Name of the Programme: M.Sc. Part-II (Physical Chemistry)

Course Code: CHP-622 **Title of the course:** Nanoscience: Concepts and Applications

Number of Credits: 4

Effective from AY: 2023-24

Prerequisites for the course:	Students should have studied the M.Sc. I courses of chemistry/ physics/ biological sciences	
Course Objective:	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	
Content	**1. Essential Concepts and definitions** Nanoscale, quantum effects, thermal properties of nanomaterials, optical properties of nanomaterials, electrical properties of nanomaterials, Metallic nanowires and quantum conductance, Surface to volume ratio of nanoparticles, surface effects and surface energy on Nanoparticle surface. Chemistry of solid surfaces.	No of hours 15
	2. Methods of nanomaterial synthesis Principles, methods, formation mechanism and structures of nanomaterials for: Gas-phase processes, Liquid-phase processes, Solid-phase processes, Self-assembly processes	10
	3. Characterization techniques Beam Probe methods (SEM, TEM), Scanning probe method (STM, AFM), optical method: principle, sample preparation technique and applications. Case studies: core-shell nanoparticles, metal nanoparticles, composite nanoparticles.	10
	4. 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 core-shell particles, Study of CdSe excitons and CdSe quantum dots, functionalization and application study.	15

	Iron oxide (Fe_3O_4): 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. Applications of nanomaterials Heterogeneous catalysts for the synthesis of fine chemicals, Polymer vesicles for drug delivery, Surface-modified metal nanoparticles for recognition of toxic organic molecules, Use of nano TiO_2 and ZnO for water and air pollution control, Carbon Materials for Energy Storage, Thermoelectric Nanomaterials	8
	6. Nanomaterials: risk, toxicity Toxicity of inorganic-based, carbon-based, composite-based nanomaterials, environmental, health, and safety issues.	2
Pedagogy	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.	
References / Readings	L. Cademartiri and G.A.Ozin, Concepts of Nanochemistry, Wiley-VCH, 2009. C.N.R. Rao and A. Govindaraj, Nanotubes and nanowires, Royal society of Chemistry, 2005. G. Cao, Nanostructures and Nanomaterials, Imperial College Press, 2004. J. M. Tour, Molecular Electronics, Imperial College Press, 2004 H. S. Nalwa (Ed), Encyclopedia of Nanoscience and Nanotechnology, American Scientific Publishers,2004. E. Roduner, Nanoscopic Materials: Size-Dependent Phenomena, RSC Publishing, Cambridge, 2006. G.A. Ozin and A.C. Arsenault, Nanochemistry: A Chemical Approach to Nanomaterials, RSC Publishing, Cambridge, 2005. C.P. Poole and F.J. Owens, Introduction to Nanotechnology, John Wiley and Sons, 2003. B. Zhang, Physical Fundamentals of Nanomaterials, Chemical industry press, 2018. C. M. Hussain, Handbook of Nanomaterials in Analytical Chemistry, Elsevier, 2020. A. Barhoum and A. S. H. Makhlouf, Emerging Applications of Nanoparticles and Architecture Nanostructures: Current Prospects and Future Trends, Elsevier, 2018. R.G. Chaudhuri and S. Paria, Core/shell nanoparticles: classes,	

	properties, synthesis mechanisms, characterization, and applications, Chemical reviews ACS, 2012, 112, 2373-2433.
Course Outcome:	1. Students will learn different techniques of synthesis and characterisation of nanomaterials. 2. Students should be in a position to understand and explain magnetic, electrical, optical and catalytic properties of materials at nanoscale. 3. Students should be in a position to apply the knowledge of subject for their dissertation and research work. 4. Students will learn about applications of nanomaterials.