



## ANIL NEERUKONDA INSTITUTE OF TECHNOLOGY & SCIENCES

UGC Autonomous

(Affiliated to AU, Approved by AICTE & Accredited by NBA & NAAC with 'A' Grade)

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### Department of Physics

#### Open elective (Common to all Branches) – (R-19)

L-T-P-E-O-C

3-1-0-0-3

NANO TECHNOLOGY AND ENGINEERING APPLICATIONS	
All Branches	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 nano technology 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 and characterization techniques involved in Nanotechnology
2	Understand the general types and different classes of Nanomaterials
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 and characterization of Nanomaterials
5	Apply the basic knowledge about the wide applications of nanotechnology in various technological fields.

## SYLLABUS

### **Unit – I:**

**10 Periods**

#### **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, triple junctions and disclinations.

**Text Book: Nanotechnology - An Introduction to Nanostructuring Techniques** by *Michael Kohfer and Wolkang Fritzsche*

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).

**Text Book: B S Murthy, P Shankar, Baldev Raj, B B Rath and James Murday-Textbook of Nano science and Nanotechnology, University Press-IIM**

### **Unit – II:**

**14 Periods**

#### **Different types of Nanomaterials:**

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

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

**Text Book: Nano: The Essentials – Understanding Nano Science and Nano Technology** by **T . Pradeep**

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

**Text Book: Nano: The Essentials – Understanding Nano Science and Nano Technology** by **T . Pradeep**

**Nanowires:** Introduction, physical properties of nanowires – ( structural, Optical, Chemical), Applications.

**Text Book: Springer Hand book of Nano Technology** by **B. Bhushan**

**Unit – III:****12 Periods****Properties of Nanomaterials:**

**Mechanical Properties:** Introduction, Grain Size Effect, Creep, Hardness, Fracture Strength, Strengthening and Toughening Mechanisms, Crack Healing (Annealing Treatment). [From *Advanced nanomaterials* by Hofman, Powder Technology Laboratory, IMX, EPFL, Version 1 Sept 2009].

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

**Text Book:** Nano Materials by A.K.Bandyopadhyay, New Age International Publishers.

**Unit – IV:****10 Periods****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).

**Text Book:** Textbook of Nanoscience and Nanotechnology, B.S. Murthy, Universities Press-IIM, Metallurgy and Materials Science, 2013

**Unit – V:****14 Periods****Applications of Nanotechnology:**

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

**Text Books:** Springer Hand book of Nano Technology by B. Bhushan

**Nano: The Essentials – Understanding Nano Science and Nano Technology** by T . Pradeep

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

Nanotechnology for information technology and Data Storage applications.

**Text Book:** Springer Hand book of Nano Technology by B. Bhushan

*Nanotechnology - Importance and applications* by M.H.Fulekar. I.K. International publishing house pvt.ltd.