

PUNJAB TECHNICAL UNIVERSITY, JALANDHAR
Study Scheme
M.Tech (Nanotechnology) Batch 2007 onwards

<u>Schedule of Teaching</u>			<u>Schedule of Examination</u>			
Lecture	Tutorials	Total	Time	Theory	Sessional Viva	Total
	(per week)		(Hrs.)	Marks	Marks	
3	1	4	3	100	50	150
					50	100
					100	100
					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

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

Schedule of Teaching

Lecture	Tutorials (per week)	Total
3	1	4

Schedule of Examination

Time (Hrs.)	Theory Marks	Sessional Marks	Viva	Total
3	100	50		150
		50	50	100
		100		100
			Satisfactory/ not Satisfactory	

Semester-II

NT-502	Nanomaterials
NT-504	Nanoprocessing and Fabrication
NT-506	Computational Methods
NT-508	Nanoelectronics
NT-	Elective 2
NT-516	Lab-II

Semester-III

NT-517	MEMS & NEMS
NT-519	Nanoenvironment & Ethical Issues
NT-521	Project
NT-522	Seminar

Semester-IV

NT-518	Dissertation
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Elective-II

NT-510	Nanoscale Technology in Biological Systems
NT-512	Nanomedicines

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 Binnig 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 Teresco, *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, Anistropy, 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, photo-lithography-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: Tsakalakos, 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)

NT-502 Nanomaterials

Nano Scale Carbon: Introduction to Nanoscale, one dimensional Nano Scale, two dimensional nanoscale, three dimensional nanoscale size dependent properties like-color, melting point, electrical conductivity, risk form molecular manufacturing, and applications of nanomaterials.

Carbon Nanostructures: Introduction to Carbon Nanostructure, Nanobelts & Nano Foams

Fullerenes: Buckyball definition, Buckminster fullerene, Nanotube synthesis

Carbon Nanotubes: introduction, studies in carbon nanotubes, chemistry of carbon nanotubes, types of carbon nanotubes, techniques to synthesize carbon nanotubes, fictionalization of carbon nanotubes, characterization of carbon nanotubes, applications.

Nanowires: Synthetic Approaches- template assisted Synthesis, Pressure Induction Technique, Electromechanical deposition Technique, vapour deposition of nanowires, Physical properties of nanowires and transport properties of nanowires. I-V Characteristics and Applications.

Quantum Dots (QD's): Shortcomings of traditional semiconductors, working of Quantum Dots, Quantum Band theory, Exciton, Exciton Bohr Radius, Quantum Confinement, quantum dot surfaces and couplings, quantum dot material and composites, QD's features- tune able absorption pattern, tune able emission pattern, molecular coupling, quantum yield, adding shells,

Nano Composite: Introduction, polymer as matrix, nylons, polyolefin, polystyrene, epoxy resins, nanomaterials as a filler, nanoclay; fabrication and processing of composites; benefits to ultimate physical, mechanical and thermal properties; nanostructured materials; applications.

References:

1. Nanotechnology:Nanostructures and Nanomaterials *M. Balakrishna Rao and K. Krishna Reddy, Campus Books, New Delhi, ed. 2007*
2. Nanostructures & Nano Materials, *Ghuzang Cao*
3. Hand Book of Nanomaterials Vol. I & II, *Zhong Lin Wang Springer*

NT-504 Nanoprocessing and Fabrication

Silicon processing methods: Cleaning / etching, oxidation-oxides, Guttering, doping, epitaxy.

Top-down techniques: Photolithography, other optical lithography's (EUV, X-ray, LIL), particle beam lithographies (e-beam, FIB, shadow mask evaporation), probe lithography's.

Processing of III-V semiconductors including nitrides: Molecular-beam epitaxy, chemical beam epitaxy, metal-organic CVD (MOCVD).

Bottom-up techniques: self-assembly, self-assembled monolayers, directed assembly, layer-by-layer assembly. Combinations of top-down and bottom-up techniques: current state of the art

Nanomedicine: Introduction, Nanotechnology & Nanomedicine, Medically used nanomaterials, Tagged Nanomaterials, Dendrimers, Smart Drugs, Nanopores & DNA sequencing, Devices used in Biotechnology, Nanorobots & medicine, Nanodevices at molecular level, nanotweezers, Nano computers, Diagnosis & treatment using Nanomedicine.

Nano Robotics: Introduction, Nanorobots & NEMS, Background Sensors, Actuators, Artificial molecular machines, Biomotors, other Nanomachines, Propulsion Control, Communication, Programming & Coordination, Nanoassembly with the SPM, Background, the AFM as a robot, Manipulation Phenomenon and protocols, Nanoparticle patterns, Linking & Embedding, Summary & Outlook.

Nanofactories Characterization of materials, techniques for fabrication-bottom-up manufacturing, chemical synthesis, self assembly, positional assembly, top-down manufacturing, precision engineering, lithography, top-down and bottom up techniques, future development, , environmental issues and resource management, National safety

Nanoproduction: Material Procesing, nanochip fabrication and integration, nanochip processing methods, characterization of structure and function, policies and measures, distribution of research potential, Industry focus and product variety, funding and profit

References:

1. Nanotechnology: Nanostructures and Nanomaterials, *By M Balakrishna Rao and K. Krishna Reddy, Campus Books, New Delhi, ed.-2007*
2. Nanotechnology: Research and Perspective *by Dr. Siddharth Vaidya, Pearl Book, New Delhi, 2007*

NT-506 Computational Methods

Differential equation: special functions Bessel's, Hermite's. Laguerre polynomials. Eigen value, Eigen functions. Perturbation theory. Numerical analysis. Idea of visual basic, c++ and c-sharp.

Numerical Solution of Partial Differential Equations Finite difference approximation to derivatives, Solution to Laplace's equation-Jacobi's method, Gauss-Siedel method, S.O.R method, Parabolic equation and their solution using iterative methods

Interpolation Method: Errors in polynomial interpretation, finite difference forward, backward and central difference, Difference of a polynomial, Newton's formulae for interpolation, central difference interpolation formulae, Interpolation with unevenly spaced points, Newton's general interpolation formula, interpolation by iteration

Scientific Modeling: Fundamental Principles of Numerical Methods, Numeric data and Numerical operations, Numerical Algorithms, Numerical Programs, Numerical Software, Approximations in Mathematical Model building, Interpolation, Numerical integration, Differentiation, Statistical Methods

Simulation Tools: Matlab, VLSI Design using VHDL, FPGA

References:

1. Mathematical Physics, *S.S. Rajput*
2. Visual Basic & C ++, *Shaum Series*
3. Numerical Computation : Methods, Software, and Analysis *by Christoph W. Ueberhuber*
4. Computer Oriented Numerical Methods-V.RajaRaman
5. Numerical Methods in Fortran -Mc Cromik and Salavadory
6. Elementary Numerical Analysis,S.D.Conte,&Cari De Boor.Mc Graw Hill.
7. Applied Numerical Methods,Cornahn B.,Et al,John Wiley

NT-508 Nanoelectronics

Technologies in Nanoelectronics: Fault Tolerant Techniques-Von Neumann's Multiplexing Techniques, N-tuple Modular Redundancy (NMR), Interwoven redundant logic and Quadded logic, Markov Chain Models,

Spintronics: Mechanism of Spintronics, Spin Waves & their advantages, Spin injection, spin valve effect, spin valves and MRAM devices Solid state devices: quantum dots, quantum wires, microwave induced transport Josephson junctions, Spintronics Devices-Datta Das spin transistor, Johnson spin Transistor, Spin Polarized Solar Battery, Magnetic Field Effect transistor, Spin based Quantum Computers.

Photonic Bandgap Materials: Nanoscale photonic devices, Special phenomena in 2D and 3D structures.

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

Nano chip Development & Quantum Computers: Nano Scale, working at nanoscale, physical and chemical properties changes at nanoscale, constructing electronic circuits from the top-down, constructing electronic circuits from the bottom-up, nanowafers level packaging program, Quantum Computers

Quantum Dots in Nano Electronics: Quantum phenomenon in nanostructures, quantum size effect,

Nanoelectronic Devices-Technology and Application: Single Electron Tunneling (SET) Devices, Nano Flash Devices, Nano Memory, Resonant Tunneling Diodes (RTDs), Rapid single Flux Quantum Logic(RSFQ), Resonant Tunneling Transistor (RTTs), Intermolecular Nanoelectronics, Electric Field Controlled Molecular Electronics Switching Devices, Spin Devices

Electronic Displays: LCD Displays, The basic properties of liquid crystals and their display and non-display applications at the nanoscale

References:

1. Nano Electronics and Information Technology: *Rainer Waser*
2. Nanotechnology in Electronics by *M Balakrishna Rao and K. Krishna Reddy*, Campus Books, New Delhi, ed.-2007
3. Nanostructure and Quantum Devices *By M Balakrishna Rao and K. Krishna Reddy*, Campus Books, New Delhi, ed.-2007
4. Introduction to Nanotechnology *By M Balakrishna Rao and K. Krishna Reddy*, Campus Books, New Delhi, ed.-2007

NT-516 Lab Practice - II

List of Experiments:

1. To grow single crystal of NaCl from solution and take its Laue photograph. Index the same photograph using Gnomonic projection.
2. To take Debye Scherrer pattern of a given poly-crystalline material and determination of third “d” values from powder lines.
3. Determination of energy gap of a semiconductor by four probe method.
4. Study of Hall effect in semiconductors:
 - a. Hall Voltage & Hall Coefficient,
 - b. Mobility of charge carriers and the carrier concentration.
5. To determine the response of silicon solar cells and the effect of prolonged irradiations, and to calculate the efficiency and fill factors of a variety of solar cells.
6. Study of ESR spectrum of a paramagnetic substance.
7. To determine
 - a. The velocity of ultrasonic waves in a liquid and,
 - b. The compressibility of the liquid.
8. Matlab Practical Applications

NT-517 MEMS & NEMS

Date Storage: Introduction to memories, DRAM, SRAM and their limitations, Problems in magnetic data storage, VLSI MEMS based storage devices, principles and operations, future development

Storage Memory in Nanotechnology: Principal of operation of Nano storage, Magneto Resistance Storage, MEMS storage, Optical Storage, Holographic Storage, Molecular Switches, Atomic Storage.

Effects of Nanotechnology on Storage Devices: Present Day Data Storage Technology, Future Data Storage Technology-Quantum Interference Spintronics

Design Issues for MEMS & NEMS: Introduction, Design Process, Design Tools, Design Procedure, Substrate Selection, Wafer pre cleaning for any oxides, Formation of required oxides, Spinning of Adhesive, Spinning of Photo resist, Prebaking Techniques, Masking of Pattern Using UV lights, Exposure to light to remove any solvent & check photo resist Uniformity, Development of resist, Post exposure & Post baking techniques, Etching of exposed oxide layers, stripping of Photo resist

Applications & Current Challenges of MEMS & NEMS: Applications of MEMS & NEMS in Biotechnology, Accelerometers, Communications, Medicines, Biology. Current challenges: Limited options, Packaging, Fabrication knowledge required.

References:

1. *Microsystems Design by S.D. Senturia*
2. *NEMS & Nanosystem Design by Tai-Ran Hsu*

NT-519 Nanoenvironment & Ethical Issues

Nano-environment: Use of Nanotechnology in Environment, Nanotechnology Products & Applications, Recent Application of Nanotechnology In environment, Sector wise classification of environment applications.

Nanoscience and Nanotechnologies: applications and development, nanotechnology as engineering and fabrication, top down and bottom up manufacturing, expectations for nanotechnology

Nanotechnology and Social Transformation: Natural resources, societal transformation and nanotechnology, transforming the present.

Environmental applications of Nanotechnology: Convergence of nanotechnology, environmental applications and implications, environmental benefits, environmental risk management, detection of nanomaterials in environment, human exposures and control

Educational implications of nanotechnology: Goals for social science research, social acceptance & implications, social, ethical and legal implications, Frontiers of nanotechnology, Challenges of Governance, R & D activities in nanotechnology.

Nanotechnology and Human Security: Recommended Social and ethical research areas, flavours of nanotechnology, cultural ecology of nanotechnology, Communication of nanotechnology, consequences of nanotechnology, security and nanotechnology.

Ethical Issues of Nanotechnology: Introduction, socio-economic challenges, ethical issues in Nanotechnology: with special reference to nanomedicine, Nanomedicine application in non-medical contexts, social issues relating to nanomedicine, Economic Impacts of Nanotechnology, Economic Impact of Nanotechnology-Implication for civil liberties and Enhancement applications

Safe Use of Nanotechnology: Safety in Nanotechnology, Safe Nanofactory design.

References:

1. *Nanotechnology and Society* by M. Balakrishna Rao, K. Krishna Reddy, Campus Books International 2007.
2. *Nanotechnology in Environment* by M. Balakrishna Rao, K. Krishna Reddy, Campus Books International 2007.
3. *Encyclopedia of Nanoscience Vol. I & II*, by S. K Prasad, Discovery Publishing House New Delhi, 2007

NT-510 Nanoscale Technology in Biological Systems

Biomaterials: Overview and Current Directions, Implantable Devices, Sensors for Measuring Ionic Flux in Live Cells, Synthesis in Cell Structures, Cellular Mechanotransduction Nanoarchitectures, Nanocomputing, Nanotechnologies and the DNA Structure ,Single-Molecule Optical Trap Studies and the Myosin Family of Motors

Biomaterialization: Physiochemical and Biological Processes in Nanotechnology Self-Assembling Toroidal Nanoparticles, Micro- and Nanoelectromechanical Systems in Medicine and Surgery ,Imaging Molecular and Cellular Processes in the Living Body, Tissue Engineering and Artificial Cells Artificial Organs and Stem Cell Biology Microbial Biofilms ,

Nanobiology in Cardiology and Cardiac Surgery: Translating Nanotechnology to Vascular Disease Nanotechnology and Cancer Nanotechnology in Organ Transplantation.

DNA Nano-Materials: Structure of Function of DNA, Nucleotide base Pairing, B-DNA, C-DNA, D-DNA and Z-DNA, PNA DNA Triplex, DNA Quadruplex and G Quartets, Branched DNA, De Novo Designed Junctions, Dimensional DNA Arrays, DNA computing

Self Assembly: Molecular synthesis of Self assembly, Principle of self assembly-STM molecular self assembly, natural templates or scaffolds, self assembly expectations, seizing opportunity.

References:

1. Nanoscale Technology in Biological Systems *by Cooper, Springer Verlag*
2. Development in Nanotechnology *By M Balakrishna Rao and K. Krishna Reddy, Campus Books, New Delhi, ed.-2007*
3. Nanotechnology in Health and Life Sciences *By M Balakrishna Rao and K. Krishna Reddy, Campus Books, New Delhi, ed.-2007*

NT-512 Nanomedicine

Introduction: Nanomedicine research, Analytical techniques and diagnostic tools, an Ideal Near-Patient diagnostic, Nanoimaging and Manipulation, Nanomaterials and Nanodevices, Drug Delivery and Pharmaceutical Development, Clinical Use, Regulatory and Toxicology Issues, Strategy of Research policy- funding mechanism, effective commercialization

Nanomedicine: Introduction, Nanotechnology & Nanomedicine, Medically used nanomaterials, Tagged Nanomaterials, Dendrimers, Smart Drugs, Nanopores & DNA sequencing, Devices used in Biotechnology, Nanorobots & medicine, Nanodevices at molecular level, nanotweezers, Nano computers, Diagnosis & treatment using Nanomedicine.

Applications of CNT in Healthcares: Introduction, Chemical Modification of Carbon Nanotubes, CNT based Tweezing & Medical Imaging, Carbon Nano Tubes in Healthcare especially for cancer treatment, Toxicity of Carbon Nano Tubes

References:

1. Non Viral Gene Therapy *by F. D. Ledley*
2. Gene Therapy for Cancer *by J. Baselga*