Course code	Course Name	L-T-P-Credits	Year of Introduction
CH363	PRINCIPLES OF NANOMATERIALS AND NANOTECHNOLOGY	3-0-0-3	2016

Prerequisite : Nil

Course Objectives

- To introduce the fundamental principles of nanotechnology and nanomaterials
- To understand the various methods of characterization and synthesis of nanomaterials
- To know the applications of nanotechnology and nanomaterials.

Syllabus

Introduction to nanotechnology- Classification of nanomaterials - Supramolecular Chemistry- Types of Nanomachines and nanotechnology- Atomic structure molecules and phase Energy-Molecular and Atomic size-surfaces and dimensional space- Instrumentation for nanoscale characterization - Methods of Synthesis of Nanometerials - Biologically-Inspired Nanotechnology- Molecular nanoscale engineered devices, Kinetically confined synthesis of nano-particles.

Expected Outcomes

The students will be able to:

i. Identify different instruments for Nano scale characterization.
ii. Explain various methods of synthesis of Nano materials
iii. Summarize various applications of nanomaterials.
iv. List the important properties of nanostructured materials.
v. Outline various manufacturing techniques of Nano scale materials.

References:

1. Bhushan, Handbook of Nanotechnology, Springer–Springer,2007
2. Carl C. Koch. Noyes, Nano-structured materials: Processing, properties and Potential Applications, William Andrew Publishing New York.
3. Challa Kumar, Nanodevices for Life Sciences, Vol 4,WILEY-VCH, 2006
4. Challa Kumar, Nanomaterials for Cancer Diagnosis and Therapy, Vol 6 and 7, WILEY-VCH
5. Challa Kumar, Nanomaterials for Medical Diagnosis and Therapy, Vol 10, WILEY VCH
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7. Christof M. Niemeyer and Chad A. Mirkin, Nanobiotechnology: Concepts, Applications and Perspectives, Wiley-VCH; 1 edition, 2004
8. David S. Goodsell, Bionanotechnology, Lessons from Nature, Wiley-Liss, 2004.
9. Fujita H, Micromachines as Tools for Nanotechnology, Springer Verlag, 2003
10. Gero Decher and Joseph B. Schlenoff, Multilayer Thin Films, Wiley-VCH Verlag GmbH and Co. KGaA, 2003
11. Guozhong A.O, Nano structure and nano-materials, Imperial College Press, London
12. Hari Singh Nalwa, “Nanostructured Materials and Nanotechnology”, Academic Press, 2002
13. Jacob Israelachvil, Intermolecular and Surface Forces, Academic Press, London, 1992.
14. Jean-Marie Lehn, Supramolecular Chemistry, Wiley VCH, 1995
15. Jonathan Steed & Jerry Atwood, Supramolecular Chemistry, John Wiley & Sons, 2004
16. Kenneth J. Klabunde, Nanoscale Materials in Chemistry, John Wiley & Sons, Inc., 2001
17. Mark J. Schulz, Mannur J. Sundaresan, Ajit D. Kelkar, Nanoengineering of Structural, Functional and Smart Materials, CRC Press

18. Nicholas A.Kotov , Nanoparticles Assemblies and Superstructures, 2006, CRC Press.
19. Niemeyer C.M and Mirkin C.A, Nanobiotechnology Concepts, Applications and Perspectives 2004, Wiley VCH Verlag GMBH and Co.
20. Poole P, Jr and Frauk J. Owens, Introduction to Nano technology, Charles P, Wiley Interscience, New Jersey, 2003.
21. Pradeep.T, Nano: The Essentials, Tata McGraw-Hill Publishing Company Ltd, 2007.
22. Ralph et al, (Eds), Nanoscale Technology in Biological Systems, 2005, CRC Press.
23. Rao C.N.R., Muller A., Chutham A.K, The Chemistry of Nanoparticles Synthesis, Properties and Applications, Vol 1 and Vol 2, WILEY-VCH
24. William A. Goddard III, Donald W Brenner, Sergey E. Lyshevski, Gerald J. Iafrate, Handbook of Nanoscience, Engineering, and Technology, CRC Press Taylor and Francis Group, 2007

Module	Content	Hours	Sem. Exam Marks
I	Introduction to Nanotechnology, its emergence and challenges Classification of nano-materials: Zero, one, two and three dimensional nano-structured materials Supramolecular Chemistry: Definition and examples of the main intermolecular forces used in supramolecular chemistry. Self-assembly processes in organic systems. Main supramolecular structures. Types of Nanomachines and nanotechnology- Atomic structure of molecules and phase Energy-Molecular and Atomic size-surfaces and dimensional space-Top down and bottom up.	7	15%
II	Instrumentation for nanoscale characterization: Basic characterization techniques; Electron microscopy; Atomic force microscopy; Photon correlation spectroscopy The measurable properties and resolution limits of each technique, with an emphasis on measurements in the nanometer range. Methods of Synthesis of Nanomaterials: Bottom-up (building from molecular level) and top-down (breakdown of microcrystalline materials) approaches.	8	15%
FIRST INTERNAL EXAMINATION			
III	Biologically-Inspired Nanotechnology: basic biological concepts and principles that may lead to the development of technologies for nano engineering systems. Coverage will be given to how life has evolved sophisticatedly Molecular nanoscale engineered devices, and discuss how these nanoscale biotechnologies are far more elaborate in their functions than most products made by humans. Synthesis of nano-particles through homogenous and heterogeneous nucleation Kinetically confined synthesis of nano-particles: Synthesis of nano-wire, rod, tubes and thin films.	7	15%

IV	Special nano-materials: carbon, carbon fullerenes and carbon, nano-tubes, nano and microporous materials, core shell structure and nano-composites. Electrical, magnetic, optical, thermal and mechanical properties of nano-structured materials	7	15%
SECOND INTERNAL EXAMINATION			
V	Manufacturing of nanoscale materials: Chemical vapor deposition of carbon nano tubes, Plasma deposition of ultra-thin functional films on nano materials. Structural nano composites, carbon nano fiber and carbon nano tube/polymer composite fibers and films Nano scale intelligent materials	6	20%
VI	Applications: Solar energy conversion and catalysis, Molecular electronics and printed electronics Nanoelectronics, Polymers with a special architecture, Liquid crystalline systems, Linear and nonlinear optical and electro-optical properties, Applications in displays and other devices, Advanced organic materials for data storage, Photonics, Plasmonics, Chemical and biosensors, Nanomedicine and Nanobiotechnology.	7	20%
END SEMESTER EXAMINATION			

Question Paper Pattern:

Maximum Marks: 100 Exam Duration: 3 Hours

Part A: There shall be **Three questions** uniformly covering Modules 1 and 2, each carrying 15 marks, of which the student has to answer any **Two questions**. At the most 4 subdivisions can be there in each main question with a total of 15 marks for all the subdivisions put together. (2 x15= 30 Marks)

Part B: There shall be **Three questions** uniformly covering Module 3 and 4, each carrying 15 marks, of which the student has to answer any **Two questions**. At the most 4 subdivisions can be there in each main question with a total of 15 marks for all the subdivisions put together. (2 x15= 30 Marks)

Part C: There shall be **Three questions** uniformly covering Module 5 and 6, each carrying 20 marks, of which the student has to answer any **Two questions**. At the most 4 subdivisions can be there in each main question with a total of 20 marks for all the subdivisions put together. (2 x20= 40 Marks)