GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Master of Engineering

Level: PG

Branch: Computer Aided Process Design

Code: ME01072071

Course / Subject Name : Nanotechnology

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

Prerequisite:	Basic fundamentals of Nanoscience and Nanotechnology
Rationale:	In this subject emphasis is given on nanotechnology, leading finally to application in chemical engineering. The first part of this subject deals with Nanotechnology and Nanomaterials. The second part gives highlights on nanomaterial synthesis and characterization of nanomaterials. The third part includes its application in the field of chemical engineering, safety, environment and others.

Teaching and Examination Scheme:

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

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	Introduction: Introduction to nanotechnology, Classification of nanostructures, Nanoscale architecture, Chemical interactions at nanoscale, One, two and multidimensional structures, Crystallography, Semiconducting Nanomaterials, Types of carbon-based nanomaterials, Metal oxide nanomaterials, Optical Properties of Nanomaterials, Magnetic Properties of Nanomaterials	8	17
2.	Approaches to Synthesis of Nanoscale Materials Top down approach, Bottom-up approach Bottom-up vs. topdown fabrication; Top-down: Atomization, Sol gel technique, Arc discharge, Laser ablation, RF sputtering; Bottom-up: Chemical Vapor Deposition	12	26
	(CVD), Metal Oxide Chemical Vapor Deposition (MOCVD), Atomic layer deposition (ALD), Molecular beam Molecular self-assembly; Ultrasound assisted, microwave assisted, Mini-, micro- and nanoemulsion, Wet grinding method, Spray pyrolysis, Ultrasound assisted pyrolysis, atomization techniques. Surfactant based synthesis procedures.		
3.	Characterization of Nanoscale Materials Types of molecular modelling methods. Size, shape, crystallinity, topology, chemistry analysis using X-ray imaging, Transmission Electron Microscopy, HRTEM, Scanning Electron Microscopy, SPM, AFM, STM, PSD, Zeta potential, DSC and TGA.	7	17
4.	Application in the field of chemical Nanocatalysts, Photocatalysts, Nanomaterials for Adsorbent Application, Cosmetics, Paints, Nanocoatings, Food and agricultural industries, pharmaceutical products, Nano composite polymers, Energy	8	18
5.	Applications to Safety, Environment and Others Biosensors, Nanostructured Materials for Sensing, Waste Water Treatment, Nanobiotechnology, Self-cleaning Nano Materials, Biological nanomaterials, Nanoelectronics, Nanomachine, nanodevices; Societal, Health and Environmental Impacts.	10	22
	Total	**45**	**100**

Course Outcomes:

After Completion of the Course, Student will able to:

No.	Course Outcomes	
01	Explain importance of nanoscience and nanomaterials.	R, U
02	Explain fundamental knowledge of various methods used in the field of nanotechnology	R
03	Interpret basics of various characterization methods in the field of Nano Technology.	A
04	Apply the basics of nanotechnology in various applications.	A

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
40	20	40	-	-	-

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

1. Louis Hornyak G., Dutta Joydeep, Tibbals Harry F. and Rao Anil K., "Introduction to Nanoscience", (CRC Press of Taylor and Francis Group LLC), May 2008, 856pp, ISBN-13: 978142004805
2. Ajayan P. M., Schadler L. S., Braun P. V., "Nanocomposite Science and Technology", Edited by WILEY-VCH Verlag GmbH Co. KGaA, Weinheim ISBN: 3-527-30359-6, 2003.
3. Kelsall Robert W., Hamley Ian W., Geoghegan Mark, "Nanoscale Science and Technology", JohnWiley & Sons, Ltd, 2006
4. Kal Ranganathan Sharma, "Nanostructuring Operations in Nanoscale Science and Engineering", McGraw-Hill Companies, Inc. ISBN: 978-0-07-162609-5, 2010.
5. Nabok Alexei "Organic and inorganic nanostructures".-(Artech House MEMS series), ISBN 1- 58053-818-5, 2005.
6. Bergmann Carlos P, Andrade Monica J, "Nanostructured materials for engineering applications", Springer, 2011
7. Rao CNR, Muller A, Cheetham AK, "The Chemistry of Nanomaterials: Synthesis, Properties and Application" Wiley VCH, 2004
8. Mogillo JF "Nanotechnology 101" Greenwood press, 2007

9. Cao G "Naostructures and Nanomaterials: Synthesis Properties and Applications", Imperial College Press, 2004

(b) Open-source software and website:

1. NPTEL lecture series.

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