Teaching Scheme					Elective - Nanotechnology (22PCM217T)					
					Examination Scheme					
L	T	P	C	Hours/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	2	2	25	50	25	--	--	100

COURSE OBJECTIVES

- Understand the fundamental concept of nanotechnology.
- Design and development of various nanomaterials.
- Apply principle and application of various analytical instruments.
- Understand the various synthesis processes for nanomaterials.
- Acquainted with prospects of nanotechnology in petrochemical industry.

UNIT I: History & background **4 Hr.**

History and origin of nanoscience and technology; Definitions: Nanoscience, nanotechnology and nanomaterials; Nanotechnology timeline: 18^{th}, 19^{th} and 20^{th} century; Evaluation of nanotechnology; Nano and nature.

UNIT II: Fundamentals of nanomaterials **10 Hr.**

Fundamental properties: Size effect on thermal, electrical, electronic, mechanical, optical and magnetic properties of nanomaterials; Types of nanomaterials (0D, 1D, 2D and 3D) with examples; Relationship between dimension and shape of nanomaterials; Synthesis approaches: Top down and bottom up approach; Metal nanocrystals by reduction, solvo-thermal synthesis, photochemical synthesis, electrochemical synthesis, nanocrystals of semiconductors and other materials by arrested precipitation, thermolysis routes, sono-chemical routes, liquid-liquid interface, hybrid methods and solvated metal atom dispersion; Post-synthetic size-selective processing.

UNIT III: Nanostructured design **6 Hr.**

Functionality of nanostructures and their characteristic evaluation; Size effect in semiconductor nanoparticles: Particle size, shape density, melting point, surface tension, wettability, specific surface area, pore-assembly of nanoparticles, functionalization and self-assembly; Application of nanotechnology in petrochemical industry.

UNIT IV: Characterization techniques **8 Hr.**

Fundamental of optical microscopy; Scanning electron microscopy (SEM), transmission electron microscopy (TEM), Fourier transform infrared spectroscopy (FTIR), X-ray diffraction (XRD) and small angle XRD, energy-dispersive X-ray (EDX) spectroscopy, thermal gravimetric analysis (TGA), dynamic light scattering (DLS) analysis and zeta sizer.

Max. 28 Hr.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Understand the history, background and the nature of the nanotechnology.
CO2: Acquainted with different type of nanostructures and analyze the top down and bottom up approach.
CO3: Explain the functionality of nanostructures and their characteristic evaluation, self-assembly and its applications.
CO4: Analyse the surface modification of nanoparticles by surface functionalization and their application.
CO5: Design of nano-catalysts for petrochemical application.

CO6: Evaluate various nanomaterial characterization techniques applied to petrochemical industry.

TEXT/REFERENCE BOOKS

1. Rao, C.N.R., Muller, A. and Cheetham, A.K. "The Chemistry of Nanomaterials: Synthesis, Properties and Applications" Volume: 2 (2004).
2. Schmidt, G. "Nanoparticles: From Theory to Applications", Edition: 2, Wiley-VCH Verlag (2004).
3. Mansfield, J. "Microscopy and Microanalysis", Volume: 27, Cambridge University Press (2021).
4. Ozin, G.A. and Arsenault, A. "Nanochemistry: A Chemical Approach to Nanomaterials", Royal Society of Chemistry (2005).

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3 Hr.**
Part A: 10 Questions each carrying 5 marks	50 Marks
Part B: 5 Questions each carrying 10 marks	50 Marks