GUJARATTECHNOLOGICALUNIVERSITY

Program Name: Master of Engineering
Level: Post Graduate Degree
Branch: Chemical Engineering

Course/Subject Code: **ME01030041**

Course/Subject Name: Application of Nanotechnology in Chemical Engineering

w.e.f. Academic Year:	2024-25
Semester:	1st Semester
Category of the Course:	PEC

Prerequisite:	None
Rationale:	This course is designed to introduce students to the ideas of nanoscience and nanotechnology in the design and construction of devices and systems that take advantage of the unique features of nanoscale materials to develop whole new functionality and capabilities. It would also focus on underlying scientific, technological, and engineering difficulties for advancing nanotechnology in the controlled synthesis of nanostructured materials, notably for industrially important, energy, and environmentally relevant technologies. The curriculum was designed to meet the educational needs of this emerging engineering discipline.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes
01	To understand and classify nanomaterials and impact of nano size on nanomaterials property.
02	To gain the knowledge of nanomaterial synthesis by different methods and its approach.
03	To understand the characterization of nanomaterials by various techniques.
04	To study the scope and applications of nanotechnology in chemical industry as well as its environmental impact.

Teaching and Examination Scheme:

Teaching Scheme(in Hours)			Total Credits L+T+(PR/2)	Assessment Pattern and Marks				Total Marks
				Theory		Tutorial/Practical		
L	T	PR	C	ESE (E)	PA/ CA (M)	PA/CA(I)	ESE(V)	
3	0	2	4	70	30	20	30	150

CourseContent:

Unit No.	Content	No.of Hours	% of Weightage
1.	**Introduction:** Definition of nanomaterial, nanoscience, nanotechnology; History and scope of nanomaterials; Emergence of nanotechnology and Moore's law; Classification of nanomaterials; Nano dimension impact on (i) elastic properties, (ii) melting point, (iii) diffusivity, (iv) Grain growth characteristics, (v) solid solubility, (vi) Magnetic, (vii) electrical, (viii) optical, (ix) mechanical and, (x) thermal properties. Physical chemistry concept of nanomaterials: (i) surface energy, (ii) Chemical potential, (iii) Electrostatic Stabilization, and (iv) Steric Stabilization.	7	16
2.	**Nanomaterial synthesis using Top-down approach:** Mechanical alloying, Equal channel angular pressing, High-pressure torsion, Accumulative roll bonding, Nanolithography	5	12
3.	**Nanomaterial synthesis using Bottom-up approach:** Physical vapour deposition, Chemical vapour deposition, Magnetron sputtering,molecular beam epitaxy,Colloidal methods,Spray conversion processing, Sol–gel process, Electrodeposition, Hydrothermal and solvothermal method, Wet chemical synthesis, Self-assembly.	5	12
4.	**Synthesis of nanoparticles:** Homogeneous nucleation, Heterogeneous nucleation, Factor affecting size of nanoparticles, Conventional methods, Novel methods such as sonochemical and microwave. Synthesis methods of 1D, 2D nanomaterials, Nanostructure fabrication by physical techniques.	5	12
5.	**Characterization of nanomaterials**: X-Ray Diffraction (XRD), Scanning Electron Microscopy, Transmission Electron Microscopy, Atomic Force Microscopy, UV/Visible Spectroscopy, Scanning Tunnelling Microscopy, Filed Ion Microscopy, Three dimensional atom probe, Nano indentation.	6	14
6.	**Synthesis route of Nanostructured Materials with High Application Potential:** (i) Quantum dot, (ii) carbon nanotube, (iii) GaN nanowires, (iv) Nano-crystalline ZnO, (v) Nano-crystalline TiO_2, (vi) Titania nanotubes, (vii)	7	14

	M50 steel, (viii) Silicon based nanostructure, (ix) Fullerene, and (x) micro and mesoporous materials.		
7.	**Applications of nanomaterials:** (i) Cosmetics and Consumer Goods, (ii) Nano Sensor, (iii) Nano catalysts, (iv) Water Treatment and the Environment, (v) Paints, (vi) Food and Agriculture Industry, (vii) energy storage, (ix) Nano-medical Applications, and (x) Textiles	5	10
8.	**Scope, Concerns and Challenges of nanotechnology:** Scalability, Environmental, ecological and health hazards of nanoparticles, Nano-toxicology and its effect	5	10
	Total	**45**	**100**

Suggested Specification Table with Marks (Theory):

DistributionofTheoryMarks					
RLevel	**ULevel**	**ALevel**	**NLevel**	**ELevel**	**CLevel**
12	35	07	09	07	00

WhereR:Remember;U:Understanding;A:Application,N:AnalyzeandE:EvaluateC:Create(asperRevisedBloom'sTaxonomy)

References/SuggestedLearningResources:

(a) Books:

1. Textbook of Nanoscience and Nanotechnology, B.S. Muty, P. Shankar, Baldev Raj, B.B Rath and James Murday, University Press, IIM (ISBN-978 81 7371 738 3).
2. Nanostructures and Nanomaterials: Synthesis, Properties and Applications by G. Cao, Imperial College Press, 2004.
3. The Chemistry of Nanomaterials: Synthesis, Properties and Applications by C. N. R. Rao, A. Muller, A. K. Cheetham, WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim, ISBN: 3-527-30686-2.
4. Nanomaterials: Synthesis, Properties & Applications, by Edelstein, A. S & R C Cammarata (Eds.), Taylor & Francis, New York, 1996.
5. Introduction to Nanotechnology, C.P. Poole Jr. and F.J.Owens, Wiley, 2003.
6. Hand book of Nanostructured Materials and Nanotechnology, H. Nalwa, Vol. 1 to 5, Academic Press, 1999.
7. Hand book of Nanotechnology, B. Bhusan, Springer, 2004.

(b) Opensourcesoftwareandwebsite:

1. NPTEL https://nptel.ac.in/courses/118104008
2. NPTEL https://onlinecourses.nptel.ac.in/noc19_mm21/preview
3. MIT: https://mitnano.mit.edu/opportunities/fall-2021-course-6s059-nanotechnology-design-atoms-everything

SuggestedCoursePractical List:If any

ListofLaboratory/Learning ResourcesRequired:

SuggestedProject List:

1. Preparation of catalyst by wet impregnation method.
2. Preparation of catalyst by precipitation method.
3. Preparation of catalyst by co-precipitation method.
4. Preparation of catalyst by hydrothermal method.
5. To synthesize a heterogeneous catalyst by sol-gel method.
6. To synthesize graphene oxide nanomaterials.
7. Synthesis of nanoparticles.
8. Effect of process conditions of size and shape of nanoparticles.
9. To identify the functional group and analyze the sample using FTIR.
10. To analyze the sample using UV-vis spectroscopy.
11. VLAB experiment on XRD
12. VLAB experiment on electron microscopy.

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