

PUNJAB TECHNICAL UNIVERSITY, JALANDHAR
Study Scheme
M.Tech (Nanotechnology)

Schedule of Teaching			Schedule of Examination					
Lecture	Tutorials (per week)	Total		Time (Hrs.)	Theory Marks	Sessional Marks	Viva	Total
3	1	4	All theory subjects	3	100	50		150
			Project			50	50	100
			Seminar			100		100
			Dissertation				Satisfactory/not Satisfactory	

SEMESTER-I

NT-501	Fundamentals of Nanotechnology
NT-503	Nanosciences
NT-505	Nanostructures & Nanocharacterization Techniques
NT-507	Semiconductor Device Theory and Modelling
NT-	Elective- 1
NT-515	Lab-I

Elective-I

NT-509	Opto Electronics
NT-511	Molecular Electronics & Biomolecules
NT-513	Nanobiology & its Applications

NT- 501 Fundamentals of Nanotechnology

Introduction to Nanotechnology, definition, Broad perspective, Narrow perspective, cultural perspective, Knowing size, Understanding Nanotechnology, Nanotechnology and today's world

History of Nanotechnology: Introduction, History of Nanotechnology-by Chris Phoenix, contribution of different scientist in Nanotechnology: Richard Feynman, K.Eric Drexler, Gerd Binning and Heinrich Rohrer, Don Eigler and Erhard schweizer, Professor Richard Smalley, Prof Mauro Ferrari, Joseph Proust, History at a Glance, Different Timelines of Nanotechnology.

Future of Nanotechnology : Introduction, The Beginning of a Technological Revolution, Silicon Based Technology, benefits and Challenges of Molecular Manufacturing, The Molecular assembler concept, Controversies and confusions, Understanding advanced capabilities, visions and objective of Nanotechnology, Nanotechnology in different fields.: materials, electronics, nanobiotechnology, medicine, nanocomputer, storage devices, automobile,

Latest Development in Nanotechnology: 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: Introduction, Sensitive Areas Where R & D is Required?, Nanotechnology and Future Perspectives, Current Perspectives, Research Work at a Glance, Nano pioneers, Convergence of Nanotechnology.

Applications of Nanotechnology: Introduction ,Nanotechnology in industries , Nanotechnology in computing, Quantum computing, molecular computation, Nanotechnology in electronics, Computational nanotechnology ,Computational electronics, Mechanical nano computers, Supercomputing systems, Nanotechnology in health and life sciences, Nanotechnology in medicine: Drug delivery, Drug encapsulation, Tissue repair and implantation, Bioresorbable materials.

References:

1. Nanotechnology Research and Perspective by *Dr. Siddharth Vaidya, Pearl Books,2007*
2. John Teresko, *2005, The History of Nanotechnology*
3. Proceedings of NC of Nanotechnology held at BMSCE, Muktsar.

NT-503 Nanosciences

Building Block : Postulates of Dalton's Theory, Atomic Structure, properties of particle formation of nanoparticles and layers from atom, synthesis and assembly, characteristics of nanostructures.

Nano Particles: 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, application, toxic effects of nanomaterials, significance of nanoparticles

Basics of Nanochemistry: Introduction, self assembly of materials, self assembly of molecules, directing self assembly of materials/molecules, family of self assembling materials, porous solids, bio-mineralization, samand soft lithography, nanowires, nanomachines

Basics of Nano Physics: Introduction, building block for nanodevices, quantum dots, mesoscopic superlattices, super conductivity at nano scale, single electron tunneling, application of nanophysics

Nano Magnetism: Introduction, Magnetic Order – Dimension Dependence, Anisotropy, Magneto electronics, Super paramagnetism, Spin waves in Nanoelements, Quantum phenomenon in Magnetic Nanoclusters, Magneto-optics, Magnetic Computer, Conclusion

Basics of Nano Electronics: Band gap theory, theory of electron Scattering, MOS modeling, Spintronics, coulombs Blockade effect, quantum communication/ computing, electronics based on Carbon Nanotubes, Single electron device, Molecular electronics.

Basics of Biotechnology: Nanotech Interceptions in Life Sciences, Molecular Nanotechnology, Nano, Nanobiotechnology –general uses and effects, Nanobiotechnology and Gene Therapy, Nanobiotechnology and Convergences of Various Sciences, Implication of Nanobiotechnology,

Basics of Nanomedicine Introduction, Regenerative & Replacement Medicine, Nanorobots, Respirocyte, Excusing out of the body, Nanorobots & Immune system, Reading of Nanorobots, Fear Factor, Application of Nanorobots, Advantages of Nanomedicine, Biomimetic Robots

References:

1. Nano Physics by Hugh Watson, Anmol Publications New Delhi, ed-2006.
2. Nano- The Next Revolution, Mohan Sunder Rajan (NBTI)
3. Introduction To Nano Technology, Charles P. Pode (Springer)
4. Quantum Dot Heterostructures, D.Bimberg, M.Grundman,
5. A Student Handbook of Nanobiotechnology Vol. 1 by Don Norman , Dominant Publishers and Distributer, New Delhi, Ed. 2008.

NT-505 Nanostructures & Nanocharacterization Techniques

Introduction: Nanotechnology, Zero Dimensional nanostructures-Nanoparticles, One dimensional nanostructures-Nanowires and Nanorods, Two dimensional nanostructures: Films, Special nanomaterials

Nanofabrication: Nanostructures fabricated by Physical Techniques, Characterization and Properties, Applications of Nanostructures

Compositional Surface Analysis: Ultraviolet (UV) and X-ray photoelectron spectroscopy (XPS), Secondary ion mass spectrometry (SIMS), Contact angles

Microscopies: Optical microscopy, fluorescence & confocal microscopy, Cathode Luminescence (CL) and Photo Luminescence (PL), TEM, SEM.

Probe Techniques: Atomic force microscopy (AFM), scanning tunneling microscopy (STM), scanning near field optical microscopy (SNOM), Deep level transient spectroscopy (DLTS)

Kelvin-Probe Measurements: Nano scale current-voltage (I-V), capacitance-voltage (C-V) relationships

Synthesis: Nanoparticles, carbon nanotubes, Nano-phosphors, Nanocomposites, sensors (ceramics-Al₂O₃, TiO₂, MgO and BaTi)

Nanolithography: Serial and parallel mode resist exposure, lithographic pattern, photolithography-coating, exposing, developing, etching, stripping, photolithographic approaches- X-ray lithography, electron beam lithography

Dispersions and Coating: Technological impact, lift-off techniques-nanosphere lift-off lithography, single atom implantation, growth of semiconductor nanowhiskers, nano-engineering intercalation, intercalation applications.

References:

1. Nanotechnology: Nanostructures and Nanomaterials, *By M Balakrishna Rao and K. Krishna Reddy, Campus Books, New delhi, ed.-2007*
2. Nanostructures & Nano Materials: *Ghuzang Cao*
3. Nanostructures: *Tsakalagos, Ovidko & Vasudevan*
4. Physics of Amorphous Solids: *Richard Xylen*
5. Nanostructured Films & Coatings: *Gang Moog Chow*

NT-507 Semiconductor Device Theory and Modelling

Semiconductor Materials : p-n junction, space charge and electric field distribution at junctions, forward & reversed biased condition, minority & majority carrier currents, Zener and avalanche break downs, Schottky barrier, Shockley diode & silicon control rectifier, Zener diodes, tunnel diodes, photo diodes.

Two Port Network Analyses: H, Y & Z parameters, B T in CE configuration, Constants of CB & CE amplifier,

FETs: FET, MOSFET, Equivalent Circuit of FET. Source amplifier. Idea of transistor biasing and amplifiers, MOS Modeling

Spintronics: Spin injection, spin valve effect, spin valves and MRAM devices Solid state devices: quantum dots, quantum wires, microwave induced transport josephson junctions

Single Electron Transistor (SET): Limitations of MOSFET, theory of SET, operation of SET, electron Tunnel effect, coulomb staircase, Conductance as a function of gate voltage, applications of SET

Nanomanipulation and Etching: Nanomanipulating using STM & AFM, Nanomanipulation molecules using Photon Beams, Mechanical methods of Etching,-Fiber probe Fabrication, Pulling Methods, Selective Etching,

Chip Fabrication Techniques: Various Lithographic techniques- Photo lithography, electron beam lithography, X-ray lithography, soft lithography,

Storage Memory: Principle of operation of Nano storage, Magneto Resistance Storage, MEMS storage, Optical Storage, Holographic Storage, Molecular Switches, Atomic Storage,

References :

1. Nanotechnology in Electronics *M. Balakrishna Rao and K. Krishna Reddy, Campus Books, New Delhi, ed. 2007*
2. Nanostructures and Quantum Devices, *M. Balakrishna Rao and K. Krishna Reddy, Campus Books, New Delhi, ed. 2007*
3. Electronic Devices & Circuits, *Millman & Halkins*
4. Solid State Electronic Devices, *Ben G Streetman*
5. Microwave Principle, *W. Reich*
6. Electronics, *S. Bhadran*

NT-509 Opto Electronics

Applied Optics: Holography, Fourier-Transform Optics, Spatial Filtering, Speckle Interferometer, Birefringence, Electro-optics, Magneto-optics and Acousto-optics, Kerr Effect,

Optical Fiber Structures, Wave guiding and Fabrication: Fiber Optics, The optical fiber, comparison of optical fiber with other interconnections, concept of an optical waveguide, rays and modes, principle of light guidance in optical wave guides,

Optical Sources: Energy Bands, semiconductor Device Fabrications, Light Emitting Diodes, Laser Diodes, Light source linearity, Modal Partition and Reflection Noise,

Photo Detectors: Physical principles of photodiodes, photo detector noise, detector response time, avalanche multiplication noise, structures for InGaAs, APDs, comparisons of photo detectors

Optical Amplifiers: Basic applications and types of Optical Amplifiers, semiconductor optical Amplifiers, Erbium-doped fiber amplifier, amplifier noise, system application, Wave Length converters,

Measurements: Measurement standards and test procedures, test equipment, attenuation measurements, dispersion measurements, OTDR field applications, eye patterns, optical spectrum analyzer applications,

Application of fiber optics: nonlinear optics, nonlinear optical susceptibility, second and third order optical susceptibilities, harmonic generation, phase matching, optical mixing, parametric generation of light, self-focusing of light, optical bistability, optical phase conjugation.

References:

1. Optical Fiber Communication by Gerd Keiser McGraw Hill, Third Ed.
2. Optical Electronics, by A. Ghatak & K. Thyagarajan
3. Quantum Electronics, by A. Yariv
4. An Introduction to Optical Fibers by A.H. Cherin

NT-511 Molecular Electronics & Biomolecules

Organic Semiconductors: Organic molecules as switches, motor-molecules and biomimetic components, conducting polymers, light emitting polymers

The Self-Assembly of Complex Organic Molecules: Molecular connections and the integration of molecular components into functional devices, Contact issues

Structure of Biomolecules: Biotechnology, recombinant DNA technology, molecular biology Structural and functional principles of bionanomachines, Interfacing bio with non-bio materials, Porous silicon

References:

1. Molecular Electronics, by T. Helgaker
2. Semiconductor Quantum Dots, by Masumota Takaga

NT-513 Nanobiology & its Applications

Basics of Nanobiology: Introduction, Nanobiology, Bio-nanotechnology, Molecular Nanotechnology, benefits of Molecular Nanotechnology.

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

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

Reference:

1. Nanoscale Technology in Biological Systems by Cooper, Springer Verlag
2. A Student Book of Nanobiotechnology (Vol. I & II) by Don Norman, Dominant Publishers and Distributors, New Delhi, 2007.

NT-515 Lab -I

List of Experiments:

1. G.M. Tube Characteristics
2. Absorption Coefficient using GM counter
3. Design & Study of CE amplifier
4. Study of operational amplifier IC – 741
5. Study of Emitter follower
6. I/V characteristics of FET
7. I/V characteristics of MOSFET
8. Simulation of Digital Circuits using VHDL
9. Realization of the digital circuits using FPGA
10. Scanning Electron Microscopy (SEM)
11. Study of Scanning Tunneling Microscopy (STM)
12. Study of Atomic Force Microscopy (AFM)