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## OPH151 -NANOMATERIALS FOR ENGINEERS

(Open Elective course for MECH & ECE)

### Course objectives:

This course inculcates the applications of Physics concepts in synthesising, characterizing, and understanding the properties of nanoscale materials.

### UNIT I      **Synthesis of nanomaterials**      **9**

Nanomaterials - surface effects of nanomaterials - Quantum confinement - Physical properties of nanomaterials - classification of nanomaterials - synthesis technique: top-down approach – ball milling – plasma arching technique - bottom-up approach: sol-gel technique. physical vapour deposition - sputtering, electrospinning deposition.

### UNIT II      **Core-shell nanoparticles**      **9**

Types: semiconductor core-shell nanoparticles, Metal-metal oxide core-shell nanoparticles, Polymer coated core-shell nanoparticles – Properties: electrochemical, optical properties – Applications: catalysis, sensing, magnetism of core-shell nanoparticles.

### UNIT III      **Carbon based nanomaterials**      **9**

Graphene - fullerene - Carbon nanotubes (CNT) – Fabrication of CNT: laser evaporation – structure of CNT – electrical properties - mechanical properties – physical properties – Application: Hydrogen storage for Fuel cell- Mechanical Reinforcement.

### UNIT IV      **Tools for nanomaterial characterization**      **9**

Structural: X-ray diffraction, Electron microscopy: transmission electron microscope, scanning tunnelling microscope. Optical: UV – visible absorption and photoluminescence techniques, - Surface analysis techniques: AFM.

### UNIT V      **Applications of nanomaterials**      **9**

Injection lasers - Quantum dot field effect transistors - quantum cascade lasers, Photonic structures - Electrochemical sensor - Optical memories – Microelectromechanical systems (MEMSs) - Nano electromechanical systems (NEMS).

**TOTAL: 45 PERIODS**

### COURSE OUTCOMES

Upon successful completion of course the students will be able to

CO1: classify the nanomaterials and explain the properties of nanomaterials and their preparation.

CO2: explain the properties and applications of core-shell nanoparticles.

CO3: explain the applications of carbon nanotubes.

CO4: identify the different characterization techniques for nano scale materials.

CO5: list the different applications of nanostructured materials.

**TEXT BOOKS:**

1. Robert W. Kelsall, Ian W. Hamley and Mark Geoghegan, 2005, *Nanoscale Science and Technology*, John Wiley, and Sons Ltd.
2. Charles P Poole and Frank J Owens, 2007, *Introduction to Nanotechnology*, Wiley India Pvt. Limited
3. T. Pradeep, 2007, *Nano: The essentials*, McGraw Hill India.

**REFERENCE BOOKS:**

1. E. L. Wolf, 2008, *Nanophysics and Nanotechnology an Introduction to Modern Concepts in Nanoscience*, Wiley.
2. Sulabha K. Kulkarni, 2014, *Nanotechnology: Principles and Practices*, Springer International Publishing.
3. Gabour L.Hornyak,H.F.Tibbals,n Joydeep, Dutta,John J.Moore, 2008, *Introduction to Nanoscience and Nanotechnology*, CRC press

**Web Reference:**

1. <https://nptel.ac.in/courses/118/104/118104008/>
2. <https://nptel.ac.in/courses/113/107/113107081/>
3. <https://www.sciencedirect.com/topics/chemistry/nanomaterial>