Course Code	Course Name	Credits
26PH606	NANOMATERIALS	04

Course Objectives

- To understand the dimensionality of the object of nanoscale on their properties.
- To understand size and shape controlled synthesis of nanomaterials and their future application in industry.

Learning Outcomes

Upon successful completion of this course it is intended that a student will be able to:

- Correlate properties of nanostructures with their size, shape and surface characteristics.
- Appreciate enhanced sensitivity of nanomaterials based sensors and their novel application in industry.

Unit 1 – Basic Properties of Nanoparticle (12 Hrs.)

Particle size; Top down and bottom up ideas, particles shape; Size effect and properties of nano-particles; Particle density; Melting point; Surface tension; Wettability; Specific surface area and pore; Composite structure; Crystal structure; Surface characteristics; Mechanical properties; Electrical properties; Magnetic properties; Optical properties; Concept of vacuum technology.

Unit 2 – Quantum Phenomen (12 Hrs.)

One dimensional quantum or electron leak; Quantized electron energy; Time dependent perturbation theory; Transition to continuum (Fermi's Golden rule);Density of states (DOS); Spin effects (Kondo resonance, Zeeman splitting) spectroscopy.

Unit 3 - Nanofabrication and Nanopatterning (12 Hrs.)

Sol-Gel synthesis, Hydrothermal Growth, Optical, X-ray, and electron beam lithography, self -assembled organic layers, scanning tunneling microscopy, atomic force microscopy.

Unit 4 – Nano Systems (12 Hrs.)

An artificial and tunable atom (quantum dot); Quantum wire; Quantum Hall effect; Carbon nano-tube; Tunnel diode; Molecular transistor; Single electron transistor; Spin polarized transistor; Thin films; Self-assembly.

Unit 5 - Applications of Nanomaterial (12 Hrs.)

Optoelectronic properties of molecular materials, nanotechnology devices: OLEDs, OTFTs. Bioelectronics and biosensors: charge transport, DNA and protein functional systems, electronic noses and biosensors.

Reference Books:

1. Principles of Nanotechnology – G. Ali Mansoori
2. Nanotechnology – Mark Ratner & Daniel Ratner
3. Fundamentals of Nanotechnology – Gabor L. Hornyak
4. E. Wolf ; Nanophysics and Nanotechnology: An Introduction to Modern Concepts in Nanoscience Second Edition, Wiley-VCH (2006).

Websites and eLearning Sources:

1. https://nptel.ac.in/courses/118104008
2. https://youtu.be/YhuUFLzJSsg?si=8iBAcXC4lq5_0S9v
3. https://youtu.be/qUEbxTkPIWI?si=r5pr9aYmDmEXndPQ

COs and Bloom's Taxonomy Mapping – 26PH606		
Course Outcomes	**On successful completion of this course, students will be able to**	**BTL**
CO1	Recall and explain fundamental properties of nanoparticles including size effects, surface characteristics, and physical properties.	K1, K2
CO2	Apply quantum concepts such as density of states, tunneling, and perturbation theory to nanoscale systems.	K3
CO3	Analyze nanofabrication and nanopatterning techniques including lithography and microscopy methods.	K4
CO4	Analyze nanosystems such as quantum dots, nanotubes, and nanoelectronic devices.	K5
CO5	Evaluate and design nanomaterials and nanodevices for applications in electronics, optoelectronics, and biosensors.	K6

BTL (Bloom's Taxonomy Level) - K1 – Remembering, K2 – Understanding, K3- Applying, K4 – Analyse, K5- Evaluate and K6 - Create

Relationship Matrix – 26PH606													
Course Outcomes	**Programme Outcomes (POs)**						**Programme Specific Outcomes (PSOs)**						**Mean Score of Cos**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	
CO1	3	2	1	1	1	1	3	2	1	1	1	1	1.58
CO2	3	3	2	2	1	1	2	3	2	2	2	1	2.00
CO3	3	3	3	2	1	1	2	3	3	2	2	2	2.25
CO4	3	3	3	2	2	1	2	3	3	2	2	2	2.33
CO5	3	3	3	3	2	2	3	3	3	3	2	2	2.58
												Total	2.15

Mean Score: 3- High, 2- Medium/Moderate, 1-Low