# M.Tech. (Nanoscience and Technology)
# Scheme of Evaluation and Syllabi
### (I to IV Semesters) w.e.f Session 2014-2015

| | Name of the Subject | Hours/ Week | | Internal Assessment Marks | Exam Marks | Total Marks |
|---|---|---|---|---|---|---|
| | | L | P | | | |
| **I Semester** | | | | | | |
| **MNST 101** | **Physics at Nanoscale** | **4** | **0** | **40** | **60** | **100** |
| **MNST 102** | **Biology for Nanotechnology** | **4** | **0** | **40** | **60** | **100** |
| **MNST 103** | **Nanochemistry** | **4** | **0** | **40** | **60** | **100** |
| **MNST 104** | **Nanomaterials Synthesis** | **4** | **0** | **40** | **60** | **100** |
| **MNST 105** | **Lab Work - I** | **0** | **15** | **40** | **60** | **100** |
| | | | | | | |
| **II Semester** | | | | | | |
| **MNST 201** | **Bionanotechnology** | **4** | **0** | **40** | **60** | **100** |
| **MNST 202** | **Fabrication Techniques for Nano Devices** | **4** | **0** | **40** | **60** | **100** |
| **MNST 203** | **Semiconductor Nanostructures & Nano-Particles** | **4** | **0** | **40** | **60** | **100** |
| **MNST 204** | **Characterization Techniques of Nanomaterials** | **4** | **0** | **40** | **60** | **100** |
| **MNST 205** | **Lab Work - II** | **0** | **15** | **40** | **60** | **100** |
| | | | | | | |
| **III Semester** | | | | | | |
| **MNST 301** | **Program Elective I*** | **4** | **0** | **40** | **60** | **100** |
| **MNST 302** | **Program Elective II*** | **4** | **0** | **40** | **60** | **100** |
| **MNST 303** | **Recent Trends in Nanotechnology**** | **4** | **0** | **100** | **0** | **100** |
| **MNST 304** | **Lab Work - III** | **0** | **15** | **40** | **60** | **100** |
| | | | | | | |
| **IV semester** | | | | | | |
| **MNST 401** | **Project Work – Report and Viva voce***** | **0** | **0** | **50** | **150** | **200** |

*For each of the Program Elective I and II student can opt for any one out of the following courses.

| | Program Elective I | Program Elective II |
|---|---|---|
| (i) | MEMS and NEMS | Nanoparticles & Microorganisms, Bionanocomposites |
| (ii) | Molecular Nano Electronics | Bionano Structures -Applications and Perspectives |
| (iii) | Nano Composites | Nanomedicine and Drug Delivery System |

**This paper is open – ended, where students make their choice on the contents. Internal evaluation will be on the basis of report and presentation.

***The Project is to be carried out for six months during Jan-June in an Industry or Institute of repute or in the Department labs. The students are required to submit a dissertation. Internal assessment of dissertation will be based on progress seminar(s). Evaluation will be done by examiners appointed by the PG Board of studies and will be based on the dissertation and Viva Voce.

In theory papers, the internal assessment will be based on two class tests, one assignment and attendance in the class. Where two teachers are teaching a paper, average of the tests and assignments will be considered. The test and assignment will be of 30 and 5 marks respectively.

# MNST 101 - Physics at Nanoscale

*Note: Eight Questions will be set from entire paper and students are required to attempt any five. All questions will carry equal marks.*

*Time: 3 Hours* *Maximum Marks: 60*

*Internal Assessment: 40*

**Introduction to Quantum Mechanics:** Schrodinger equation and expectation values, Solution of the Schrodinger equation for free particle, particle in a box, particle in a finite well, Reflection and transmission by a potential step and by a rectangular barrier.

**Angular momentum** and its operators, Eigen values and Eigen functions of the angular momentum operators, spin, Pauli spin operators and their properties, density of states, free electron theory of metals.

**Electronic Properties:** Free electron theory of metals, Band theory of solids, Bloch Theorem, Kroning-Penney model, Metals and Insulators, Semiconductors: Classification, Transport properties, Size and Dimensionality effects, Band structures, Brillouin zones, Mobility, Resistivity, Relaxation time, Recombination centers, Hall effect.

**Confinement and Transport in nanostructures**: Current, Reservoirs and Electron Channels, Conductance formula for nanostructures, Quantized conductance, Local density of states, Ballistic transport, Coulomb blockade, Diffusive transport.

**Optical Properties:** Optical Properties, Photoconductivity, Optical absorption & transmission, Photoluminescence, Fluorescence, Phosphorescence, Electroluminescence, Thermoluminescence.

**Magnetic Properties:** Basic Magnetic Phenomena, Diamagnetism, Paramagnetism, Superparamagnetism, Ferromagnetism, Ferrimagnetism, Anti-ferromagnetism, Some examples of these materials and their applications, RKKY Interactions, Ferrofluids.

A brief account on Structural and Mechanical Properties at Nanoscale.

**References**:


1. Quantum Mechanics: Theory and Applications , Ghatak & Loknathan
2. Quantum wells, Wires & Dots: Theoretical & Computational Physics of Semiconductors Nanostructures, Paul Harrison
3. Principles of Quantum Mechanics, R. Shankar , 2nd ed.
4. Modern Quantum Mechanics , Sakurai, J.J. & Jim Napolitano (2011).
5. Statistical Mechanics, Pathria, R.K. & P.D. Beale (2011), Reprint Elsevier.

# MNST 102 - Biology for Nanotechnology

*Note: Eight Questions will be set from entire paper and students are required to attempt any five. All questions will carry equal marks.*

*Time:3Hours* *Maximum Marks: 60*

*Internal Assessment: 40*

**Structure and organization of prokaryotic and eukaryotic cell** (Animal cell, plant cell & Microbial cell), tissues and organs, Stem Cell Culture, Artificial organ synthesis, Different forms of microorganisms, Applications of Microorganisms in Agriculture and industry.

**Introduction Gene - protein-Central dogma of cell-molecular targets** - Estimation of RNA, DNA, Protein Estimation, SDS – PAGE.

**Recombinant DNA technology:** Scope and Milestones in Genetic Engineering, Molecular tools used in Genetic Engineering, Gene cloning , Ethical issues – Merits and Demerits of cloning, Transgenic organisms, Genomics and Functional Genomics, Whole genome analysis, Human Genome Project, Gene therapy, Gene delivery.

**Basic Immunology and Immune system:** Antigen & Antigencity, antibody structure and its types, Immunity, Adjuvants, Complement system, MHC & graft transplantation and graft rejection.

**Biosynthesis of Nanoparticles:** Biological synthesis of Nanoparticles, Biomineralization, Magnetosomes, DNA based Nano structures, Protein based Nano structures, Bacteriorhodopsin.

**Biofertilisers:** Biopesticides, Nanopesticide Capsules and Nanoparticles in Remediadation.

**References**:


1. Biotechnology, B.D Singh, Kalyani Publication
2. Biotechnology and Genomics, P.K Gupta (2004), Rastogi Publications.
3. Immunology, Janis Kuby (1997), 3rd Edition,W.H Freeman & Co, Newyork.
4. Cell Biology, Thomas D. Pollard, William C. Earnshaw, Jennifer Lippincott-Schwartz.
5. Immunology- An introduction, Tizard I.R. (2013), 5th Edition, Philadelphia Saunders College press.
6. Encyclopedia of Nanotechnology, Bhushan, Bharat (Ed.) (2012), Springer.
7. The Handbook of Nanomedicine, Jain, K. K. (2012), Springer.

# MNST 103 - Nanochemistry

*Note: Eight Questions will be set from entire paper and students are required to attempt any five. All questions will carry equal marks.*

*Time: 3 Hours* *Maximum Marks: 60*

*Internal Assessment: 40*

**Chemical Bonding**: Atomic Bonding, Types of Bond: Metallic, Ionic, Covalent and Vander Waals bond.

**Physical Chemistry of Solid Surfaces**: Surface Energy, Chemical Potential as a function of Curvature, Electrostatic Stabilization, Surface Charge Density, Electric Potential at the proximity at solid surface, Vander Waals attraction potential, DLVO theory, Steric Stabilization.

**Materials Structure** : Space lattice and unit cells, crystal system, Symmetry operation, Structures of common metallic, Semiconductor ceramic and superconductor materials, Miller Indices, Representation of Directions and planes, Packing fractions, Structure determination using X-ray diffraction, silicates and clay structures, glass transition temperature, non-crystalline materials, Imperfections.

**Phase Diagrams And Phase Transformation:** Definition of diffusivity, concept of activation energy, Fick's Law of diffusion, Diffusion mechanism and their applications diffusion process, Solid solution, Intermediate phases and inter metallic compounds, Phase, phase rule, unary, binary phase diagrams, microstructure changes during cooling, lever rule, invariant reactions, Nucleation and growth of phases, heat treatment processes

**Nanoparticles in Science and Technology:** Catalysis on Nanoparticles, Oxide Reactions, Nanochemistry in Biology and Medicine.

**References:**


1. Nanostructures and Nanomaterials: Synthesis, Properties, and Applications by Guozhong Cao, Ying Wang.
2. Material Science and Engineering by William D. Callister.
3. Nanochemistry, S.B. Sergeev, Elsevier.

# MNST 104 - Nanomaterials Synthesis

*Note: Eight Questions will be set from entire paper and students are required to attempt any five. All questions will carry equal marks.*

*Time: 3 Hours* *Maximum Marks: 60*

*Internal Assessment: 40*

**Introduction to Nanomaterials:** Bottom up and Top Down approach, Properties of Nanomaterials, Zero dimension, one dimension and two dimensional nanostructures, Smart materials.

**Physical Methods:** Inert gas condensation, Arc discharge, RF-plasma, Plasma arc technique, Ion sputtering, Laser ablation, Laser pyrolysis, Ball Milling, Molecular beam epitaxy, Chemical vapor deposition method and other variants, Electrodeposition.

**Chemical Methods:** Metal nanocrystals by reduction, Solvothermal synthesis, Photochemical synthesis, Electrochemical synthesis, Nanocrystals of semiconductors and other materials by arrested precipitation, Thermolysis routes, Sonochemical routes, Liquid-liquid interface, Hybrid methods, Solvated metal atom dispersion, Post-synthetic size-selective processing. Sol-gel, Micelles and microemulsions, Cluster compounds.

**Biological Methods of Synthesis:** Use of bacteria, fungi, Actinomycetes for nanoparticle synthesis, Magnetotactic bacteria for natural synthesis of magnetic nanoparticles, Mechanism of formation,Viruses as components for the formation of nanostructured materials, Synthesis process and application, Role of plants in nanoparticle synthesis

**Carbon Allotropes:** Fullerenes, Carbon Nanotubes, Types of Carbon Nanotubes, Functionalization of Carbon nanotubes, Properties and Synthesis of Carbon nanotubes.

**Thin Films:** Electro plating, Electroless plating, Langmuir-Blodget films, Thermal growth, Chemical vapor deposition, sputtering deposition, molecular beam epitaxy atomistic nucleation process, cluster coalescence and deposition, grain structure of films and coatings, amorphous thin films.

**References**:


1. The Material Science of Thin Films, M. Ohring
2. The Chemistry of Nanomaterials: Synthesis, Properties and Applications. C. N. R. Rao, A. Muller, A. K. Cheetham

# MNST 201 - Bionanotechnology

*Note: Eight Questions will be set from entire paper and students are required to attempt any five. All questions will carry equal marks.*

*Time: 3 Hours* *Maximum Marks: 60*

*Internal Assessment: 40*

**Bionanotechnology :** An Overview: What can engineers learn from biology? From biotechnology to Bionanotechnology, Bionanomachines in action. Molecular recognition: How molecular recognition underlies cellular communication, material transfer into and within cells, and biotransformations. Information: How information is stored in the cell and how it is read?

**Biophysics:** Bioelectromagnetism, bioenergetics, biomechanics, Neuro transport, Biological Rhythyms.

**Modern Biomaterials:** Proteins, Nucleic acids, Lipids, Polysaccharides.

**Biomolecular Design and Biotechnology:** Molecular Modeling and Biomolecular structure determination.

**Structural Principles of Bionanotechnology:** Natural Bionano-machinery, Hierarchical strategy, raw materials, Protein folding, self-assembly and self- organization, molecular recognition and flexibility.

**Functional Principles of Bionanotechnology:** Information driven Nano assembly, Energetics, chemical transformation, regulation, Biomolecular motors, Biomolecular sensing, self replication and machine - phase Bionanotechnology.

**Bionanotechnology Today and Future:** Basic capabilities, Nanomedicine today, DNA computers, hybrid materials, artificial life and biosensors.

**References**:


1. The Handbook of Nanomedicine , Jain, K. K. (2012),Springer
2. Encyclopedia of Nanotechnology ,Bhushan Bharat (Ed.) (2012),Springer.
3. Bio-Nanotechnology- Concepts and Applications , Sharon, M. & Sharon, M (2012), CRC Press.
4. Bionanotechnology- Lessons from Nature ,Goodsell, David S. 2004, John Wiley & Sons INC., Publication.
5. Nanobiotechnology- Concepts, Applications and Perspectives Niemeyer C.M. & Mirkin, C.A. 2004,Wiley-VCH Verlag.
6. Nano Science and Technology Series, Avouris, P., Klitzing, K. Von, Sakaki H. &Wiesendanger, R. 2003,Springer.
7. Biophysics, Pattabhi, V & Gautham, N. 2002, Narosa Publications.

# MNST 202 – Fabrication Techniques for Nano Devices

*Note: Eight Questions will be set from entire paper and students are required to attempt any five. All questions will carry equal marks.*

*Time: 3 Hours* *Maximum Marks: 60*

*Internal Assessment: 40*

**Device Fabrication:** Clean Room Technology, Semiconductor crystal growth techniques (Czochralski, Bridgman, Float Zone), Substrate Cleaning Processes, Oxidation of Silicon, Dopant and dopant sources

**Photolithography and patterning:** Negative Photoresist, Positive Photo Resist, Resist exposure, development and application, Dry, wet, chemical and plasma etching, Lift-off process.

**Lithographic Techniques :** AFM based nanolithography and nanomanipulation, E beam lithography and SEM based nanolithography and nanomanipulation, Ion beam lithography, oxidation and metallization, Mask and its application, Deep UV lithography, X-ray based lithography.

**Sensors and Actuators:** Micro and Nano-sensors, Fundamentals of sensors, micro fluidics

**Packaging:** Packaging and characterization of sensors, Method of packaging at zero level, die level and first level.

**Nano systems:** Sensors for aerospace and defense: Accelerometer, Pressure Sensor, Night Vision System, Nano tweezers, nano-cutting tools, Integration of sensor with actuators and electronic circuitry

**Devices:** Metal Insulator Semiconductor devices, classical MOSFET (fabrication and working), Schottky devices.

**References**:


1. Science and Engineering of Microelectronic Fabrication by Stephen A. Campbell.
2. Sensors: Micro & Nanosensors, Sensor Market trends (Part 1&2) by H. Meixner.
3. Nanotechnology and Nanoelectronics – Materials, Devices and Measurement Techniques, W.R.Fahrner, Springer, 2006
4. Physics of Semiconductor Devices by S M Sze and Kwok Ng. Wiley India Pvt Ltd.

# MNST 203 - Semiconductor Nanostructures & Nano-Particles

*Note: Eight Questions will be set from entire paper and students are required to attempt any five. All questions will carry equal marks.*

*Time: 3 Hours* *Maximum Marks: 60*

*Internal Assessment: 40*

**Nanotubes and Nanowires:**

Two dimensional systems: band engineering, doping modulation, Less than two dimensional systems: mesoscopic systems.

**Quantum Dots**

Nanoscale Materials and Quantum Mechanics, Nanoscale Materials as Intermediate Between Atomic and Bulk Matter , From Atoms to Molecules and Quantum Dots Shrinking Bulk Material to a Quantum Dot, One-Dimensional Systems (Quantum Wires),Zero-Dimensional Systems (Quantum Dots), Energy Levels of a (Semiconductor) Quantum Dot ,Varieties of Quantum Dots: Lithographically Defined Quantum Dots, Epitaxially Self-Assembled Quantum Dots, Colloidal Quantum Dots, Optical Properties of Quantum Dots : Metal Nanoparticles

**Semiconductor nanoparticles Synthesis**

Cluster compounds, quantum-dots from MBE and CVD, wet chemical methods, reverse micelles, electro-deposition, pyrolytic synthesis, self-assembly strategies.

**Semiconductor Nanowires**

Fabrication strategies, quantum conductance effects in semiconductor nanowires, porous Silicon, nanobelts, nanoribbons, nanosprings.

**References:**


1. Nanoparticles: From Theory to Application Edited by Gunter Schmid
2. The physics of low-dimensional semiconductors, by John H. Davies
3. Quantum Transport: Atom to Transistor, by S. Datta
4. Transport in nanostructures, by D. K. Ferry and S. M. Goodnick

# MNST 204 - Characterization Techniques of Nanomaterials

*Note: Eight Questions will be set from entire paper and students are required to attempt any five. All questions will carry equal marks.*

*Time: 3 Hours* *Maximum Marks: 60*

*Internal Assessment: 40*

**Microscopy Techniques:** Optical Microscopy, Fluorescence Microscopy, Scanning Electron Microscopy, Transmission Electron Microscopy, Electron Energy Loss Spectroscopy, Auger and XPS Microscopy.

**Scanning Probe Microscopy**: Atomic Force Microscopy, Scanning Tunneling Microscopy, Scanning Near Field Optical Microscopy, Laser Confocal Microscopy

**Spectroscopic Techniques:** Electromagnetic spectrum, UV-Visible Spectroscopy, Photo-luminescence spectroscopy, Infra-red spectroscopy, Photo Correlation Spectroscopy, Raman Spectroscopy, NMR spectroscopy, Electron Spin Resonance, Mass Spectroscopy.

**Thermal Analysis:** Differential Scanning Calorimetry, Thermogravimetric Analysis, Thermomechanical analysis

**X-Ray analysis:** Principle and Application of X-Ray diffraction, X-ray Fluorescence Spectroscopy and X-ray Absorption fine Structure.

**Advanced Techniques:** Low energy electron diffraction, Electron Scattering for Chemical Analysis, Nanoindentation, Neutron Scattering, Rutherford Scattering, Circular Dichroism.

**References**:


1. Instrumental Methods of Analysis, Willard
2. Nanotechnology: Basic Science and Emerging Technology by Mick Wilson.
3. Instrumental Methods of Chemical Analysis, Ewing.
4. NanoScience and Technology Series. Scanning Probe Microscopy- Analytical Methods by Avouris, P., Klitzing, K. Von, Sakaki, H. &Wiesendanger,R.
5. Nano: The Essentials by T Pradeep.

# MNST 301 (i) - Program Elective I

## MEMS and NEMS

*Note: Eight Questions will be set from entire paper and students are required to attempt any five. All questions will carry equal marks.*

*Time: 3 Hours* *Maximum Marks: 60*

*Internal Assessment: 40*

MEMS and NEMS basics, Limitations of Silicon device Fabrication, basic microfabrication techniques, MEMS fabrication techniques, Nanofabrication Techniques, Material aspects of MEMS and NEMS ( Si, Ge, Metals, Harsh-environment semiconductors, GaAs, InP and related III-V materials, Ferroelectric materials)

MEMS and NEMS devices and applications, Carbon Nanotube sensor concepts-design considerations, fabrication of the CNT sensors and state of art applications.
Biosensors: Clinical Diagnostics, Classification of biosensors, immobilization characteristics applications, conducting Polymer based sensor, DNA Biosensors, optical sensors, Biochips.

Nanomechanical cantilever Array Sensors: Technique, modes of operation, microfabrication, measurement setup, functionalization techniques, application.
Therapeutic Nanodevices: Definition, approaches for Nanotherapeutic device components, technological and biological opportunities, application of therapeutic devices.

Microfluidic and their applications to lab-on-chip: Materials for microfludic devices and micro/nano fabrication techniques, active microfluidic devices, smart passive microfluidic devices, Lab-on-chip for biochemical analysis.
Failure mechanism of MEMS/NEMS devices: failure modes and failure mechanisms, stiction and charge related failure mechanisms, creep, fatigue, wear and packaging related failures.

**References:**


1. Springer Handbook of Nanotechnology by Bhushan 2nd Edition.
2. Microfluidic Diagnostics: Methods and Protocols, Jenkins, Gareth, Mansfield, Colin D. (Eds.) (2013), Springer.
3. Nano-Bio Probe Design and Its Application for Biochemical Analysis,Ye Bang-Ce, Zhang, Min, Yin, Bin-Cheng (2012),Springer.
4. Nano-Bio-Sensing,Carrara, Sandro (Ed.) (2011), Springer.

# MNST 301 (ii) - Program Elective I

## Molecular Nano Electronics

*Note: Eight Questions will be set from entire paper and students are required to attempt any five. All questions will carry equal marks.*

*Time: 3 Hours* *Maximum Marks: 60*

*Internal Assessment: 40*

**Introduction** Recent past, the present and its challenges, Future, Overview of basic Nanoelectronics.

**Molecular Electronics Components** Characterization of switches and complex molecular devices, polyphenylene based Molecular rectifying diode switches.
Technologies, Single Electron Devices, Quantum Mechanical Tunnel Devices, Quantum Dots & Quantum wires

**Nanoelectronic & Nanocomputer architectures and nanotechnology** Introduction to nanoelectronic and nanocomputers, Quantum DOT cellular Automata (QCA), Single electron circuits, molecular circuits Nanocomputer Architecture.

**Spintronics**
Introduction, Overview, History & Background, Generation of Spin Polarization Theories of spin Injection, spin relaxation and spin dephasing, Spintronic devices and applications, spin filters, spin diodes, spin transistors.

**References**:


1. Nanoelectronics & Nanosystems: From Transistor to Molecular & Quantum Devices: Karl Goser, Jan Dienstuhl and others.
2. Concepts in Spintronics – Sadamichi Maekawa
3. Spin Electronics – David Awschalom
4. From Atom to Transistor-Supriyo Datta

# MNST 301 (iii) - Program Elective I

## Nano Composites

*Note: Eight Questions will be set from entire paper and students are required to attempt any five. All questions will carry equal marks.*

*Time: 3 Hours* *Maximum Marks: 60*

*Internal Assessment: 40*

**Metal based Nano composites** Metal-Oxide or Metal-Ceramic composites, Silicides, Different aspects of their preparation techniques and their final properties and functionality, Metal-metal nanocomposites, some simple preparation techniques and their new electrical and magnetic properties.

**Design of Super hard materials** Super hard Nano composites, its designing and improvements of mechanical properties.

**New kind of Nano composites** Fractal based glass-metal Nano composites, its designing and fractal dimension analysis, Electrical property of fractal based Nano composites, Core-Shell structured Nano composites.

**Polymer based Nano composites** Preparation and characterization of diblock Copolymer based nanocomposites, Polymer-carbon Nanotubes based composites, their mechanical properties, and industrial possibilities.

**References**:


1. Nano composites Science and Technology - P. M. Ajayan, L.S. Schadler, P. V. Braun.
2. Physical Properties of Carbon Nanotubes- R. Saito
3. Carbon Nanotubes , M. Endo, S. Iijima, M.S. Dresselhaus, Pergamon,1996.

# MNST 302 (i) - Program Elective II

## Nanoparticles & Microorganisms, Bionanocomposites

*Note: Eight Questions will be set from entire paper and students are required to attempt any five. All questions will carry equal marks.*

*Time: 3 Hours* *Maximum Marks: 60*

*Internal Assessment: 40*

**Microorganisms for synthesis of nanomaterials and for toxicity detection:** Natural and artificial synthesis of nanoparticles in microorganisms, Use of microorganisms for nanostructure formation, Testing of environmental toxic effect of nanoparticles using Microorganisms.

**Nanocomposite biomaterials, teeth and bone substitution:** Natural nanocomposite systems as spider silk, bones, shells, organic-inorganic nanocomposite formation through self-assembly, Biomimetic synthesis of nanocomposite material, Use of synthetic nanocomposites for bone, teeth replacement.

**Nanobio Systems:** Nanoparticle-biomaterial hybrid systems for bioelectronic devices, Bioelectronic systems based on nanoparticle-enzyme hybrids, nanoparticle based bioelectronic biorecognition events, Biomaterial based metallic nanowires, networks and circuitry, DNA as functional template for nanocircuitry, Protein based nanocircuitry, Neurons for network formation.DNA based nanomechanical devices, Biosensor and Biochips.

**Diagnostics using nanomaterial, Nanoparticles for bioanalytical applications:** Nanodevices for sensing and therapy, Use of nanoparticles for MRI, X Ray, Ultrasonography, Gamma ray imaging, Nanoparticles as molecular labels, biological labeling using quantum dots as molecular labels

**Tissue Engineering:**

Major physiologic systems of current interest to biomedical engineers: cardiovascular, endocrine, nervous, visual, auditory, gastrointestinal, and respiratory, Useful definitions, the status of tissue engineering of specific organs, including bone marrow, skeletal muscle and cartilage, Cell biological fundamentals of tissue engineering.

## **References**:


1. Molecular Biology of the Gene, Watson, James, T.Baker, S.Bell, A.Gann, M.Levine, and R. Losick, 5th ed, San Francisco: Addison-Wesley, 2000.
2. Molecular Biology of the Cell, Alberts, Bruce, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter,4th ed, New York: Garland Science, 2002.
3. Nano-Antimicrobials,Cioffi, Nicola, Rai, Mahendra (Eds.) (2012), Springer

# MNST 302 (ii) - Program Elective II

## Bionano Structures - Applications and Perspectives

*Note: Eight Questions will be set from entire paper and students are required to attempt any five. All questions will carry equal marks.*

*Time: 3 Hours* *Maximum Marks: 60*

*Internal Assessment: 40*

**Protein Based Nanostructures:** S- layers: structures, self assembly, Recrystallization, Diagnostics, lipids chips , Engineered Nanopores- potential applications, methods of production, protein engineering, supported Bilayers, Membrane arrays, protein microarrays Microbial Nanoparticle production, Magnetosomes- Nanoscale magneticiron minerals in bacteria, Biochemistry, Gene expression and applications, Bacteriorhodopsin and its potential in technical applications & preparation of Bacteriorhodopsin films, Polymer nano containers and their role in therapy.

**DNA based Nanostructures:** DNA-Protein Nanostructures- overview, conjugation, supra-molecular Assembly, DNA directed immobilization, Microarray Technologies, DNA-template electronics, DNA Gold Nanoparticles conjugates- Chip Based DNA detection assays, DNA Nanostructures for mechanics and Computing, Nanoparticles as Non-Viral Transfection Agents, Real Time PCR based methods in Diagnosis of Infectious Diseases.

**Analysis of Biomolecular Structures:** Luminescent quantum dots for BiologicalLabeling, Nanoparticle molecular labels, Role of AFM and Force spectroscopy in Nanoanylytics and molecular pulling, Bioconjugated Silica Nanoparticles for Bioanalytical Applications.

**Nano Structured Fluids and Soft Materials:** Properties, Characterization, design & formulation, applying our knowledge – Applications in drug solubilization and delivery, nutraceuticals, enhanced oil-recovery, antimicrobial and cosmetic nano-emulsions, Textiles, smart materials, food colloids, and templating of nanoparticles.

**References**:


1. DNA Nano Technology: From structure to function, Fan, Chunhai (Ed.) (2013), Springer.
2. Bio-synthetic Polymer Conjugates, Schlaad, Helmut (Ed.) 2013, Springer.
3. Nanobiotechnology- Concepts, Applications and Prespectives, Niemeyer C.M. &Mirkin, C.A, 2004, Wiley-VCH Verlag.
4. Biomineralization- From Biology to Biotechnology and Medical Applications, Bauerlein, E. 2000, Wiley-VCH Verlag.
5. Nanostructures and Nanomaterials ,Cao Guozhong, 2004, Imperial College Press.

# MNST 302 (iii) - Program Elective II

## Nanomedicine and Drug Delivery System

*Note: Eight Questions will be set from entire paper and students are required to attempt any five. All questions will carry equal marks.*

*Time: 3 Hours* *Maximum Marks: 60*

*Internal Assessment: 40*

**Nanocarriers**: Viral nanocarrriers, Polymeric nanocarrier, lipid nanocarrier, carbon nanostructures, dendrimers, silica nanoparticles, carbon based nanostructures.

**Gene Therapy and Nanotechnology:** An Introduction, gene therapy using nanoparticles, stem cell therapy

**Nanotechnology for Imaging - Detection and Therapy:** Fluorophores and Quantum dots, Labeling and functionalization, Image analysis, Imaging facilitating surgical approaches, Diagnostics using nanomaterial, Nanoparticles for bioanalytical applications, Nanodevices for sensing and therapy, Use of nanoparticles for MRI, X Ray, Ultrasonography

**Drug Delivery,** Therapeutic action of nano particles and nano devices, Nanotechnology for Drug Targeting, Targeted, non-targeted delivery, controlled drug release, exploiting novel delivery routes using nanoparticles, Nanostructures for use as antibiotics, Diseased tissue destruction using nanoparticles.

**Nanotechnology for Cancer Therapy : Cancer biology** – Fundamentals, Physiology of Tumourgenesis, clinical aspects & current approaches, Challenges in cancer therapy, Role of nanotechnology in cancer therapy, Nanotechnology platforms, Properties of nanoplatforms, Passive versus active targeting, Tumor-targeted drug delivery systems (DNA, siRNA, etc), Nanoparticles: silica, vesicles, dendrimers etc , Drug encapsulation strategies.

**Ethical, Safety and Regulatory issues of Nanomedicine:** Toxicity of nanomaterials, Safety Guidelines, Regulation of nanoparticles.

**References**:


1. Handbook of Nanostructured Biomaterials and Their Applications in Nanobiotechnology - Hari Singh Nalwa
2. Bionanotechnology by Renugopalakrishnan, V.
3. Microfluidic Diagnostics: Methods and Protocols,Jenkins, Gareth, Mansfield, Colin D. (Eds.) (2013), Springer.
4. Stem Cells and Tissue Engineering, Pavlovic, Mirjana, Balint, Bela (2013) Springer.
5. siRNA Design Methods and Protocols, Taxman, Debra J. (Ed.) (2013), Springer