

APPENDIX-A

PHY-AD01: ADD-ON DIPLOMA IN NANOTECHNOLOGY

Objective of the Course: To provide background, current status and applications of nanoscience and Nanotechnology to students of chemistry, biology, computer science and physics.

Eligibility: 10+2 in Science and Regular UG/PG/ Research students of Science/Engineering courses

Reservation: SC/ST/OBC as per university rules.

Duration: One Year part time, 80 hrs of teaching

Fee: Rs 2500/- (For regular students from University Departments), Rs 3000/- for others

Seats: Thirty

Examination: Examination will be conducted in theory and practical by the university. Theory paper will be of 100 marks and 3hrs duration consisting eight questions out of which candidates will be required to answer any five. Practical paper will be of six hours duration carrying 100 marks. Total marks of the examination will be 200.

In order to be eligible for the Certificate, candidate is required to score 50% of the total marks. Those who fail to get 50% marks will be required to reappear in the examination as and when conducted by the university.

SYLLABUS

Theory paper: BASICS OF NANOTECHNOLOGY AND ITS APPLICATIONS

Introduction and Definition of Nanotechnology (8 lectures): Introduction, Definition, Length scales, Importance of Nanoscale and Technology, History of Nanotechnology, Future of Nanotechnology: Nano Technology Revolution, Silicon based Technology, Benefits and challenges in Molecular manufacturing: The Molecular assembler concept, Controversies and confusions, Understanding advanced capabilities, Visions and Objective of Nanotechnology, Nanotechnology in Different Fields: Automobile, Electronics, Nanobiotechnology, Materials, Medicine, Dental care, Nanocomputers, Power storage, Nanotechnology products

Latest Developments in Nanotechnology(4 Lectures) Introduction, Current situation, Future Assumptions, Latest Developments, Nanocopters, Nanotubes, Biosensors, Nano structure fluid, Computers, Plastic electronics, Light emitting diodes, Solar cells, Other Developments

Research & Development in Nanotechnology (8 Lectures) , Introduction , Sensitive Areas Where R & D is Required, Why R & D is Required?, Nanotechnology and Future Perspectives, Current Perspectives, ResearchWork at a Glance, Nanopioneers, Convergence of Nanotechnology, Nanotechnology Globally: Introduction, Potential Through R & D, Timelines for Beginning of Industrial Commercialization, Areas of Investments in Different Aspects in Nanotechnology, Efforts of Western Countries, Nanotechnology in Asia, Nanotechnology in India Introduction,

Present Status, Basic Requirements in India, Research Areas in Nanotechnology, Promotion of Nanotechnology

Ethical Issues in Nanotechnology (4 Lectures) Introduction, Socio-economic Challenges, Ethical Issues in Nanotechnology: With Especial Reference to Nanomedicine, Nanomedicine Applied in Non-medical Contexts, Social Issues Relating to Nanomedicine. Social and Ethical Issues, Economic Impacts, Other Issues, Nanotechnology and Future Socio-economic Challenges

Scanning Probe Microscopy (4 Lectures) : Scanning Tunneling microscopy, Atomic force microscopy: Operation, topography, phase imaging, nanolithography. Characterisation and Particle size determination: X-ray diffraction, Transmission Electron Microscope

Basics of Nano Chemistry (4 Lectures) :Introduction, Self Assembly of Materials, SelfAssembly of Molecules, Directing SelfAssembly of Materials/ Molecules, Family of SelfAssembling Materials, Porous Solids, Bio-Mineralization, Samand Soft Lithography, Nanowires, Nanomachines,

Nano Particles (4 Lectures) :Introduction, Types of Nanoparticles, Pure Metal, Gold, Silicon, Silver, Cobalt, Metal Oxides, Silica, Zinc oxide, Iron oxide, Alumina, Titania, Techniques to Synthesize Nanoparticles, Characterization of Nanoparticles, Applications, Toxic effects of Nanomaterials, Significance of Nanoparticles

NANOTECHNOLOGY APPLICATIONS:

Applications in different areas (12 Lectures): Introduction, Nanotechnology in Industries, Nanotechnology in Computing, Quantum computing, Molecular computation, Nanotechnology in Electronics, Computational nanotechnology, Computational optoelectronics, Mechanical nanocomputers, Supercomputing systems, Nanotechnology in Health and Life Sciences, Nanotechnology in medicine, Drug delivery, Drug encapsulation, Tissue repair and implantation, Bioresorbable materials, Other application of nano technology in health and medicine, Nanotechnology in Smart Materials, Sensors, Smart instruments- atom computers, Nanotechnology in Defence, Nanotechnology in Optics, Optical industry, Metrology, Electronics, optoelectronics and ICT, Nanotechnology in Environment, Nanotechnology Products & Applications, Recent Applications of Nanotechnology - Sector Wise Classification

Experiments & Demonstrations (20 hrs) : STM, AFM , X-ray Diffraction, TEM

Select any one of unit from following (12 Lectures)

UNIT-A

Basics of Nano Physics :Introduction, Building Block for Nanodevices, Quantum Dots, Mesoscopic Superlattices, Super Conductivity at Nano Scale, Single Electron Tunneling, Application of Nanophysics

Nanomaterials: Top down and bottom up approaches, common growth methods. Properties of selected nanomaterials including carbon nanotubes

and other carbon based materials, metallic nanoclusters, Materials for advanced devices

Nano Magnetism :Introduction, Magnetic Order - Dimension Dependence, Anisotropy, Magnetoelectronics, Superparamagnetism, SpinWaves in Nanoelements, Quantum Phenomena in Magnetic Nano Clusters, Magneto-Optics, Magnetic Computer

UNIT-B

Nano Electronics: Introduction, Theory of Electron Scattering, Coulomb Blockade Effects, Quantum Communication/ Computing, Spintronics, Electronics Based on Carbon Nanotubes, Single Electron Device, Molecular Electronics

Nano Robotics: Introduction, Nanorobots and NEMS, Background, Sensors, Actuators, Artificial molecular machines, Biomotors, Other nanomachines, Propulsion, Control, Communication, Programming and coordination, Nanoassembly with the SPM, Background, TheAFMas a robot, Manipulation phenomena and protocols, Nanoparticle patterns, Linking and embedding, Summary and Outlook

UNIT-C

Nanoreactors: Alkali and Alkali earth elements, transition metal groups III-VII in the periodic table, Elements of the group VIII, Subgroups of copper and Zinc, subgroup of boron and Arsenic, Assemblies involving nanoparticles

Carbon Nanotubes : Introduction, Studies in Carbon Nanotubes, Chemistry of Carbon Nanotubes, Types of Carbon Nanotubes, Techniques to Synthesize Carbon Nanotubes, Functionalisation of Carbon Nanotubes, Characterisation of Carbon Nanotubes, Applications

Nano Composites : Introduction, Polymer as Matrix, Nylons, Polyolefins, Polystyrene, Epoxy resins, Nano Materials as a Filler, Nano fibre, Nano clay, Fabrication and Processing of Composites, Benefits to Ultimate Physical, Mechanical and Thermal Properties, Nanostructured Materials, Applications

UNIT-D

Basics of Nanobiology: Introduction, Nanobiology, Bionanotechnology, Molecular Nanotechnology, Benefits of Molecular Nanotechnology,

Nanobiology Today: Nano Dendrimers, Buckyball and Nanotube, Self Assembly, Molecular self assembly, Molecular self assembly in biology, Application of self assembly, Nanosomes, Quantum dots, Nanowire,

Nanomedicine: Introduction, Regenerative and Replacement Medicine, Nanorobots, Spirocyte, Excising out of the body, Nanorobots and immune system, Reading the nanorobots, Fear factor, Applications of nanorobots, Advantages of Nanomedicine, Biomimetic Robots,

Biomedical Applications of Nanobiology;Introduction. Nanopharmacology, Nanocapsule, Biosensor Chips, Medibots, Artificial Pancreas, Spinal Cord Treatment, Artificial Muscles

Practical: Experiments based on theory paper to determine particle size using X-ray diffraction, Study of nanomaterials using Scanning Tunneling Microscope, AFM, Interpretation of TEM, AFM results, Simulation and Visualization experiments in nanotechnology.

Reference Books:

1. Nanotechnology: A Gentle Introduction to the Next Big Idea by Mark Ratner and Daniel Ratner, 2002
2. There's Plenty of Room at the Bottom: An Invitation to Enter a New Field of Physics – Richard Feynman, Free on line book <http://www.zyvex.com/nanotech/feynman.html>
3. Nanophysics and Nanotechnology, E.L. Wolf, Wiley 2006
4. Nanotechnology in Biology and Medicine: Method, Devices and Applications by Tuan Vo Dinh, CRC Press 2007
5. The Chemistry of Nanomaterial: Synthesis, Properties & Applications, Vol I & II by CNR Rao, Springer 2006