical, electronic, mechanical, optical and magnetic properties of nanomaterials- surface area and aspect ratio- band gap energy- quantum confinement size, Fick's Law-mechanisms of diffusion - Kirkendall effect - surface defects in nanomaterials - effect of microstructure on surface defects - interfacial energy, Classifications of nanomaterials Nanoparticles through homogeneous and heterogeneous nucleation-Growth controlled by surface and diffusion process- Oswald ripening process - influence of reducing agents-solid state phase segregation- Mechanisms of phase transformation- grain growth and sintering precipitation in solid solution- Hume Rothery rule. 2. **Synthesis and Applications of Nanomaterials** Top down and bottom up approaches–Mechanical alloying and mechanical ball milling Mechanical and chemical process, Inert gas condensation technique – Arc plasma and laser ablation. Sol gel processing-Solvothermal, hydrothermal, precipitation, Spray pyrolysis, Electro spraying and spin coating routes, Self-assembly, self-assembled monolayers (SAMs). Langmuir-Blodgett (LB) films, micro emulsion polymerization- templated synthesis, pulsed electrochemical deposition Vapor deposition and different types of epitaxial growth techniques (CVD,MOCVD, MBE,ALD)- pulsed laser deposition, Magnetron sputtering - lithography :Photo/UV/EB/FIB techniques, Dip pen nanolithography, Etching process :Dry and Wet etching, micro contact printing , Application of nanomaterials in physics, chemistry and biological sciences **1. Characterization Techniques in Nanotechnology** Optical microscopy: Use of polarized light microscopy – Phase contrast microcopy – Interference Microscopy – hot stage microscopy – surface morphology – Introduction toconfocal microscopy.	12hours 14hours 12 hours

	Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Atomic Force Microscopy (AFM), Scanning Tunneling Microscopy 4. **Applications of Nanoscience** Nanomaterials for energy applications, Nanoelectronics, Nanomagnetism and devices, Nanophotonics, Surface plasmons, Nanobio applications, Environmental issues	10 hours
Pedagogy:	lectures/ tutorials/ seminars/ assignments/ presentations/ etc. or a combination of some of these.	
References/Readings	1. G. Cao, ―Nanostructures & Nanomaterials: Synthesis, Properties & Applications Imperial College Press, 2004. 2. Murthy. B. S., Textbook of nanoscience and nanotechnology, University Press 3. L. Novotny and B. Hecht, Principles of nano-optics, Cambridge University Press, 2009. 4. M. Baker et al., ―Lithographic pattern formation via metastable state rare gas atomic beam, Nanotechnology 15, 1356, 2004. 5. H. Schift et al., ―Fabrication of polymer photonic crystals using nanoimprint lithography, Nanotechnology 16, 261, 2005. 6. R.D. Piner, ―Dip-Pen‖ Nanolithography, Science 283, 661, 1999. 7. W.L.Barnes et. al., Nature 424, 825, 2003. 8. Heinz Raether, Surface Plasmons on Smooth and Rough Surfaces and on Gratings Springer Tracts in Modern Physics, Vol. 111, Springer Berlin 1988. 9. Plasmonics: Fundamentals and Applications, Stefan Maier, Springer 2007.	
Learning Objectives	1. Gain knowledge in Nanoscience and Nanotechnology 2. Understand various techniques in cutting-edge science 3. Apply the knowledge in nanoscience in research based situations	