GUJARAT TECHNOLOGICAL UNIVERSITY

CHEMICAL (COMPUTER AIDED PROCESS DESIGN) (16)

APPLICATION OF NANOTECHNOLOGY IN CHEMICAL ENGINEERING

SUBJECT CODE: 3711614

SEMESTER: I

Type of course: Program Elective - 2

Prerequisite: A course on 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:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE(E)	PA (M)	PA (V)	PA (I)	
3	0	0	3	70	30	0	0	100

Content

Sl. No.	Topic	Teaching Hours	Module 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	9	17
2.	Approaches to Synthesis of Nanoscale Materials Top down approach, Bottom-up approach Bottom-up vs. top-down fabrication; Top-down: Atomization, Sol gel technique, Arc discharge, Laser ablation, RF sputtering; Bottom-up: Chemical Vapor Deposition (CVD), Metal Oxide Chemical Vapor Deposition (MOCVD), Atomic layer deposition (ALD), Molecular beam Molecular self-assembly; Ultrasound assisted, microwave assisted, Mini-, micro- and nano-emulsion, Wet grinding method, Spray pyrolysis, Ultrasound assisted pyrolysis, atomization techniques. Surfactant based synthesis procedures.	14	26
3.	Characterization of Nanoscale Materials Types of molecular modelling methods. Size, shape, crystallinity, topology, chemistry analysis using X-ray	9	17

	imaging, Transmission Electron Microscopy, HRTEM, Scanning Electron Microscopy, SPM, AFM, STM, PSD, Zeta potential, DSC and TGA.		
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	10	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.	12	22

Reference Books:

1. 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. 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. 3. Kelsall Robert W., Hamley Ian W., GeogheganMark, "Nanoscale Science and Technology",John Wiley & Sons, Ltd, 2006
4. 4. Kal Ranganathan Sharma, "Nanostructuring Operations in Nanoscale Science and Engineering", McGraw-Hill Companies, Inc. ISBN: 978-0-07-162609-5, 2010.
5. 5.NabokAlexei "Organic and inorganic nanostructures".-(Artech House MEMS series), ISBN 1- 58053-818-5, 2005.
6. 6. Bergmann Carlos P, Andrade Monica J, "Nanostructured materials for engineering applications", Springer, 2011
7. 7. Rao CNR, Muller A, Cheetham AK, "The Chemistry of Nanomaterials: Synthesis, Properties and Application"Wiley VCH, 2004
8. 8. Mogillo JF "Nanotechnology 101" Greenwood press, 2007
9. 9. Cao G "Naostructures and Nanomaterials: Synthesis Properties and Applications", Imperial College Press, 2004

Course Outcome:

At the end of the course, the student will be able to:

1. Understand Nanotechnology and Nanomaterials
2. Understand different top down and bottom up approaches for nanoparticles
3. Learn the characterization techniques for nanoparticles.
4. Get to know the different applications of nanoparticles in chemical engineering field.
5. Get to know the different applications of nanoparticles in Environment and Safety

List of Open Source Software/learning website:

1. Students can refer to video lectures available on the websites including NPTEL lecture series.
2. Students can refer to the CDs available with some reference books for the solution of problems using softwares/spreadsheets. Students can develop their own programs/spreadsheets for the solution of problems.
3. Literature available on Nanotechnology and its application
4. MIT Open course lecture on Nanotechnology and Application