SCHEME OF EXAMINATION

&

SYLLABUS for M.Tech.

in

Nano Science & Technology

Implemented from August 2008

UNIVERSITY SCHOOL OF BASIC & APPLIED SCIENCES

GGS INDRAPRASTHA UNIVERSITY

KASHMERE GATE

DELHI – 110403

Approved in 27th meeting of the academic council held on 15-06-2009. Agenda Item No. 27.9
Outline of the course

• **Duration**: 2 Years (4 semesters)

• **Total Credits**: 105 (Minimum required for the degree: 100 Credits)

• **Admission Criterion**: GATE Score *

• **Number of Seats**: 15

• **Eligibility**:
  - M. Sc. (Physics / Applied Physics / Electronics / Mathematics / Chemistry / Biotechnology / Biosciences / Life Sciences);
  - BE / B.Tech (Electronics / Computer Science / Electrical / Mechanical / Engineering Physics / Metallurgy / Material Engg. / Information Technology / Biotechnology / Chemical Engg. or Technology)
  - Minimum 55% aggregate marks and Mathematics at +2 level is a must.
Scheme of Examination for M.Tech Nano Science & Technology

**Semester - I**

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Course Code</th>
<th>Title of the course</th>
<th>Credits</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>NST-101</td>
<td>Elements of Physics</td>
<td>4</td>
<td>4/0/0</td>
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<tr>
<td>2</td>
<td>NST-103</td>
<td>Elements of Physical Chemistry</td>
<td>4</td>
<td>4/0/0</td>
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<tr>
<td>3</td>
<td>NST-105</td>
<td>Nanoparticles and Microorganisms, Bionanocomposites</td>
<td>3</td>
<td>3/0/0</td>
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<tr>
<td>4</td>
<td>NST-107</td>
<td>Elements of Material Science and properties of Nanomaterials</td>
<td>4</td>
<td>4/0/0</td>
</tr>
<tr>
<td>5</td>
<td>NST-109</td>
<td>Nanotechnology &amp; Society</td>
<td>1</td>
<td>1/0/0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(NUES)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>NST-111</td>
<td>Basic Mathematics / Life Sciences</td>
<td>2</td>
<td>2/0/0</td>
</tr>
<tr>
<td>7</td>
<td>NST-151</td>
<td>Laboratory-I</td>
<td>6</td>
<td>0/0/12</td>
</tr>
<tr>
<td>8</td>
<td>NST-153</td>
<td>Self Study-I</td>
<td>3</td>
<td>0/3/0</td>
</tr>
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L = Lecture, T = Tutorial, P = Practical

NUES => Non University Examination System

w.e.f. August 2008

DEAN : USBAS

Approved in 27th meeting of the academic council held on 15-06-2009. Agenda Item No. 27.9
### Semester - II

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Course Code</th>
<th>Title of the course</th>
<th>Credits</th>
<th>L/T/P</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>NST-102</td>
<td>Fabrication techniques and Characterisation of Nanomaterials</td>
<td>4</td>
<td>4/0/0</td>
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</tr>
<tr>
<td>2.</td>
<td>NST-104</td>
<td>Soft Synthetic Routes &amp; Some Novel Nanomaterials</td>
<td>4</td>
<td>4/0/0</td>
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<tr>
<td>3.</td>
<td>NST-106</td>
<td>Nanodevices &amp; Nanosensors</td>
<td>4</td>
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<tr>
<td>4.</td>
<td>NST-108</td>
<td>Scientific Computation &amp; Simulation</td>
<td>1</td>
<td>1/0/0</td>
<td>(NUES)</td>
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<tr>
<td>5.</td>
<td>NST-110</td>
<td>Solutions &amp; Surface Phenomenon</td>
<td>4</td>
<td>4/0/0</td>
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<tr>
<td>6.</td>
<td>NST-112</td>
<td>Business Enterprise in Nanotechnology &amp; Project Management</td>
<td>1</td>
<td>1/0/0</td>
<td>(NUES)</td>
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<tr>
<td>7.</td>
<td>NST-152</td>
<td>Laboratory-II</td>
<td>6</td>
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<tr>
<td>8.</td>
<td>NST-154</td>
<td>Self Study-II</td>
<td>3</td>
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<tr>
<td>9.</td>
<td>NST-156</td>
<td>Scientific Computation &amp; Simulation</td>
<td>2</td>
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</table>

NUES => Non University Examination System

The students will proceed for summer training at the end of second semester for a period of 6-8 weeks. They will submit the training report after its completion to the program coordinator.

w.e.f. January 2009
<table>
<thead>
<tr>
<th>S. No.</th>
<th>Course Code</th>
<th>Title of the course</th>
<th>Credit /wk</th>
<th>Remarks L/T/P</th>
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<tbody>
<tr>
<td>1.</td>
<td>NST-201</td>
<td>Advanced Nanomaterials</td>
<td>3</td>
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<tr>
<td>2.</td>
<td>NST-203</td>
<td>Semiconductor nanostructures and nanoparticles</td>
<td>3</td>
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<tr>
<td>3.</td>
<td>Electives (any 2)</td>
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<tr>
<td></td>
<td>NST-205</td>
<td>Molecular Nanoelectronics</td>
<td>3</td>
<td>3/0/0</td>
</tr>
<tr>
<td></td>
<td>NST-207</td>
<td>Photonics &amp; Plasmonics</td>
<td>3</td>
<td>3/0/0</td>
</tr>
<tr>
<td></td>
<td>NST-209</td>
<td>Carbon Nanotubes &amp; Functionalisation</td>
<td>3</td>
<td>3/0/0</td>
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<tr>
<td></td>
<td>NST-211</td>
<td>Computational Nanoscience</td>
<td>3</td>
<td>3/0/0</td>
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<td>4.</td>
<td>NST-213</td>
<td>IPR &amp; Nanotechnology</td>
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<td>1/0/0 (NUES)</td>
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<tr>
<td>5.</td>
<td>NST-251</td>
<td>Self Study-III</td>
<td>2</td>
<td>0/2/0</td>
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<td>6.</td>
<td>NST-253</td>
<td>Minor Project</td>
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<td>7.</td>
<td>NST-255</td>
<td>Summer training (Viva-voce)</td>
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NUES => Non University Examination System
### Semester - IV

<table>
<thead>
<tr>
<th>S. NO.</th>
<th>Course Code</th>
<th>Title of the course</th>
<th>Credit/wk</th>
<th>Remarks</th>
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</thead>
<tbody>
<tr>
<td>1.</td>
<td>NST-202</td>
<td>Project Work /Internship (Seminar)</td>
<td>20</td>
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<td>2.</td>
<td>NST-204</td>
<td>Comprehensive Viva Voce</td>
<td>5</td>
<td>NUES</td>
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</table>

NUES => Non University Examination System

Total Credits: 105

Credits Required for the Degree: 100

w.e.f. August 2008  

DEAN : USBAS

Approved in 27th meeting of the academic council held on 15-06-2009. Agenda Item No. 27.9
Detailed Syllabi

**Semester-I**

**Course Code: NST-101**

**Title: Elements of Physics**

**L/T/P: 4/0/0**

**Unit-I:** Introduction to Quantum Mechanics: Wave-particle duality, Schrödinger equation and expectation values, Uncertainty principle. Solutions of the one-dimensional Schrodinger equation for free particle, particle in a box, particle in a finite well, linear harmonic oscillator. Reflection and transmission by a potential step and by a rectangular barrier.

**Unit-II:** Solution of Time independent Schrödinger equation at higher dimensions and more complicated systems Particle in a three dimensional box, linear harmonic oscillator and its solution, density of states, free electron theory of metals. The angular momentum problem. The spin half problem and properties of Pauli spin matrices.

**Unit-III** Approximate methods, Time independent and time dependent perturbation theory for non-degenerate and degenerate energy levels, the variational method, WKB approximation, adiabatic approximation, sudden approximation

**Unit-IV:** Statistical Mechanics, Microstates and entropy and its statistical definition, Entropy of mixing, Gibb’s free energy, Gibb’s paradox, phase space density, ergodic hypothesis, Liouville’s theorem, The microcanonical-, canonical- and grand canonical- ensemble and their connections, Fluctuations. Classical Statistical systems, Boltzman statistics and quantum statistical systems, Fermi-Dirac and Bose-Einstein Statistics and their applications ( An overview ).

**References: (NST 101)**
1. Quantum Physics – A. Ghatak
2. Quantum Mechanics-Mc Quarie
3. Quantum Mechanics - Bransden and Joachen
4. Quantum Mechanics - Vol 1&2 - Cohen-Tannoudji
5. Quantum wells, Wires & Dots,: Theoretical & Computational Physics of Semiconductors Nano-structures, Paul Harrison
9. Thermodynamics and Statistical Mechanics - A N Tikhonov, Peter T Landberg, Peter Theodore Landsberg
10. Thermodynamics and Statistical Mechanics by John M. Seddon , J. D. Gale
11. Statistical Physics by K. Huang

w.e.f. August 2008

**DEAN : USBAS**

*Approved in 27th meeting of the academic council held on 15-06-2009, Agenda Item No. 27.9*
Unit I- Chemical Bonding: Atomic Bonding in solids, Types of bond: Metallic, Ionic, Covalent and vanderwaals bond; Hybridisation; H- bonding Molecular orbital theory for simple molecules such as diatomic molecule etc. Types of Material: Metals, Semiconductors, Composite materials, Ceramics, Alloys, Polymers.

Unit II- Overview to Thermodynamics: The first and second laws of thermodynamics. Thermodynamic functions, heat capacity, enthalpy, entropy. Phase equilibrium in one component system, real gases, the interactions between gases. Ehrenfest classification of phase transition, the physical liquid surface; surface tension, curved surfaces, capillary action. Theory of Solution and related topics: Liquid mixtures: free energy as a function of composition, ideal solutions and excess functions. Equilibrium Electrochemistry; electrochemical cells, Methods for calculation of thermodynamic equilibrium. Electrochemical processes.

Unit III- Diffusion-Fick's Law, mechanisms of diffusion; generation of point defects; self-diffusion; the influence of the pressure and pressure gradient; Kirkendall effect; fast diffusion; influence of isotropic state; experimental methods of investigation of diffusion.


References: (NST 103)
2. Thermodynamics-Glasston.
3. Principals of Physical Chemistry-Marron-Pruton.
4. Advanced Physical Chemistry – Atkins Peter, Paula Julio
Unit – I Biological Methods of Synthesis: Use of bacteria, fungi, Actinomycetes for nanoparticle synthesis, Magnetotactic bacteria for natural spynthesis 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

UNIT – II 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;

Unit – III 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.

Unit – IV Nanobio Systems, Nanoparticle-biomaterial hybrid systems for bioelectronic devices, Bioelectronic systems based on nanoparticle-enzyme hybrids; nanoparticle based bioelectronic biorecognition events. Biomaterial nanocircuitry; Protein based nanocircuitry; Neurons for network formation. DNA nanostructures for mechanics and computing and DNA based computation; DNA based nanomechanical devices. Biosensor and Biochips.

References: (NST – 105)
1. Bionanotechnology: Lessons from Nature by David S. Goodsell
3. Handbook of Nanostructured Biomaterials and Their Applications in Nanobiotechnology - Hari Singh Nalwa
5. Nanocomposite Science & Technology Ajayan, Schadler & Braun
6. BioMEMS (Microsystems) - Gerald A. Urban
7. Introduction to Nanoscale Science and Technology (Nanostructure Science and Technology) -Massimiliano Di Ventra
8. Nanosystems: Molecular Machinery, Manufacturing, and Computation - K. Eric Drexler
9. Springer Handbook of Nanotechnology - Bharat Bhushan

w.e.f. August 2008

DEAN : USBAS
Course Code: NST-107  
Title: Elements of Material Science and Properties of Nanomaterials  
L/T/P: 4/0/0

Unit-I  Solid State Physics (Overview): Amorphous, crystalline, crystals, polycrystals, symmetry, Unit Cells, Crystal Structures (Bravais Lattices), Crystallographic Directions, Crystallographic Planes, Miller Indices, Bragg’s Law, X-ray Diffraction.  
Imperfections of crystal structure: point defects, Grain boundaries, phase boundaries, Dislocations Screw, Edge and Mixed Dislocations generation of defects by quenching, by plastic deformation and by radiation, interaction between point defects and dislocations

Unit-II  Electronic Properties, Classification of materials: Metal, Semiconductor, Insulator, Band structures, Brillouin zones, Mobility, Resistivity, Relaxation time, Recombination centers, Hall effects.

Unit –III  Confinement and transport in nanostructure, Current, reservoirs, and electron channels, conductance formula for nanostructures, quantized conductance. Local density of states. Ballistic transport, Coulomb blockade, Diffusive transport, Fock space.  
Dielectric properties: Polarisation, Ferroelectric behaviour.

Unit-IV  Optical Properties, Photoconductivity, Optical absorption & transmission, Photoluminescence, Fluorescence, Phosphorescence, Electroluminescence.

References: (NST - 107)

1. Introduction to Solid State Physics -C. Kittel  
5. Scanning Probe Microscopy: Analytical Methods (NanoScience and Technology)- Roland Wiesendanger  
6. Advanced X-ray Techniques in Research and Industries - A. K. Singh (Editor)  

w.e.f. August 2008

DEAN : USBAS

Approved in 27th meeting of the academic council held on 15-06-2009. Agenda Item No. 27.9
Introduction to Societal Implications of Nanoscience and Nanotechnology, Nanotechnology Goals: Knowledge and scientific understanding of nature, Industrial manufacturing, materials and products, Medicine and the human body, Sustainability: Agriculture, water, energy, materials and clean environment, Space exploration, National security, Moving into the market.

References: (NST - 109)


w.e.f. August 2008

DEAN : USBAS

Approved in 27th meeting of the academic council held on 15-06-2009. Agenda Item No. 27.9
UNIT I

1. Exploring Life

2. The evolutionary history of biological diversity

3. Brief classification of living kingdom

4. Differences between prokaryotes and eukaryotes

5. Plants and animal diversity:-Five kingdoms-Monera, Protista, Fungi, Plantae, Animalia; Three domains-Bacteria, Archaea and Eukarya

Unit II


Unit III


Unit IV

8. Integrated control Systems: Nervous system and Endocrine system

Unit V

9. Natural synthesis of some biological materials: Their composition and properties-Teeth, Bone, silk etc.

w.e.f. August 2008

DEAN : USBAS

Approved in 27th meeting of the academic council held on 15-06-2009. Agenda Item No. 27.9
Section A

1. To study kinetics of hydrolysis of an ester.

2. Effect of surfactant concentration on equivalent conductance and determination of critical micelle concentration (CMC).

3. Verification of Lambert Beer’s law and determination of concentration of unknown solution by UV-Vis spectrophotometer.

4. Preparation of colloidal Silver (Ag) nanoparticles with trisodium citrate and their characterization by UV-Vis spectroscopy.

5. To study Hydrogen bonding by FT-IR spectroscopy

6. Preparation of metal oxide nanoparticles by microemulsion technique.

7. Characterization of prepared metal oxide nanoparticles by XRD and determination of their size by Scherrer’s Equation.

Section B

1. To determine the Band-Gap of given Semiconductor Using Four Probe Method from Liquid Nitrogen Temp to Room Temperature

2. To determine the Band-Gap of given Semiconductor Using Four Probe Method From Room Temperature to 100 C

3. Synthesis of at least two different sizes of Nickel Oxide Nano Particles Using Sol-Gel Method

4. Synthesis of at least two different sizes of Copper Oxide Nano Particles Using Sol-Gel Method

5. Synthesis of at least two different sizes of Zinc Oxide Nano Particles Using Sol-Gel Method

6. Determine the Radius of Curvature of Lens using Newton's Ring Method

7. Determine the wavelength of given Laser , estimate the slit width using Laser

8. Calculate the diameter of given thin wire using Laser.

w.e.f. August 2008

DEAN : USBAS

Approved in 27th meeting of the academic council held on 15-06-2009. Agenda Item No. 27.9
Course Code: NST-153  Title: Self Study-I
L/T/P: 0/3/0

Presentations by the students on topics assigned and supervised by the faculty.

w.e.f. August 2008

DEAN : USBAS

Approved in 27th meeting of the academic council held on 15-06-2009. Agenda Item No. 27.9
Semester-II

Course Code: NST-102                                          Title: Fabrication techniques and Characterisation of Nanomaterials

L/T/P: 4/0/0

**Unit – I** Fabrication of Nanomaterials by Physical Methods: - Inert gas condensation, Arc discharge, RF-plasma, Plasma arc technique, Ion sputtering, Laser ablation, Laser pyrolysis, Ball Milling, Molecular beam epitaxy, Chemical vapour deposition method and Electro deposition.

**Unit – II** Scanning Electron Microscopy (SEM), Scanning Probe Microscopy (SPM), TEM and EDAX analysis, X-ray diffraction

**Unit – III** Optical Microscope and their description, operational principle and application for analysis of nanomaterials, UV-VIS-IR Spectrophotometers, Principle of operation and application for band gap measurement

**Unit – IV** M 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.

**References: (NST-102)**

1. Fabrication of fine pitch gratings by holography, electron beam lithography and nano-imprint lithography (Proceedings Paper) Author(s): Darren Goodchild; Alexei Bogdanov; Simon Wingar; Bill Benyon; Nak Kim; Frank Shepherd
2. Microfabrication and Nanomanufacturing- Mark James Jackson
4. Processing & properties of structural nanostructures - Leon L. Shaw (editor)

w.e.f. August 2008

DEAN : USBAS

Approved in 27th meeting of the academic council held on 15-06-2009. Agenda Item No. 27.9
Course Code: NST-104  Title: Soft Synthetic Routes & Some Novel Nanomaterials  

L/T/P: 4/0/0

Unit–I Chemical Routes for Synthesis of Nanomaterials: Chemical precipitation and co-precipitation; Metal nanocrystals by reduction, Sol-gel synthesis; Microemulsions or reverse micelles, myle formation; Solvothermal synthesis; Thermolysis routes, Microwave heating synthesis; Sonochemical synthesis; Electrochemical synthesis; Photochemical synthesis, Synthesis in supercritical fluids

Unit–II Nanocomposites: An Introduction: Types of Nanocomposite (i.e. metal oxide, ceramic, glass and polymer based); Core-Shell structured nanocomposites Superhard Nanocomposite: Synthesis, applications and milestones.

Unit–III Nanopolymers: Preparation and characterization of diblock Copolymer based nanocomposites, Nanoparticles polymer ensembles; Assembly of polymer-Nanoparticles composite material; Fabrication of polymer-mediated organized Nanoparticles assemblies; Applications of Nanopolymers in Catalysis

Unit–IV Metal Nanoparticles: Size control of metal Nanoparticles and their characterization; Study of their properties: Optical, electronic, magnetic; Surface plasmon band and its application; Role in catalysis, Alloy Nanoparticles, Stabilization in Sol, Glass, and other media, Change of bandgap, Blueshift, Colour change in sol, glass, and composites, Plasmon Resonance.

References: (NST - 104)


w.e.f. August 2008  DEAN : USBAS

Approved in 27th meeting of the academic council held on  
15-06-2009. Agenda Item No. 27.9
Unit-I Quantum and classical regimes of electron transport, mesoscopic transport. Diffusive transport: Boltzmann transport equation, electron mobility and diffusion coefficient, Drift-diffusion model. Quantum electron transport; Double barrier Resonant-Tunneling structures: Coherent tunneling and sequential tunneling, Negative differential resistance, single electron tunneling, Coulomb blockade.

Unit-II Introduction to MEMs / NEMs, Electronic Transport in Nanostructures, Semiconductor devices to Single electron Transistors


Unit-IV State of Art Ion-beam exchange in Nanostructure material. Nanostructure based Photovoltaic Cells.

References: (NST 106)

2. Between Technology & Science : Exploring an emerging field knowledge flows & networking on the nanoscale by Martin S. Meyer.
3. Nanoscience & Technology: Novel structure and phenomena by Ping Sheng (Editor)
7. MEMS & MOEMS Technology and Applications- P. Rai Choudhury
8. Processing Technologies- Gandhi
9. From Atom to Transistor- Supriyo Datta

w.e.f. August 2008

DEAN : USBAS
Unit-I Computational physics in Science & Technology, brief introduction to the Linux operating system; A review of the numerical techniques (Interpolations, differentiation, integration; Nonlinear equations, the bisection methods, Newton’s method, root finding; Differential equations, Euler’s method, the Runge-Kutta method; Matrices-inverting, finding eigenvalues and eigenfunctions, etc.).

Unit-II Simple problems based on section –I Using Matlab, Mathematica (mechanics, optics and quantum mechanics)/Atomistix and related softwares, Introduction to Labveiw software

Unit-III Introduction to Monte Carlo techniques, Random processes in science, Monte Carlo integration.

Unit-IV Applications and examples based on the Monte Carlo technique: Random walk, Percolation, Ising model, etc.

References: (NST 108)

2. Introductory Computational Physics Kelvin and Godunov (Cambridge).
Course Code: NST-110

Title: Solutions and Surface Phenomenon

L/T/P: 4/0/0


Unit – II Surface Chemistry: Colloidal state: Interfacial Properties, Origin of Charge on Colloidal Particles, Determination of size of colloidal particles; Types of surfactants: Anionic, cationic, zwitterionic & non-ionic (non-ionic); Theory of surfactants; CMC – Effect of chemical structure, temperature; Kraft temperature; Emulsions & gels

Unit – III Phase Behaviour of Concentrated Surfactant Systems: Micelle type, Micellar growth, Micellar solution saturation; Structure of liquid; crystalline phases; Phase rule, Phase diagram, Binary and ternary phase diagrams of two components & three components, Surfactant geometry & packing; Introduction to microemulsion

Unit – IV Phase Transformations: Mechanisms of phase transformation; homogeneous and heterogeneous nucleation; spinodal decomposition; grain growth; precipitation in solid solution; transformation with constant composition; order-disorder transformations; Martensitic transformation

References: (NST 110)

5. Introduction to Surface Physics – Martin Prutton, Oxford University Press (1994)

w.e.f. August 2008

DEAN : USBAS

Approved in 27th meeting of the academic council held on
15-06-2009. Agenda Item No. 27.9
COURSE DESCRIPTION/OBJECTIVES:

This course aims at imparting knowledge in respect of organizational and managerial structure of Indian businesses. Besides acquiring skills related to decision making, the students will be introduced to the tools and techniques, like PERT/CPM etc., for effective project management. The students will gain knowledge and experience through lectures, case studies and special topic presentations.

Lecture Schedule:

Lecture 1.: Indian Business Enterprise
Lecture 2: Business Organization design and structure
Lecture 3: Introduction to Organization Behavior
Lecture 4: Team building and Motivation
Lecture 5: Leadership, Communication and interpersonal skills
Lecture 6: Managing R&D and Innovations
Lecture 7: Entrepreneurship
Lecture 8: Analyzing business environment
Lecture 9: Decision Making techniques
Lecture 10: Project Management
Lecture 11: PERT / CPM – I
Lecture 12: PERT / CPM – II
Lecture 13: Presentations

References: (NST: 112)


w.e.f. January 2009

DEAN: USBAS

Approved in 27th meeting of the academic council held on 15-06-2009. Agenda Item No. 27.9
Section A

1. To investigate adsorption of oxalic acid from aqueous solution by activated charcoal and examine the validity of Freundlich and Langmuir adsorption isotherm.

2. Determination of critical micelle concentration of ionic and non-ionic surfactant by surface tension method.

3. Determination of mutual solubility curve of phenol & water, and hence the consolute point. Study the effect of presence of salt to the above system.

4. Preparation of water-in-oil microemulsion and measurement of droplet sizes by Dynamic Light Scattering (DLS).

5. To study the effect of salt & valency of adsorbing ions on particle dispersion stability.

6. Preparation of quantum dot (ZnS) nanoparticles and estimation of band gap from band edge.

7. Preparation of liquid crystals

Section B

1. Synthesize copper oxide nanoparticles by sol-gel method and determine the average size of nanoparticles using Zetasizer.

2. Synthesize nickel oxide nanoparticles by sol-gel method and determine the average size of nanoparticles.

3. Fabricate silver nanoparticles embedded in silica glass by ion exchange method and study surface plasmon resonance using UV-visible spectroscopy.

4. Fabricate copper nanoparticles embedded in silica glass by ion exchange method and determine the size of nanoparticles using optical absorption spectroscopy.

5. Synthesize silver nanocrystals in solution by citrate reduction method and study the effect of capping using optical absorption spectroscopy.

6. Study the growth kinetics of silver nanoparticles embedded in ion exchanged glass at different temperatures using optical absorption spectroscopy.
Course Code: (NST-154) 
Title: Self Study-II
L/T/P: 0/3/0

Presentations by the students on topics assigned and supervised by the faculty.

Course Code: (NST-156) 
Title: Scientific Computation & Simulation
L/T/P: 0/0/4

The syllabus will remain same as for the paper NST-108. The students will be made to practice and learn computational work in this lab.

w.e.f. August 2008

DEAN : USBAS

Approved in 27th meeting of the academic council held on 15-06-2009. Agenda Item No. 27.9
Semester- III

Course Code: NST-201  
Title: Advanced Nanomaterials
L/T/P: 3/0/0


Unit-II Nanostructure Magnetism; Effect Bulk Nanostructuring of Magnetic property; Gaint and colossal Magnetic resistance; Super Para Magnetism in metallic nanoparticle; Super para magnetism / FM in Semi-conduction quantum dots.

Unit-III Carbon Nano Structures: Introduction; Fullerenes, C60, C80 and C240 Nanostructures; Properties & Applications (mechanical, optical and electrical).

Unit-IV Thermo Electric Materials (TEM): Concept of phonon, Thermal conductivity, Specific heat, Exothermic & endothermic processes. Different types of TEM; Bulk TEM Properties. One dimensional TEM; Composite TEM; Applications.

References: (201)

1. Novel Nanocrystalline Alloys and Magnetic Nanomaterials- Brian Cantor
11. CRC Handbook of Thermoelectrics, Ed. CR Rowe

w.e.f. August 2008  
DEAN : USBAS

Approved in 27th meeting of the academic council held on 15-06-2009. Agenda Item No. 27.9
Course Code: NST-203  
Title: Semiconductors Nanostructure & Nano-particle  
L/T/P: 3/0/0

Unit –I Semiconductor nanoparticles: Synthesis, Cluster compounds, quantum-dots from MBE and CVD, wet chemical methods, reverse micelles, electro-deposition, pyrolytic synthesis, self-assembly strategies.

Unit –II Semiconductor nanoparticles: size–dependant physical properties, Melting point, solid-state phase transformations, excitons, band-gap variations-quantum confinement, effect of strain on band-gap in epitaxial quantum dots, single particle conductance.

Unit-III Semiconductor nanoparticles – applications, Optical luminescence and fluorescence from direct band gap semiconductor nanoparticles, surface-trap passivation in core-shell nanoparticles, carrier injection, polymer-nanoparticle, LED and solar cells, electroluminescence, barriers to nanoparticle lasers, doping nanoparticles, Mn-Zn-Se phosphors, light emission from indirect semiconductors, light emission form Si nanodots.

Unit-IV Semiconductor nanowires, Fabrication strategies, quantum conductance effects in semiconductor nanowires, porous Silicon, nanobelts, nanoribbons, nanosprings.

References: (NST – 203)

1. Encyclopedia of Nanotechnology- Hari Singh Nalwa
2. Springer Handbook of Nanotechnology - Bharat Bhusan
Electives

Course Code: NST 205                                                  Title: Molecular Nanoelectronics
L/T/P: 3/0/0

Unit –I Introduction: Recent past, the present and its challenges, Future, Overview of basic Nanoelectronics.


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

Unit –IV 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: (NST 205)

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
Physics of Linear Photonic Crystals: Maxwell’s Equations, Bloch’s Theorem, Photonic Band Gap and Localized Defect States, Transmission Spectra, Nonlinear Optics in Linear Photonic Crystals, Guided Modes in Photonic Crystals Slab

Technology, Materials, and Fabrication of Photonic Crystals: Choices of Materials: Semiconductors, Amorphous, and Polymers, Fabrications of Photonic Crystals Structures (1-D, 2-D, 3-D)

Applications of Photonic Crystals Devices: 1-D Photonic Crystals, Couplers, Waveguides, High-Q Cavities, etc, 2-D Photonic Crystals , Photonic Crystal Fibers, 4 Tunable Photonic Crystal Filters

Physics of Nonlinear Photonic Crystals: 1-D Quasi Phase Matching, Nonlinear Photonic Crystal Analysis, Applications of Nonlinear Photonic Crystals Devices, Materials: LiNbO3, Chalcogenide Glasses, etc, Wavelength Converters, etc

Elements of Plasmonics: Introduction to Plasmonics, merging photonics and electronics at nanoscale dimensions, single photon transistor using surface plasmon, nanowire surface plasmons-interaction with matter, single emitter as saturable mirror, photon correlation, and integrated systems. All optical modulation by plasmonic excitation of quantum dots, Channel plasmon-polariton guiding by subwavelength metal grooves, Near-field photonics: surface plasmon polaritons and localized surface plasmons, Slow guided surface plasmons at telecom frequencies.

References: (NST 207)

1. The Handbook of Photonics By Mool Chand Gupta, John Ballato
2. Nanotechnology for Microelectronics and Optoelectronics - J. M. Martinez-Duart, Raúl J. Martín-Palma, Fernando Agullo-Rueda
3. Nanoplasmonics, From fundamentals to Applications vol 1 & 2- S. Kawata & H. Masuhara
4. Optical Properties of Photonic Crystals-K. Sakoda
5. Applied Photonics by Chái Yeh
6. Silicon Photonics: An Introduction by Graham T. Reed, Andrew P. Knights

w.e.f. August 2008

DEAN : USBAS

Approved in 27th meeting of the academic council held on
15-06-2009. Agenda Item No. 27.9
Course Code: NST 209                                                   Title: Carbon Nanotube & Its Functionalisation
L/T/P: 3/0/0

Preparation of Carbon Nano-Tubes: CVD and other methods of preparation of CNT

Properties of Carbon Nanotubes: Electrical, Optical, Mechanical, Vibrational properties etc.

Applications of Carbon Nanotubes: Field emission, Fuel Cells, Display devices

Functionalization of Carbon Nanotubes: Carbon Nanotubes, Functionalization of Carbon Nanotubes, Reactivity of Carbon Nanotubes,


Other Important Carbon based materials: Preparation and Characterization Fullerene and other associated carbon clusters/molecules, Graphene-preparation, characterization and properties, DLC and nanodiamonds.

References: (NST 209)

1. Nanoscale materials -Liz Marzan and Kamat
2. Physical properties of Carbon Nanotube-R Satio
5. CARBON NANOTECHNOLOGY- Liming Dai

w.e.f. August 2008                                                   DEAN : USBAS

Approved in 27th meeting of the academic council held on
15-06-2009. Agenda Item No. 27.9
Course Code: NST 211        Title: Nanocomposites
L/T/P: 3/0/0

Metal based nanocomposites: Metal-Oxide or Metal-Ceramic composites, 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 nanocomposites, its designing and improvements of mechanical properties.


Polymer based nanocomposites: Preparation and characterization of diblock Copolymer based nanocomposites; Polymer-carbon nanotubes based composites, their mechanical properties, and industrial possibilities.

References: (NST 211)

1. Nanocomposites Science and Technology - P. M. Ajayan, L.S. Schadler, P. V. Braun
2. Physical Properties of Carbon Nanotubes- R. Saito
4. The search for novel, superhard materials- Stan Veprijek (Review Article) JVST A, 1999
5. Electromagnetic and magnetic properties of multi component metal oxides, hetero

w.e.f. August 2008                           DEAN : USBAS

Approved in 27th meeting of the academic council held on
15-06-2009. Agenda Item No. 27.9
Course Code: NST 211

Unit – I Introduction to Matlab and Mathematics (and their open source counterparts-Scilab and Octave); examples from nano-optics and nano-electronics.

Unit – II Monte Carlo Simulations; Computational methods and Simulations from ab initio to multiscale Modeling.

Unit – III Molecular dynamics, computing and simulations.

Unit – IV Nanodesign Nano-CAD, Modeling of Nanodevices. Applications and examples problems based on Molecular dynamics simulations.

References: (NST: 211)


w.e.f. August 2008

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15-06-2009. Agenda Item No. 27.9
Nanotechnology with its vast potential applications in day to day life will surely face lot of legal challenges. The objective of this course will be focused towards sensitizing the students towards relating IPR with relation to Nano Science.

In this course the students are asked to make comprehensive presentations relevant to the course content under the direct supervision of the faculty members.

w.e.f. August 2008

DEAN : USBAS

Approved in 27th meeting of the academic council held on 15-06-2009. Agenda Item No. 27.9