Course Type	Course Code	Name of Course	L	T	P	Credit
DE	NPHD514	PHYSICS OF NANOMATERIALS	3	0	0	3

Prerequisite: Condensed Matter Physics, Quantum Mechanics

Course Objectives

- To introduce the students with science and technology involved with the viable materials at nanoscale
- To get the students ready for research in advanced fields of materials science and to be a professional in development and production industry.

Learning Outcomes

Upon completion a student will know about:

- Properties of nanomaterials
- Physical and chemical sciences working behind the properties exhibited by the materials at nanoscale;
- Various physical and chemical techniques of synthesis and fabrication of nanomaterials and nanostructures
- Some typical technologically important nanomaterials.

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	**Introduction:** Band Structure, Density of States (DOS) in bands, Variation of DOS with energy, Variation of DOS and band gap with size of crystal; Joint Density of States, Dimensional dependence of DOS of Fermi gas electrons. Electron confinements in infinitely deep and finite square well potentials; Physical concepts of circular, parabolic and triangular well potentials.	9	After this unit being taught the students can learn the basic theoretical concepts essential for understanding the nanostructured materials.
2	**Quantum size effect:** Properties of nanoparticles, Characteristic lengths, Clusters, Magic Numbers; Quantum well, Quantum wire, Quantum dot; Energy subbands; Conduction electrons and dimensionality; Properties dependent on DOS. Electrical transport properties, Diffusive and ballistic regime, Single electron tunnelling, Excitons, Optical absorption in quantum well; Surface plasmon resonance; Nanomagnetism; Nanomechanical properties.	12	After studying this unit, one will learn about the most important forms of various nanostructured materials and some of their interesting properties.
3	**Preparation of nanomaterials and nanostructures**: Classification, Top-down and Bottom-up approach, Overview of different fabrication and synthesis techniques such as Ball Milling, Chemical bath Deposition, Electrodeposition, Sol-Gel, Anodization technique, Photolithography, E-beam lithography, Hot-embossing Technique, Physical Vapor Deposition, Glancing angle deposition, Pulsed Laser Deposition, Molecular Beam Epitaxy. Growth mechanisms of nanocrystals and nanostructures.	12	The main learning outcome of this unit is knowledge of various synthesis techniques for nanostructured materials.
4	**Typical nanomaterials**: Graphene, Fullerenes and Carbon Nanotubes; Supramolecular structures; Nanocomposites, Zeolites.	9	In this unit the properties of some new age novel nanomaterial will be discussed.
	Total	**42**	

Text Books:

1. Introduction to Nanotechnology, Poole and Owners, Wiley India Pvt Ltd, 2007.
2. Nanostructures and Nanomaterials: Synthesis, Properties, and Applications, Cao; World Scientific Publishing Company, 2011.
3. Nanoscience and Nanotechnology – Fundamentals to Frontiers: M. S. Ramachandra Rao; Wiley, 2013.

Reference Books:

1. Handbook of Nanophysics – Principles and Methods: By Klaus D. Sattler; CRC Press, 2010.
2. Materials Science and Engineering: An Introduction, W. D. Callister, John Wiley and Sons, 2006.
3. Materials Science and Engineering, V. Raghvan, PHI Learning Pvt. Ltd., 2004.
4. Nanoscience and Nanotechnology in Engineering, V. K. Varadan, World Scientific, 2010.
5. Quantum Dots, Jacak, Hawrylak and Wojs, Springer, 1998.
6. Nanotechnology: Principles and fundamentals, Günter Schmid, Wiley-Vch, 2008.
7. Nanomaterials and Nanochemistry; C. Brchignac, P. Houdy and M. Lahmani; Springer, 2008.