

GANPAT UNIVERSITY									
FACULTY OF ENGINEERING & TECHNOLOGY									
Programme		Master of Technology				Branch/Spec.		Chemical Engineering	
Semester		II				Version		1.0.0.0	
Effective from Academic Year			2026-27			Effective for the batch Admitted in			July 2026
Subject code		3CH21PE13		Subject Name		Nanoscience and Engineering			
Teaching scheme						Examination scheme (Marks)			
(Per week)	Lecture (DT)		Practical (Lab.)		Total		CE	SEE	Total
	L	TU	P	TW					
Credit	3	0	0	0	3	Theory	40	60	100
Hours	3	0	0	0	3	Practical	0	0	0
Pre-requisites:									
Course Outcomes									
On successful completion of the course, the students will be able to:									
CO1	Explain fundamentals of nanoscience and nanoscale material behavior.								
CO2	Explain structure, bonding, and functional properties of advanced nanomaterials.								
CO3	Compare nanomaterial synthesis routes and evaluate scale-up considerations.								
CO4	Interpret nanomaterial properties using advanced characterization techniques.								
CO5	Assess nanomaterial applications in catalysis, separation, and energy processes.								
Theory syllabus									
Unit	Content								Hrs
1	Fundamentals of Nanotechnology: Nanoscale concept and historical perspective, Surface-to-volume ratio and quantum size effects, Thermodynamics and kinetics at nanoscale, Classification of nanomaterials (0D, 1D, 2D, 3D), Metal, metal oxide, carbon and polymer nanomaterials, Thermal properties (thermal conductivity k, heat capacity Cp), Diffusivity and mass transfer enhancement, Catalytic activity and surface reactivity								8
2	Nanomaterials and Functional Systems: Structure and bonding in solids, Crystal systems and crystallographic planes, Mechanical properties at nanoscale, Electrical and quantum transport properties, Optical and magnetic properties, Carbon nanomaterials (CNT, graphene), Porous materials (MOFs, zeolites, aerogels), Polymer nanocomposites, Nanomaterials in catalytic and separation systems								9
3	Synthesis and Manufacturing: Bottom-up and top-down approaches, Sol-gel method, Hydrothermal and solvothermal synthesis, Chemical vapor deposition (CVD), Colloidal synthesis and nucleation-growth mechanism, Template-assisted synthesis, Spray pyrolysis, High-energy ball milling, Sputtering techniques (DC, RF, magnetron), Laser ablation, Physical vapor deposition (PVD)								10
4	Characterization Techniques: X-ray diffraction (XRD), BET surface area analysis, X-ray photoelectron spectroscopy (XPS), SEM and FE-SEM, TEM, FTIR spectroscopy, Raman spectroscopy, UV-Vis spectroscopy, TGA-DTA								8
5	Applications in Chemical Engineering: Nano-catalysis and reaction engineering, Process intensification using nanomaterials, Wastewater treatment and adsorption, Nano-membranes for separation, Nano-fluids for heat transfer enhancement, Hydrogen storage, Biofuel production,								10

	Enhanced oil recovery, Polymer nanocomposites in process equipment	
Text Books		
1	<i>Introduction to Nanotechnology</i> Wiley-Interscience, 2003 by Charles P. Poole Jr and. Frank J. Owens	
2	<i>Nanostructures and Nanomaterials: Synthesis, Properties and Applications</i> Imperial College Press, 2004 by G. Cao	
3	<i>Nanotechnology: Principles and Practices</i> , 3rd Ed., Capital Publishing Company, New Delhi, 2016, by S.K. Kulkarni.	
4	<i>Nanoscience and Nanotechnology: Fundamentals to Frontiers</i> , 1st Ed., Wiley India Pvt. Ltd., 2013, by M.S.R. Rao and S. Singh.	
5	<i>Nanocharacterization</i> , RSC Publishing, 2007, by A.I. Kirkland and J.L. Hutchison.	
Reference Books		
1	<i>Nanoscale Science and Technology</i> by Robert Kelsall, Ian W. Hamley and Mark Geoghegan	
ICT/MOOCs references		
1)	Coursera via NPTEL (Swayam): "Nanotechnology in Chemical Engineering" by Prof. Taraknath Das (IIT Roorkee). https://onlinecourses.nptel.ac.in/noc25_ch62/preview	

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