

Course Code	Course Name	Credits
26CH514	NANOTECHNOLOGY	04

Course Objectives

- To understand the fundamentals, scale, and size-dependent properties of nanotechnology.
- To explain different classes, synthesis methods, and fabrication techniques of nanomaterials.
- To analyze characterization techniques and diverse applications of nanomaterials in science and technology.

Learning Outcomes

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

- Understand fundamental concepts of nanotechnology, including nanoscale properties and size-dependent phenomena.
- Classify different types of nanomaterials such as carbon-based, metal-based, and biological nanomaterials.
- Apply various synthesis, fabrication, and characterization techniques for nanomaterials.
- Evaluate applications of nanotechnology in electronics, energy, medicine, and environmental systems.

Unit 1 - Basics and scale of Nanotechnology (12 Hrs.)

Introduction to Nanotechnology; Scientific Revolutions; Time and Length Scale in Structures; Definition of Nanosystem; Dimensionality and Size-Dependent Phenomena; Surface-to-Volume Ratio; Fraction of Surface Atoms; Surface Energy and Surface Stress; Surface Defects; Properties at Nanoscale (Optical, Mechanical, Electronic, Magnetic)

Unit 2- Different classes of nanomaterials (12 Hrs.)

Classification based on dimensionality-Quantum Dots, Wells and Wires- Carbon- based nano materials (buckyballs, nanotubes, graphene)– metal based nano materials (nanogold, nanosilver metal sulfides and metal oxides) - nanocomposites- nanopolymers – nanoglasses –Nano ceramics and carbon nanocomposites-Biological nanomaterials.

Unit 3 - Synthesis of nanomaterials (12 Hrs.)

Chemical Methods (Metal Nanocrystals by Reduction, Solvothermal, Photochemical, Sonochemical, Chemical Vapor Deposition (CVD), Metal Oxide CVD (MOCVD)); Physical Methods (Ball Milling, Electrodeposition, Spray Pyrolysis, Flame Pyrolysis, DC/RF Magnetron Sputtering, Molecular Beam Epitaxy (MBE))

Unit 4 – Nanofabrication (12 Hrs.)

Photolithography and its Limitations; Electron Beam Lithography (EBL); Nanoimprint Lithography; Soft Lithography Patterning; Characterization Techniques: Field Emission Scanning Electron Microscopy (FESEM); Environmental Scanning Electron Microscopy (ESEM); High Resolution Transmission Electron Microscopy (HRTEM); Scanning Tunneling Microscopy (STM); Surface Enhanced Raman Spectroscopy (SERS); X-ray Photoelectron Spectroscopy (XPS); Auger Electron Spectroscopy (AES); Rutherford Backscattering Spectroscopy (RBS).

Unit 5 - Applications (12 Hrs.)

Solar Energy Conversion and Catalysis; Molecular and Printed Electronics; Nanoelectronics; Advanced Polymer Architectures; Liquid Crystalline Systems; Optical and Electro-Optical Properties; Applications in Displays and Devices; Data Storage; Photonics and Plasmonics; Chemical and Biosensors; Nanomedicine and Nanobiotechnology; Nanotoxicology Challenges

Reference Books:

1. Pradeep T ,A Textbook of Nanoscience and Nanotechnology,2012 Tata McGraw Hill Education Pvt. Ltd.
2. Hari Singh ,Nanostructured Materials and Nanotechnology, 2002 Nalwa,Academic Press.
3. Nabok A ,Organic and Inorganic Nanostructures, 2005 Artech House.
4. C.Dupas, P. Houdy, M. Lahmani, Nanoscience: Nanotechnologies and Nanophysics, 2007 Springer-Verlag, Berlin Heidelberg.
5. G.Hornyak, Louis, H.F Tibbals, Dutta, Joydeep, Fundamentals of Nanotechnology, 2009 CRC Press.

Websites and eLearning Sources:

1. https://www.youtube.com/watch?v=ebO38bbq0_4&list=PLbMVogVj5nJTdeiLvuGSB_AE8hloTAHWJ
2. <https://www.youtube.com/watch?v=qDnzI05vvSc&list=PLMlC7Vx5awsenMs5y02xcW6i5NmdEIRGx>
3. <https://www.youtube.com/watch?v=0EWCqCIsFOA>

COs and Bloom's Taxonomy Mapping – 26CH514

Course Outcomes	On completing P.G. program the students will be able to	BTL
CO1	Remember and define nanotechnology, their size and dimensional structure and their characteristic.	K1, K2,
CO2	Classify the different type of nanomaterial along with nanocomposite and biological nanomaterial materials.	K3
CO3	Synthesized variety of nanosized material utilizing different synthetic approaches.	K4
CO4	Fabricate and characterized nanomaterial utilizing different advance instrumentation technique.	K5
CO5	Development of various devices using nanomaterials such as solar cell, display devices, storage devices and nanomedicine.	K6

BTL K1 and K2 – remembering and understanding, K3- Applying, K4 – Analyse, K5- Evaluate and K6- Create

Relationship Matrix – 26CH514

Course Outcomes	Programme Outcomes (POs)						Programme Specific Outcomes (PSOs)					Mean Score of Cos
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	2	2	1	1	1	3	2	2	1	1	1.7
CO2	3	3	2	2	1	1	3	2	2	1	1	1.9
CO3	3	3	2	2	2	1	3	3	2	1	1	2.1
CO4	3	3	3	2	1	1	3	3	2	2	1	2.2
CO5	3	3	3	3	1	1	3	3	3	2	1	2.4
Total												2.0

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