

DEPARTMENT OF PHYSICS

FORMAT- OPEN ELECTIVE

NANO TECHNOLOGY AND ENGINEERING APPLICATIONS

MEC , ECE, EEE, 301

Credits:3

Instruction: 3 Periods&1 Tut/week

Sessional Marks: 40

End Exam : 3 Hours

End Exam Marks: 60

Prerequisites:

Engineering Physics, Applied Physics

Course Objective:

1. To introduce the concept of nanotechnology and understand the importance of nanotechnology.
2. To give deep insight to fabrication and characterization techniques for nanostructures.
3. To provide an overview about the wide applications of nanotechnology in various technological fields.

Course Outcomes:

By the end of the course, the student will be able to :	
1	Apply the basic concepts of nanotechnology and gain basic knowledge on various synthesis techniques involved in Nanotechnology
2	Understand the general types and different classes of Nanomaterials and their importance
3	Apply the knowledge on different properties of Nanomaterials and selection of material for the specific purpose of application
4	Understand and apply the knowledge of different characterization tools for the characterization of Nanomaterials
5	Apply the basic knowledge about the wide applications of nanotechnology in various technological fields.

Mapping of course outcomes with program outcomes:

		PO										PSO			
		1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO	1														
	2														
	3														
	4														
	5														

SYLLABUS

**UNIT – I:
Periods**

11

Introduction and synthesis of Nanomaterials:

Introduction to nanotechnology – definition, invention, building blocks of nanotechnology, chemical bonds - Van der Waals Interactions, Dipole-Dipole interactions, Microstructure and Defects in Nanocrystalline Materials – dislocations, twins, stacking points and voids; grain boundaries.

Synthesis of Nanomaterials: Bottom – Up Approaches: Physical Vapour Deposition (PVD), Chemical Vapour Deposition (CVD), spray pyrolysis. Top- Down Approaches: Mechanical alloying, High Pressure Torsion (HPT).

**UNIT – II:
Periods**

15

Different types of Nanomaterials:

Carbon Nanotubes (CNT): Introduction, classification of CNT'S, synthesis and physical properties of CNT (Electrical, Transport, Mechanical), applications.

Semiconductor Quantum dots: Introduction, synthesis of Quantum dots, physical and chemical properties, applications.

Nanocomposites: Introduction, synthesis and processing of Inorganic nanotubes and polymeric nanocomposites, applications.

Nanowires: Introduction, physical properties of nanowires – (structural, Optical,

Chemical), Applications.

**Unit – III:
Periods**

13

Properties of Nanomaterials:

Mechanical Properties: Introduction, Grain Size Effect, Creep, Hardness, Fracture Strength, Strengthening and Toughening Mechanisms, Crack Healing (Annealing Treatment).

Electrical and optical properties: Electrical conduction and tunnelling conduction in nano particles, electronic conduction with nano particles (AC Conductivity & DC Conductivity). Transmission, Absorption, Reflection in nano particles, optical constants (Absorption coefficient, extinction coefficient and Refractive index).

**UNIT – IV:
Periods**

10

Characterization Tools:

XRD (X-Ray diffraction), SAXS (Small Angle X-ray Emission Spectroscopy), SEM (Scanning Electron Microscopy), TEM (Transmission Electron Microscopy), STM (Scanning Tunnelling Microscopy), AFM (Atomic Force Microscopy).

**UNIT – V:
Periods**

15

Applications of Nanotechnology:

Electrical and electronic applications: MEMS (Micro Electro Mechanical Systems), NEMS (Nano Electro Mechanical Systems), Nanosensors.

Nanotechnology for Renewable Energy: Hydrogen energy, fuel cell technology, wind and solarenergy.

Nanotechnology for information technology and Data Storage applications.

Text books:

1. B S Murthy, P Shankar, Baldev Raj, B B Rath and James Murday *Textbook of Nano science and Nanotechnology*, University Press-IIM.
2. T. Pradeep, *Nano: The Essentials – Understanding Nano Science and Nano*

Technology, Tata McGraw Hill Education

3. A.K.Bandyopadhyay, *Nano Materials*, New Age International Publishers.

Reference Books:

1. Michael Kohfer and Wolkang Fritzsche *Nanotechnology - An Introduction to Nanostructuring Techniques*
2. M.H.Fulekar *Nanotechnology - Importance and applications*, I.K. International publishing house pvt.ltd.

Web Resources:

1. Springer Hand book of Nano Technology by B. Bhushan.