

ANDHRA UNIVERSITY
A.U. COLLEGE OF ENGINEERING
PRE-PHD COURSE WORK
APPLIED NANOTECHNOLOGY
Syllabus
for
Qualifying Examination for PhD Submission
for (Full time, Part time and Extra Mural) in
Center for Nanotechnology

APPLIED NANOTECHNOLOGY

Quantum mechanics, Quantum Confinement and Semiconductor Electronics: Introduction to Quantum mechanics and Quantum confinement and application with reference to Quantum wells, Quantum wires, Quantum dots, Nano clusters and Nano crystals, Fundamental Physics of semiconductor materials and its significance in Nanotechnology. Introduction to Physical, Chemical, Electrical, Mechanical & Functional properties of nanomaterials.

Introduction to Synthesis of Nanomaterials: Types and strategies for synthesis of nanomaterials depending on end applications.

Zero-Dimensional Nanostructures: Nanoparticles: Introduction, different strategies for synthesis of 0D nanomaterials and their technological applications.

One-Dimensional Nanostructures: Nanorods and Nanowires: Introduction, different strategies for synthesis of 1D nanomaterials and their technological applications.

Two-Dimensional Nanostructures: Thin Film: Introduction, different strategies for synthesis of 2D nanomaterials and their technological applications.

Three-Dimensional Nanostructures: Nanostructure assembly: Introduction, different strategies for synthesis of 3D nanomaterials and technological applications.

Special Nanomaterials and applications: Introduction, different strategies for synthesis of special nanomaterials (e.g. carbon, micro and mesoporous, zeolites, core-shell structures, hybrid nanomaterials etc. and their technological applications.

Applications of Nanotechnology in various fields:

- Renewable energy, solar energy, fuel cells etc.
- Materials manufacturing and automobile industry
- Biomedical science, medicine, diagnostics, etc.
- Computers, electronics and communication
- Analytical, Pharma and Environmental sciences
- Biosciences- (Nano Biosciences - Biotechnology)
- Sport sector, printing, optics
- Agriculture, food, textile, cosmetics
- Defense, Aerospace and Marine Nanotechnology
- MEMS, NEMS and structure nanotechnology.

Characterization and characterization techniques of nanomaterials : Introduction, structural characterization, X-ray diffraction (XRD-Powder/Single crystal), Small angle X-ray scattering (SAXS), scanning electron microscopy (SEM), transmission electron microscopy (TEM), energy dispersive X-ray analysis (EDAX), Low Energy Electron Diffraction (LEED), scanning probe microscopy (SPM) – principle of operation, instrumentation and probes, Atomic force microscopy (AFM), Optical spectroscopy, luminescence spectroscopy, UV-vis spectroscopy (liquid and solid state), UV Photo electron spectroscopy (UPS), Infrared spectroscopy, Raman spectroscopy, XPS, ESCA, Auger, Thermal Analysis Methods etc.

Fabrication of nanomaterials: Top Down Approach Grinding, Planetary milling and Comparison of particles, Bottom Up Approach, Wet Chemical Synthesis Methods, Microemulsion Approach, Colloidal Nanoparticles Production, Sol Gel Methods, Sonochemical Approach, Microwave and Atomization, Gas phase Production Methods : Chemical Vapour Depositions.

Functional coatings and thin films: Philosophy of functional surface engineering, general applications and requirements, Principles and design of optical coatings, Physics of the plasma state and plasma surface interactions, Surface engineering as part of a manufacturing process, Integrating coating systems into the design process, Coating, manufacturing processes; Electro deposition. Auto-catalytic deposition, Physical and chemical vapour deposition, Ion-beam techniques, plasma spray deposition, overview of synchrotron-radiation based techniques for thin films, Data interpretation and approaches to materials analysis, Coating systems for mechanical applications, Multilayered coating architectures, Applications of functional films in electronic, catalysis and biomedical applications.

Nanocomposites - design and synthesis: Introduction to Nanocomposites, Composite material, Mechanical properties of Nano composite material: stress - strain relationship, toughness, strength, plasticity. Synthesis methods for various nanocomposite materials: mechanical alloying, thermal spray synthesis etc. Nano composites for hard coatings; DLC coatings; Thin film nanocomposites; Modeling of nanocomposites.

Text books:

1. Charles P.Poole.Jr.& Frank J.ownes, Introduction to Nano technology - John wielly&sons Inc. Publishers -2006
2. Guozhong Cao, Nano structures and Nano materials: Synthesis, properties and applications - Imperial College press.
3. Kulkarni Sulabha K, Nanotechnology: Principles and Practices, Capital Publishing Company, 2007
4. Stuart M. Lindsay, Introduction to Nanoscience, Oxford University Press, 2009.
5. Robert Kelsall, Ian Hamley, Mark Geoghegan, Nanoscale Science and Technology, John Wiley & Sons, England 2005.
6. Gabor L. Hornyak , H.F. Tibbals , Joydeep Dutta , John J. Moore Introduction to Nanoscience and Nanotechnology CRC Press

7. Davies, J.H. 'The Physics of Low Dimensional Semiconductors: An Introduction', Cambridge University Press, 1998.
8. T. Pradeep , "NANO The Essential, understanding Nanoscience and Nanotechnology". Tata McGraw-Hill Publishing Company Limited, 2007.
9. C.N.R. Rao, A. Muller and A.K. Cheetham, The Chemistry of nanomaterials: Synthesis, Properties and Applications, Vol-I.
10. P.M. Ajayan, L.S. Schadler and P.V. Braun, Nanocomposite Science & Technology - Wiley-VCH GmbH Co.
11. Z.L. Wang, Characterization of nanostructured materials
12. B. Roszek , The Handbook of Nanotechnology – Wiley, 2005
13. Gabor L. Hornyak, Nano Thread, Inc., Golden, Colorado, USA; H.F. Tibbals, University of Texas Southwestern Medical Center, Dallas, USA; Joydeep Dutta, Asian Institute of Technology, Pathumthani, Thailand; John J. Moore, Colorado School of Mines, Golden, USA, "Introduction to Nanoscience and Nanotechnology".
14. Chatopadhyaya.K.K, and Banerjee A.N, Introduction to Nanoscience and Nanotechnology
15. Michael Wilson, Kamali Kannangara Geoff Smith, Michelle Simmons, Burkhard Raguse, NANOTECHNOLOGY Basic Science and EmergingTechnologies – CHAPMAN & HALL/CRC PRESS 2002.
16. Schmid et. Al. Nanotechnology - Spriger International edition
17. A.K.Bandhyopadhyay, Nanomaterials New Age International Pub. New Delhi
18. Fundamentals of Nanoelectronics by George W. Hanson (Perason education, New Delhi