GUJARAT TECHNOLOGICAL UNIVERSITY
CHEMICAL ENGINEERING (30)
APPLICATION OF NANOTECHNOLGY IN CHEMICAL ENGINEERING
SUBJECT CODE: 3713018
SEMESTER: I

Type of course: Chemical Engineering (ELECTIVE -II)
Prerequisite: None

Rationale:
This course is intended to familiarize students about the concepts of nanoscience and nano-technology in the design and manufacture devices and systems that exploit the unique properties of nanoscale materials to create entirely new functionality and capabilities. It would also focus on underlying scientific, technical, and engineering challenges for advancing nanotechnology in the controlled synthesis of nanostructured materials, especially for industrially important, energy, and environmentally related technologies. The curriculum is built to address the educational needs of this new engineering field.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
Th	Tut	Lab	C	ESE(E)	PA (M)	ESE (V)	PA(I)	
3	0	2	4	70	30	30	20	150

SR. No	Topic	Teaching hours	Module weightage
1	Concept of nanoscale; historical applications of nanotechnology, examples of reduced dimensionality system: 1D, 2D, 3D confinements, Effect of nanometer length scale on different physico-chemical properties of matter.	10	16
2	Synthesis of nanomaterials, top down and bottom up approach: Milling, Equal Channel Angular Pressing, High Pressure torsion, Lithography, Chemical and Physical Vapor Deposition, Sputtering, Laser Method, Spray Pyrolysis, Thermo Chemical /Flame Decomposition of metal organic Precursors methods	7	13
3	Synthesis of nanoparticles, homogeneous nucleation, microemulsion based methods, synthesis of carbon fullerene, synthesis of nanowires, nanorods and nanotubes, Deposition of thin film, synthesis of microporous and mesoporous materials.	7	13
4	Oxide nanoparticles, Routes for the Preparation of Isolated Oxide Nanoparticles Hydrolysis, oxidation, thermolysis, methathesis, solvothermal methods, oxidation and hydrolysis	6	10
5	Reactive methods in high boiling point solvents 20, hydrothermal and solvothermal methods, gas-phase synthesis of semiconductor nanoparticles, synthesis in a structured medium, the suitability of such methods for scaling	7	13

6	Tools to characterize nanomaterials: X-Ray Diffraction (XRD), Scanning Electron Microscopy, Transmission Electron Microscopy, Atomic Force Microscopy,UV/Visible Spectroscopy, Scanning Tunneling Microscopy, Filed Ion Microscopy, Three dimensional atom probe, Nanoindentation	5	9
7	Applications of nanomaterials: Cosmetics and Consumer Goods, Nano Sensor, Nano catalysts, Water Treatment and the Environment, Paints, Food and Agriculture Industry. Nano-medical Applications, Textiles, Paints	7	13
8	Concerns and Challenges of nanotechnology: Environmental, ecological and health hazards of nanoparticles, Nanotoxicology and its effect	7	13

Reference Books:

1. Nanostructures and Nanomaterials: Synthesis, Properties and Applications by G. Cao, Imperial College Press, 2004.
2. Engines of creation: The coming era of Nanotechnology by Drekler, K. E., Anchor Books, New York, 1986.
3. Nanomaterials: Synthesis, Properties & Applications, by Edelstein, A. S & R C Cammarata (Eds.), Taylor & Francis, New York, 1996.
4. 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.
5. The self made Tapestry: Pattern formation in nature, Oxford Press, Oxford, 2001.
6. 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).
7. Introduction to Nanotechnology by Charles P. Poole Jr and. Frank J. Owens, Wiley-Inter science, 2003.

Course outcome:

Following learning outcomes are anticipated

- To prepare students for nanotechnology by providing them with a sound grounding in multidisciplinary areas of nanoscience and nanoengineering
- To increase students' understanding of materials and their properties at the atomic and nanometer level,
- To develop understanding of the intimate relationship between material scale (nanostructure) and the properties/functionality of materials
- To know the processing of Nanoparticles and Nanomaterials along with their major applications.
- Prepare students to conduct research and development of economically feasible and innovative applications of nanodevices

List of tutorials

- To explain and identify the physical and instrumental principles of techniques used for the characterization of nanostructures including molecular and continuum (macroscopic) scale characterization of organic and inorganic materials and their application to specific questions.
- Read and understand a scientific paper: Identify the goal, method, result and conclusion of the research. Explain the content to a fellow student

List of Open Source Software/learning website

Students can refer to video lectures available on various websites including NPTEL. Students can refer to the CDs which are available with some reference books for the solutions¬ of problems using software. Students can develop their own programs for the solutions using excel, Chemical and other simulation software.