Core Courses for Semester – II

MSNT201-CR	Synthesis of Nanomaterials: Physical and Chemical Approaches
4 Credits	

Unit-I

Nanomaterial synthesis- Fundamentals of growth and nucleation. Homogenous and heterogeneous nucleation. Strategies towards synthesis of nanomaterials. Top down and bottom-up approaches for the synthesis of nanomaterial. Different Classes of Nanoparticles, including Core/shell nanoparticles.

Unit-II

Nanomaterial synthesis by Physical methods- with suitable examples in each method: Inert gas condensation, Arc discharge, Ion sputtering, Laser ablation, Ball milling, Lithographic techniques, Pyrolysis and other methods, Spray Pyrolysis, Molecular beam epitaxy, Chemical vapor deposition method and other variants.

Unit-III

Nanomaterial synthesis by Chemical methods- with suitable examples: in each method: Metal nanocrystals by reduction, Solvothermal/hydrothermal route, Nanocrystals of semiconductors and other materials by arrested precipitation, Sonochemical and Microwave assisted synthesis, Micelles and microemulsions.

Unit-IV

Nanofibers synthesis by Electrospinning method- various parameters influencing nanofiber morphology, porosity and other characteristics. Synthesis of polyurethane, polypropylene and nylox-6 fibers. Organic nanoparticles, and their synthesis. Biomimetic synthesis of nanocomposite material and tissue engineering- Different routes for synthesis of tissue engineered materials.

Books Recommended

♣ *G. Cao, Nanostructures and Nanomaterials: Synthesis, properties and applications, Imperial College Press, 2004.*

♣ *C. N. R. Rao, A. Muller, A. K. Cheetham, The chemistry of nanomaterials: Synthesis, properties and applications, Wiley (2004).*

♣ *Hornyak, Dutta, Tibbals and Rao, Introduction to Nanoscience and Nanotechnology, New York, CRC press, 2008.*

♣ *Hod Lipson, Melba Kumran: The new world of 3D Printing. John Wiley & Sons, Inc.*

♣ *Arkadii Arinstein: Electrospun Polymer Nanofibers, Taylor & Francis*

MSNT202-CR	Characterization Methods of Nanomaterials
4 Credits	

Unit-I

XRD – operational principle and applications. Nano Perspective. Peak broadening and crystallite size- The Scherrer equation**,** Electron probe characterization methods. Optics and resolution, Electron interaction with matter. Electron Microscopy (SEM, TEM) - operational principle and applications.

Unit-II

Electron probe microanalysis. Scanning probe microscopy (AFM, STM) - operational principle and applications, Other important electron probe methods: Auger electron spectroscopy, Low energy electron spectroscopy (LEED) and Energy electron loss spectroscopy (EELS).

Unit-III

Spectral characterization of nanomaterials. Spectroscopy – Raman, IR, UV-Vis - operational principle and applications. Photoluminescence (PL) Spectroscopy. X-ray photoelectron spectroscopy (XPS). Surface area and porosity, Particle size determination by light scattering and surface charge on nanoparticles (Zeta potential).

Unit-IV

Thermal analysis methods: Principle and Instrumentation of Thermogravimetry; Differential Thermal Analysis and Differential scanning calorimetry- Nanoindentation principles- elastic and plastic deformation -mechanical properties of materials in small dimensions. Vibrating sample Magnetometer and Electrochemical Characterization measurements.

Books Recommended

♣ *J. Goldstein, D. E. Newbury, D.C. Joy, and C.E. Lym, "Scanning Electron Microscopy and X-ray Microanalysis", 2003.*

♣ *D. Williams and B. Carter, "Transmission Electron Microscopy - A Textbook for Materials Science", Plenum Press, New York, 2nd Edition, 2009*

♣ *Banwell C. N, Fundamental of molecular Spectroscopy, McGraw Hill, 1996.*

♣ *Hornyak, Dutta, Tibbals and Rao, Introduction to Nanoscience and Nanotechnology, New York, CRC press, 2008.*

♣ *Solid State chemistry, AR West*

MSNT203-CR	Human Physiology and Disease
4 Credits	

Unit-I

Major human physiologic Systems of current Interest for biomedical applications- for example, cardiovascular, endocrine, nervous, gastrointestinal, and respiratory system. Various aspects of normal functioning of these systems & relationship to common pathologies from a diagnostic,

assessment and management perspective. Human Genetic Diseases, Metabolic disorders in humans-Diabetes

Unit-II

Immunity & Pathogenesis: Natural Molecular Recognition, Innate Immune System, Adaptive Immune System, Cells of Immune system, Cytokines, Antigens, MHC restriction, Cell mediated cytotoxicity: Mechanism of T cells and NK cell mediated lysis, ADCC and macrophage mediated cytotoxicity. Infection & Immunity: Immune response against parasitic and viral infections; Hybridoma Technology for monoclonal antibodies- Application of Monoclonal antibodies as therapeutics for various diseases; Tumor immunology, Immunotherapy for cancers.

Unit III

Cell signalling, the basic elements of cell signalling. Signalling molecules and their receptors Functions of G-protein- coupled receptors and their second messengers Protein \phosphorylation and its role in signal transduction Cytokine Receptors. Role of calcium and NO as an intracellular messenger. Detailed mechanism of signalling in the following pathways: GPCR pathway, RAS, MAPK pathway, PI3 Kinase Pathway

Unit-IV

Cancer Biology, the nature of cancer, causes of cancer, cellular oncogenes, Tumour suppressor genes, Properties of cancer cell, Hallmarks of cancer, cell immortalization and tumorigenesis, Insensitivity to antigrowth signals, Evading Apoptosis (Anoikis), Angiogenesis, Tissue invasion and metastasis, Conventional chemotherapy drugs their mechanism and limitations.

Books Recommended

- ♣ *Textbook of Medical Physiology by Guyton and Hall*
- ♣ *Essential immunology by Roitt /Kuby*
- ♣ *How immune system works by Lauren Sompayrac.*
- ♣ *The Breakthrough: Immunotherapy and the race to cancer by Charles Graeber*
- ♣ *Cancer Immunotherapy: Immune Supression and Tumor Growth by G. C, Prendergst.*
- ♣ *Text book of Cell Signalling in Cancer. Am educational approach by Jacques Robert*
- ♣ *Biochemistry of sinal transduction and regulation by Gerhard Krauss*
- ♣ *The biochemistry of cell signalling by Ernest Helmreich*
- ♣ *The biology of cancer by Rober A, Weinberg.*

MSNT204-CR	**Concepts in Nanoscale Physics**
2 Credits	

Unit-I

Electronic Structure of ID Systems, ID Sub-bands, Spectroscopy of Van-Hove Singularities, ID Metals-Coulomb Interactions and Lattice Couplings, Electrical Transport in ID, Conductance Quantization and the Landauer formula, Two barriers in series-resonant Tunneling, Incoherent Addition and Ohm’s law, Voltage Probes and the Buttiker-Landauer formalism.

Unit-II
Quantization in Semiconductor Nanocrystals, Metallic Dots, Discrete Charge States, Coulomb Oscillations, Spin, Mott insulators, and the Kondo Effect, Cooper pairing in superconducting Dots, Vibrational and thermal properties of Nanostructures, Quantized Vibrational Modes, Transverse Vibrations, Heat capacity and Thermal Transport.

Books Recommended
- ♣ *Introduction to Solid State Physics by C. Kittel.*
- ♣ *Solid State Physics – A.J. Dekker.*
- ♣ *Introduction to Solid State Physics – H.P. Myers.*
- ♣ *Solid state Physics – N.N. Ashcroft and N.D. Mermin.*
- ♣ *Solid state theory – F. Seitz.*

MSNT205-CR	**Introduction to Electronics**
2 Credits	

Unit-I
Semiconductor bandgap Engineering, Junction (PN, MS) diode analysis and its applications,

Unit-II
Transistors (BT, MESFET, MOSFET) and its applications, CMOS technology with design examples.

Books Recommended
- ♣ *Microelectronics circuits by Sedra & smith,*
- ♣ *Electronic Devices & circuit Theory By Bolysted.*
- ♣ *Physics and Technology of Semiconductor Devices A. S. Grove, John Wiley and Sons,*
- ♣ *Solid State and Semiconductor Physics by Mc Kelvey*
- ♣ *Floyd, "Digital Fundamentals", Pearson Pub.*

Discipline Centric Courses – Semester – II (Compulsory)

MSNT206-DCE	**Nanotechnology Laboratory Course-I**
4 Credits	

The Experiments for Nanotechnology Laboratory Courses for Semesters II will be conducted as per the availability of infrastructure and instrumentation. Following the proposed experiments for

Nanotechnology Laboratory Course-I (Practical's)
1. Basic laboratory apparatus, handling, lab safety and protocols.
2. Sol-gel synthesis of nanomaterials.
3. Microemulsion based synthesis of nanomaterials.
4. Synthesis of ZnO nanoparticles and determining its Band Gap.
5. Hydrothermal/solvothermal synthesis of nanomaterials.

6. Synthesis of nanomaterials by a wet-chemical method (Noble metal, ZnS, Mn:ZnS).
7. Microwave-assisted synthesis of noble-metal nanoparticles and their optical properties.
8. Synthesis of nanocomposites using a solid-state reaction.
9. Agarose Gel electrophoresis and Quantification of DNA and RNA.
10. Enzyme assay determination of specific activity of enzyme.
11. Determination of molecular weight of a protein by SDS-PAGE.
12. Western Blotting.
13. Immunoprecipitation (IP).
14. GST protein expression and purification.
15. Animal Cell Culture & Fluorescence Microscopy.
16. Media Preparation, Competent cell preparation and Bacterial Transformation.
17. Gene Cloning: Plasmid Isolation, Restriction digestion, PCR gene amplification

MSNT207-DCE	**Introduction to Mathematics-II**
2 Credits	

Unit-I

Laplace Transforms: Linearity property, first and second translation property of LT– Derivatives of Laplace transforms – Laplace transform of integrals – value theorems; Methods for finding LT: direct and series expansion method, Method of differential equation; Inverse Laplace transforms: Linearity property, first and second translation property, Convolution property – Application of LT to differential equations and boundary value problems.

Unit-II

Fourier Series and Integrals Fourier series definition and expansion of a function – Drichlet's conditions – Assumptions for the validity of Fourier's series expansion and its theorems – Complex representation of Fourier series - Problems related to periodic functions – graphical representation of FS – Fourier integrals - convergence of FS – some applications of Fourier transforms.

MSNT208-DCE	**Bionanoscience & Therapeutics**
2 Credits	

Unit-I

Levels of organization in living systems: Top Down to Bottom Up, Cellular processes at nanoscale; Nanoparticles in Medicine, Biological synthesis of nanomaterials/ Green synthesis- Use of biological systems like fungi, plants, purified enzymes and biological templates for synthesis of nanomaterials - Protein-Based Nanostructure Formation - DNA Templated Nanostructure Formation - Protein Assembly.

Unit-II

Conventional Routes of administration of Drug; adsorption enhancement / solubility factor/ bioavailability, Chemical modification of proteins/ therapeutics, Combinatorial Synthesis:

Chemistry, Biology, and Biotechnology, Drug Metabolism: Oxidation, reduction, hydrolysis, and conjugation. Need for developing new drugs: Procedure followed in drug design, Assay systems and models. Pre-clinical to clinical testing: Challenges and Future Perspectives.

Books Recommended

• *Hornyak, Dutta, Tibbals and Rao, Introduction to Nanoscience and Nanotechnology, New York, CRC press, 2008.*

• *Nanochemistry: A Chemical Approach to Nanomaterials – Royal Society of Chemistry, Cambridge, UK (2005).*

• *Nanostructures & Nanomaterials: Synthesis, Properties & Applications, Guozhong Gao, Imperial College Press (2004)*