

Title	<b>Nanomaterials and Nanodevices</b>	Number	CYL7XX0
Department	Chemistry	L-T-P [C]	2-0-1 [3]
Offered for	MSc/PhD (CY) Program	Type	Elective
Prerequisite			

### Objectives

The Instructor will:

1. Underlying scientific basis for the behavior of nanomaterials
2. Methods of synthesis, fabrication and characterization of nanomaterials
3. Scope of nanomaterials and potential translation as products

### Learning Outcomes

The students are expected to have the ability to:

1. Able to describe the basic science behind the properties of materials at the nanometer scale
2. Learn principles behind advanced experimental techniques for studying nanomaterials
3. Systematically solve scientific problems related specifically to Nano technological materials

### Contents

*Concepts, Definitions and Examples:* Nanoscale processes, nanosystems, nanostructures, important nanomaterials such as clusters, nanocrystals, nanotubes and nanowires. (2 Lectures)

*Size-dependent properties:* Quantum confinement, Bandgap, Surface effects in nanosystems. Optical, mechanical, electronic and magnetic properties along with surface reactivity. (6 Lectures)

*Synthesis of nanomaterials:* Top-down and bottom-up, soft versus hard methods, chemical and physical methods, hybrid methods for synthesis of nanomaterials. (6 Lectures)

*Experimental methods for the study of nanomaterials:* Electron microscopes (SEM and TEM), scanning probe microscope (AFM and STM), X- ray photoelectron spectroscopy, BET surface area, electroanalytical techniques and miscellaneous methods (6 Lectures)

*Nanolithography for Nanodevices:* Concepts and methods; fabrication of devices, clean room practices, optical, electron, ion- beam lithography, soft lithography, micromolding, nanoimprint lithography. (6 Lectures)

*Applications:* Translating nanomaterials and nanodevices as commercial products. (4 lectures)

### Laboratory Experiments

Synthesis of metal nanoparticles, Particle size analysis by UV Visible spectroscopy, synthesis of semiconducting ZnO nanoparticles, quantum dots, optical band gap analysis by emission spectrum, SEM imaging, AFM analysis, patterning by Photo/Soft Lithography, graphene synthesis and surface property analysis

### Text Books

1. Pradeep, T., (2012), *Textbook of Nanoscience and Nanotechnology*, Mc Graw Hill
2. C. N. R. Rao, P. J. Thomas and G. U. Kulkarni (2007) *Nanocrystals: Synthesis, Properties and Applications*, Springer.

### Reference Books

1. Nalwa, H. S., (2004), *Encyclopedia of Nanoscience and Nanotechnology*, Edition American Scientific Publishers, Los Angeles
2. Rao, C.N.R. and Govindaraj, A., (2005), *Nanotubes and nanowires*, RSC Publishing
3. C. N. R. Rao, P. J. Thomas and G. U. Kulkarni (2007) *Nanocrystals: Synthesis, Properties and Applications*, Springer.

### Self Learning Material

1. Subramaniam, A., Balani, K. *Nanostructures and Nanomaterials: Characterization and Properties*, NPTEL Course Material, Department of Materials Science & Engineering, Indian Institute of Technology, Kanpur, <http://nptel.ac.in/courses/118104008/>;