GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3143906

Semester – IV
Subject Name: Elements of Nanoscience and Nanotechnology -II

Type of course: Nanoscience and Nanotechnology

Prerequisite: Basic knowledge of engineering and sciences as well as fundamentals of nanotechnology

Rationale: The objective of this course is to provide an advance understanding of Nanoscience and Nanotechnology. In addition, the course is expected to encourage engineering students to think about solving industrial problems with engineering tools.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	4	5	70	30	30	20	150

Sr. No.	Contents	Teaching Hrs.	Module Weightage (%)
1	**Surface Effect and Physical Properties of Nanomaterials-I** 1.1 Surface Energy 1.2 Surface stress, 1.3 Shape of Nanocrystals 1.4 Comparison of Solid and Liquid Surfaces 1.5 Shape of Cluster and Nanocrystals 1.6 Clusters: magic numbers for stability Clusters: ionic, semiconducting & metallic clusters Self-assembled ordered nanostructures & their properties, 1.7 Meso porous materials 1.8 Self-assembles ordered nanostructures Hierarchically structured nanomaterials Core-shell nanostructures 1.9 Curvature effects in nanocrystals 1.10 Precipitate coarsening Case study (curvature effects)	8	15
2	**Surface Effect and Physical Properties of Nanomaterials-II** 2.1 Absorption 2.2 Adsorption 2.3 Molecular sieves 2.4 Nano-sponges. 2.5 Catalyst 2.6 Excitons 2.7 Effective Mass Approximation 2.8 Photoluminescence 2.9 Electroluminescence 2.10 Cathodoluminescence 2.11 Thermoluminescence 2.12 Melting of Nanoparticles	8	15

3	**Concepts of Self-Cleaning Surfaces** 3.1 Introducing super-hydrophobicity 3.2 Contact Angles and Wetting 3.3 Contact Angle Hysteresis 3.4 The Effect of Roughness on Contact Angles 3.5 Bridging the Roughness; Cassie and Baxter's Equation 3.6 Flat Surfaces, Wenzel Case, Cassie–Baxter Case 3.7 Important Considerations 3.8 self-cleaning on superhydrophobic surfaces 3.9 mechanisms of self-cleaning on superhydrophobic surfaces 3.10 Factors: Water Impact Condensation Oil Contamination Multiple Scale Roughness (Hierarchical Roughness) 3.11 Nature and super-hydrophobic surfaces 3.12 Functional Properties of Superhydrophobic Surfaces 3.13 Evaporation and Condensation Resistance 3.14 Frost/Ice Resistance, Anti-Fouling, Anti-Corrosion 3.15 Transparent and Anti-Reflective Properties 3.16 Materials and Fabrication 3.17 Future Perspectives	12	23
4	**Industrial Synthesis Techniques** 4.1 Template based nano synthesis 4.2 Electrochemical Etching 4.3 Electrophoretic deposition 4.4 The Electrospinning Process 4.5 Key Processing Parameters 4.6 Nanofiber Yarns and Fabrics Formation 4.7 Potential Applications of Electro-spun Fibres 4.8 Supercritical Fluids 4.9.1 Introduction 4.9.2 Role of – Solubility, Viscosity, and Diffusion 4.9.3 Applications 4.10 Transparent Conducting Thin Films	14	27
5	**Advanced Nanotechnology Based Applications** 5.1 AgX photography 5.1.1 Introduction and Light Sensitivity Material, 5.1.2 Working, 5.1.3 Application 5.2 Dye Sensitized Solar Cell 5.2.1 Principal 5.2.2 Material 5.2.3 Working 5.2.4 Efficiency 5.3 Aerogel and Silica aerogel 5.3.1 Properties of Aerogels 5.3.2 Applications of Aerogels	10	20

Reference Books:

1. Nanomaterials, Nanotechnologies and Design: An Introduction to Engineers and Architects, D. Michael Ashby, Paulo Ferreira, Daniel L. Schodek, Butterworth-Heinemann, 2009.

2. Handbook of Nanophase and Nanostructured Materials (in four volumes), Eds: Z.L. Wang, Y. Liu, Z. Zhang, Kluwer Academic/Plenum Publishers, 2003.
3. Handbook of Nanoceramics And Their Based Nanodevices (Vol. 2) Edited by Tseung-Yuen Tseng and Hari Singh Nalwa, American Scientific Publishers.
4. G. Cao, Nanostructures & Nanomaterials: Synthesis, Properties & Applications, Imperial College Press, 2004
5. Self-Cleaning Materials and Surfaces A Nanotechnology Approach Edited by Walid A. Daoud, John Wiley & Sons, Ltd
6. Nanomaterials Handbook Edited by Yury Gogotsi
7. Nanotechnology: Principles and Practices by Sulabha K. Kulkarni

Course Outcome

Sr. No.	CO statement	Marks % weightage
CO-1	Students will be able to understand various aspects associated with surface effect and physical properties of nanomaterials	**30**
CO-2	Students will be able to appreciate effectiveness of nano-patterning in self-cleansing surfaces	**23**
CO-3	Students will be able to get acquainted with various synthesis approaches used in industries	**27**
CO-4	Students will be able to gain understanding of advanced nanotechnology-based applications	**20**

Bloom's Taxonomy for Cognitive Domain	Marks % weightage
Recall	30
Comprehension	40
Application	30
Analysis	0
Evaluate	0
Create	0

List of Experiments:

Sr. No	**Topics**
1.	Synthesis of Aqueous Ferro fluid
2.	Preparation of metal oxide nanoparticles by micro emulsion technique
3.	Synthesis of at least two different sizes of Copper Oxide Nano Particles Using Sol-Gel Method
4.	Synthesis of at least two different sizes of Zinc Oxide Nano Particles Using Sol-Gel Method
5.	Synthesis different size of Cu nanoparticles using electrochemical methods.
6.	Prepare conducting glass using chemical deposition