Annexure No.	**46 B**
SCAA Dated	**29.02.2008**

BHARATHIAR UNIVESITY, COIMBATORE
M.Sc. NANOSCIENCE AND TECHNOLOGY (CBCS) WITH COMPULSORY DIPLOMA IN COMMUNICATIVE ENGLISH

With effect from 2008-2009
Scheme of Examinations

I Semester		**Credit**
Core Paper 1 Classical Mechanics & Statistical Mechanics	----------	4
Core Paper 2 Condensed Matter Physics	----------	4
Core Paper 3 Fundamentals of Nanoscience	----------	4
Elective 1 Quantum Physics and Applications	----------	2
Elective 2 Electronics	----------	2
Supportive 1 From Chemistry / Bio-technology / Computer Science Department	----------	2
Viva voce	----------	
		18
II Semester		
Core Paper 4 Synthesis of Nanomaterials	----------	4
Core Paper 5 Characterization of Nanomaterials	----------	4
Core Paper 6 Inorganic Semiconductor Nanomaterials	----------	4
Elective 3 Nano-Electronics	----------	4
Supportive 2 From Chemistry / Bio-technology / Computer Science Department	----------	2
Practical I	----------	3
Viva voce	----------	
		21
III Semester		
Core Paper 7 Nano-Lithography	----------	4
Core Paper 8 Nano-Biotechnology	----------	4
Core Paper 9 Nano-Medicine and Drug Delivery Systems	----------	4
Elective 4 Nanoscale Magnetic Materials and Devices	-------	4
Supportive 3 From Chemistry / Bio-technology / Computer Science Department	----------	2
Practical II	----------	3
Viva voce	----------	
		21
IV Semester		
Project	----------	8
Theory Paper Related to Project	----------	4
		12

Total		**72**

COMPULSORY DIPLOMA IN COMMUNICATIVE ENGLISH

SEM 1 - PAPER - I : SPEAKING & WRITING –I	----------	4
SEM 2 - PAPER-II: LISTENING & READING –I	----------	4
SEM 2 - PAPER-III: SPEAKING & WRITING –II	----------	4
SEM 4 - PAPER-IV: LISTENING & READING –II	----------	4
		16 Credits

Core Paper 1 Classical Mechanics and Statistical Mechanics

Unit – I: Introduction to Classical Dynamics

Basic Principles of Classical Dynamics – Foundation of Mechanics - Conservation laws for n bodies: Conservation of Linear Momentum, Conservation of Angular Momentum, Conservation of Energy - Degrees of Freedom - Generalized co-ordinates - Limitations of Newton's Law - Euler-Lagrangian Differential Equation - Hamiltonians Variation Principle.

Unit – II: Motion in the Central field potential

General features of central force motion: Conservation of Energy, Conservation of angular Momentum, Lagrangian Equation of Motion, Expression for r(t) and θ(t), Equation of the path (orbit) - Equivalent one body problem - Equivalent one dimensional problem (General features of the orbit): Orbit under the Inverse Square law of Force, Motion with different values of k - Kepler's Problems: Detection of Kepler's Laws.

Unit – III: Lagrangian Dynamics and Hamiltonian Dynamics

Invariance and Covariance – Geometry of the motion in configuration space - D' Alemberts Principle - Derivation of Lagrangian Equation of motion from D' Alemberts Principle and Hamilton's Principle - Simple Application of Lagrangian Equation: Atwood Machine, Spherical pendulum, Isotropic Oscillator - Phase space and motion of the system - Hamiltonian's canonical equations of motion - Physical significance of H - Applications of Hamiltonian's equations of motion - Compound pendulum, Simple pendulum, Particle in a central field of force.

Unit – IV: Statistical Mechanics

Foundation of Statistical Mechanics and Thermodynamics: Phase space – Ensembles: Types of Ensembles – Microcanonical Ensembles, Canonical Ensembles, Grand canonical Ensembles - Uses of Ensembles – Classical Distribution Law: Microstates and Macrostates – Stirling's approximation - Maxwell-Boltzman distribution law - Bose-Einstein distribution law - Fermi-Dirac distribution law – Comparison of the three distribution laws.

Books for Study:

Unit 1,2,3 - Classical Mechanics, by L.S. Gupta, V. Kumar, and H.V. Sharma, Pragati Prakashan Publication, 2007

Unit 4 - Statistical Mechanics, by Gupta and Kumar, Pragati Prakashan Publication and Modern Physics, by R. Murugeshan, Ninth Edition

Reference:

1. Classical Mechanics, by H.Goldstein, Addison Wesley
2. N.C. Rana and P.S. Joag, Classical Mechanics (Tata Mc Graw Hill, 1991)
3. A. Sommerfield, Mechanics (Academic Press, 1952)
4. G.H. Wannier , Statistical Physics.(2nd edition)

Core Paper 2 Condensed Matter Physics

Unit I: Introduction

Crystal Structure: Basis of Crystal structure – Unit Cell: Primitive cell structures– Symmetry Operation – Types of Symmetry Operation – Translation operation, Point operation, Hybrid operation – Crystal types – Two and three dimensional crystal lattices – Indices of a lattice direction and a lattice plane - Miller Indices – Crystal Imperfections: Point imperfections – Vacancy, Substitution and interstitial impurity - Elastic constants of crystals – Elastic stress, Elastic strain.

Unit II: Free Electron Fermi Gas

Energy levels in One Dimension – Derivation of Fermi-Dirac Distribution – Effect of Temperature on the Fermi-Dirac Distribution – Free electron Gas in Three Dimension – Derivation of expression for electrical conductivity in metals - Derivation of Expression for Thermal conductivity in metals: Weidman-Franz Law - Phonons - Phonon heat capacity: Planck Distribution - Normal Mode Enumeration - Density of States in One and Three Dimension - Debye Model for Density of States - Debye T^3 Law.

Unit – III: Dielectric and Ferroelectrics

Diamagnetism: Classical Theory of diamagnetism (Langevin's Theory) - Paramagnetism: Classical Theory of Paramagnetism (Langevin's theory and curie law for paramagnetism) – Polarization and Susceptibility –The Local Field – Dielectric constant and Polarizability - Source of Polarizability: Electronic, Ionic and Orientation Polarization - Frequency dependence of total polarization - Basics of Ferroelectricity.

Unit – IV: Plasmons, Polaritons and Polarons

Basics of Plasma optics: Plasmons - Basics of Electrostatic Screening: Screened coulomb potential, Pseudopotential component - Basics of Polarition – LST Relation – Polarons (Electron-phonon interaction) – Superconductivity: Introduction - Meissner effect – Supercurrents and Penetration Depth - Critical field and Critical temperature – Soft superconductors (Type I) – Hard Superconductors (Type II) - Some Applications of superconductors.

Books for study

Unit 1 Elements of Solid state Physics, by J.P. Srivastava, Prentice Hall of India Private Limited.

Unit 2 Introduction to Solid State Physics, by Charles Kittel, Seventh Edition.

Unit 3. Solid State Physics and Electronics, by R.K.Puri and V.K.Babbar, S.Chand & Company Ltd.

Unit 4 (i) Introduction to Solid State Physics, by Charles Kittel, Seventh Edition.
(ii) Solid State Physics and Electronics, by R.K.Puri and V.K.Babbar, S.Chand & Company Ltd.

Reference:

1. Solid state Physics, by S.O.Pillai, New Age international Publishers
2. Materials Science and Engineering, by V. Raghavan, Fourth Edition
3. Introduction to Solid State Theory, by Madelung
4. Quantum theory of Solid State, by Callaway
5. Quantum theory of Solid State, by Kittel

Core Paper 3 FUNDAMENTALS OF NANOSCALE SCIENCE

Unit I :

Background to nanotechnology - scientific revolutions – types of nanotechnology and nano machines – atomic structure – molecules & phases – energy – molecular and atomic size – surfaces and dimensional space – top down and bottom up. Misnomers and misconception of Nanotechnology.

Unit II :

Basic problems and limitations - opportunities at the nanoscale – time and length scale in structures – energy landscapes – basic intermolecular forces – interdynamic aspects of intermolecular forces. Evolution of Band structures and Fermi surface.

Unit III :

Definition of a nano system -dimensionality and size dependent phenomena; Quantum dots, Nanowires and Nanotubes, 2D films; Nano & mesopores – size dependent variation in Magnetic, electronic transport, reactivity etc.,

Unit IV :

Forces between atoms and molecules, particles and grain boundaries, surfaces - strong intermolecular forces - Van der Waals and electrostatic forces between surfaces – similarities and differences between intermolecular and interparticle forces – covalent and coulomb interactions – interactions involving polar molecules and polarization – weak intermolecular forces and total intermolecular pair potentials – Forces between solvation, hydration; polymers at surfaces; adhesion – thermodynamics of self-assembly; micelles, bilayers, vesicles – bionanomachines – biological membranes.

References:

1. Nanotechnology: basic science and emerging technologies – Mick Wilson, Kamali Kannangara, Geoff Smith, Michelle Simmons, Burkhard Raguse, Overseas Press (2005).
2. Amorphous and Nanocrystalline Materials: Preparation , Properties, and Applications, A.Inoue, K.Hashimoto (Eds.,) (2000)
3. Understanding Nanotechnology, Scientific American, editors at Scientific American, Warner Books (2002)

4. Introduction to Nanotechnology by Charles P. Poole, Frank J. Owens, Wiley-Interscience (2003).
5. www. nanonet.rice.edu/intronanosci/
6. www.acclab.helsinki.fi/~knordlun/nanotiede/
7. Nanotechnology: A Gentle Introduction to the Next Big Idea, Mark A. Ratner, Daniel Ratner, Mark Ratne, Prentice Hall PTR; 1st edition (2002)

QUANTUM PHYSICS AND APPLICATIONS (Elective 1)

Unit I: Quantum Physics

Basis of Quantum Physics – De Broglie's concept – Operators – Bra and Ket notation- Physical imperfection of wave function – Normalised and orthogonal wave function - Heisenberg's Uncertainty Principle – Statement and illustrations.

Unit II: Quantum Dynamics

Linear Harmonic oscillator – Operator Method - Hydrogen atom – Solution of radical Equation – Energy Eigen value - Angular momentum – Total angular momentum operators – Commutation relationship with components - Addition of angular momentum (Elementary ideas only)

Unit III: Approximate Methods and Scattering

WKB approximation – variational method – Ground state Helium – Scattering – Differential Scattering – Scattering cross-section - Stationary scattering wave – Scattering amplitude

Unit IV: Perturbation Theory

Stationery Perturbation theory- Non degenerate case – First order perturbation – Evaluation of first order energy and wave function – Degenerate case – Removal of degeneracy in the first order

Books for Study:

1. Quantum Mechanics – Satya Prakash and C. K Singh Kedar Nath and Ram Nath Co
2. Quantum Mechanics – G. Aruldhas – Princitan Hall of India, New Delhi

References

1. L. I. Schiff, Quantum mechanics (McGraw-Hill)
2. Modern Physuics and Quantum Physics – E.E Anderson, Macmillan Co., India

Electronics (Elective 2)

Unit – I: Transistor

Bipolar Junction Transistor (BJT), Junction Field Effect Transistor (JFET), Metal Oxide Semiconductor Field Effect Transistor (MOSFET) and Metal-Semiconductor Junction Field Effect Transistor (MESFET): Structure, working, I-V characteristic studies and Applications.

Unit – II: Microwave Devices

Tunnel Diode, Transfer Electron devices (Gunn Diode) – principle, working, I-V characteristic studies and Applications - PIN diode: Structure, working, - PIN diode parameters - PIN diode as switches - PIN diode as limiters.

Unit – III: Photonic Devices

Radiation and non radioactive transition – Optical absorption - Photo detectors – Photo Diode - Light Emitting Diode (LED) – Principle, Construction, Working and Characteristics – Laser - Absorption and Emission of radiation – Population inversion – Properties of Laser Beam – Semiconductor Laser, Diode laser.

Unit – IV: Memory devices and other Electronic devices

Static and dynamic random access memories (SRAM and DRAM), CMOS, optical and Ferroelectric memories, - Electro optic Effect: Introduction, Electro optic effect in KDP crystals: longitudinal mode, Transfers mode, Electro optic effect in lithium niobate crystals – Acoustooptic effect: Introduction, Raman-Nath and Bragg regimes of diffraction.

Books for study:

Unit 1 - Basic Electronics, by B.L. Theraja,
Unit 2 - Microwaves, by M.L. Sisodia, V.L. Gupta, and New Age International, 2001.
Unit 3 - (i) Semiconductor Devices, by Kanaan Kano, Prentice Hall of India Pvt.
(ii) Modern Physics, by R. Murugeshan, Ninth Edition
Unit 4 - (i) Digital Computer Fundamentals by Thomas C. Bartee, Tata Mc Graw Hill
(ii) Optical Electronics by Ajoy Ghatak and K. Thyagarajan, Cambridge University Press

Reference:

1. Semiconductor Devices – Physics and Technology, by S.M. Sze. Wiley (1985)
2. Introduction to Semiconductor devices, M.S. Tyagi, John Wiley & sons
3. Measurement Instrumentation and experimental Design in physics and Engineering, by M. Saver and A. ManSingh, Prentice Hall, India (2000)
4. Optical Electronics by Ajoy Ghatak and K. Thyagarajan, Cambridge University Press.

II Semester
Core Paper 4 SYNTHESIS OF NANO MATERIALS

Unit I :
Nano outline - introduction – various preparation techniques – basic concepts of nano-structured materials – nucleation: surface nucleation growth – grain size distribution – nano particle transport in low density media – vapour nano phase thermodynamics – coagulation of nano particles, determination of grain size – aggregate formation – mass fractal morphologies.

Unit II :
Film deposition methods - introduction – fundamentals of film deposition – thermal evaporation – Spray Pyrolysis, Flame Pyrolysis - molecular beam epitaxy – pulsed laser deposition – sputter deposition – chemical vapour deposition – layer by layer growth and ultra thin films – chemical solution deposition – Langmuir Blodgelt films.

Unit III :
Sol-gel processing - fundamentals of sol-gel process – sol-gel synthesis methods for oxides –other inoranics and nano composites – the Pecheni method – silica gel – zirconia and Yttrium gel – aluminosilicate gel – polymer nano composites.

Unit IV :
New forms of carbon – types of nanotubes – formation of nanotubes – methods and reactants - arcing in the presence of cobalt – laser methods – ball milling – chemical vapour deposition methods – Catalytic route – properties of nano tubes – plasma arcing – electro deposition – pyrolytic synthesis – zeolites and templated powders layered silicates, soft chemical & combustion methods, Graphene.

References:

1. www.eng.uc.edu/~gbeaucag/Classes/NanoPowder.html
2. Nanoelectronics and information technology: Advanced electronic materials and novel devices (2^{nd} edition), Rainer Waser (Ed.), Wiley-VCH Verlag, Weiheim (2005).
3. Recent Advances in the Liquid-phase syntheses if inorganic nanoparticles, Brain L.Cushing, Vladimir L.Kolesnichenko, Charles J. O'Connor, Chem Rev. 104 (2004) 3893-3946.
4. Nanocomposite science and technology, Pulickel M.Ajayan, Linda S.Schadler, Paul V.Braun, Wiley-VCH Verlag, Weiheim (2003).
5. Amorphous and Nanocrystalline Materials: Preparation, Properties, and Applications, A.Inoue, K.Hashimoto (Eds.,) (2000).

Core Paper 5 CHARACTERIZATION OF NANO MATERIALS

UNIT I :
Electron microscopes – scanning electron microscopes – transmission electron microscopes - scanning probe microscopy – atomic force microscopy – scanning tunneling microscope – Scanning Non-linear Dielectric microscopy - nano manipulator – nano tweezers – XPS – ICP.

Unit II :
Mechanical characterization - modulus and load carrying capability of nano region/compression – micro hardness - fatigue - failure stress and strain toughness – glass transition and relaxation behaviour – abrasion and wear resistance, super plasticity – Nano indentation.

Unit III :
Neutron and X-ray diffraction - Debye-Scherer formula – dislocation density – micro strain – comparison of X-ray and neutron powder pattern – the Rietveld for powder pattern – macro molecular crystallography using synchrotron radiation – role for neutron scattering in nanoscience.

Unit IV :
Optics - photonics of nanotechnology - properties of light and nano technology – interaction of light with nanao systems – absorbance, Surface plasma excitation, Size dependent PL – nano holes and photons – imaging – solar energy absorbents using nano particles – nano technology and day light – photonic crystals – wave guides and control of light paths.

References:

1. Nanotechnology: basic science and emerging technologies – Mick Wilson, Kamali Kannangara, Geoff Smith, Michelle Simmons, Burkhard Raguse, Overseas Press (2005).
2. Nanocomposite science and technology, Pulickel M.Ajayan, Linda S.Schadler, Paul V.Braun, Wiley-VCH Verlag, Weiheim (2003).
3. www.eng.uc.edu/~gbeaucag/Classes/XRD/NeutronDiffractionatLNL.pdf

Core Paper 6 INORGANIC SEMICONDUCTOR NANOMATERIALS

Unit I Basics of semiconductor physics

Introduction-Semiconductor-Doping-Concept of effective mass-Carrier transport, mobility and electrical conductivity-Optical properties of semiconductors-Excitons-Phonons-Types of semiconductors.

Unit II Quantum confinement in semiconductor nanostructures

Quantum confinement in one dimension: quantum wells- Quantum confinement In two Dimensions: quantum wires- Quantum confinement in three Dimensions: quantum dots-Superlattices band-Band Offsets-Quantum dot lasers.

Unit III Fabrication techniques and Physical processes

Requirements for an ideal semiconductor nanostructure - Epitaxial growth of quantum wells - Lithography and etching-Cleaved-edge overgrowth-Growth on vicinal substrates-Strain – Induced dots and wires - Electro statically induced dots and wires-Quantum well width fluctuations-Thermally annealed quantum wells-Semiconductor nanocrystals - Colloidal quantum dots-Self-assembly techniques - Physical processes in semiconductor nanostructures - Characterization of semiconductor nanostructures-Applications of semiconductor nanostructures.

Unit IV Processing and properties of inorganic semi conducting nanomaterials

Classification - thermodynamics and kinetics of phase transformations-Synthesis methods-Structure - Microstructural stability - Powder consolidation - Physical, Chemical, Mechanical properties - Catalytic properties - present and potential applications for nanomaterials.

References

1. Robert W. Kelsall, Mark. Geoghegan, Ian W. Hamley, Nanoscale Science and Technology, John Wiley and Sons, 2005 ISBN 0470850868

NANO ELECTRONICS (Elective 3)

Unit I :
Basics of nano electronics - what will nano electronics do for us? – some physical fundamentals – basics of information theory- the birth of electronics – the tools for micro and nano fabrication- Basics of Lithographic techniques for nano electronics.

Unit II :
Quantum electronic devices - from classical to quantum physics: upcoming electronic devices – electrons in mesoscopic structure – short channel MOS transistor – split gate transistor – electron wave transistor – electron spin transistor – quantum cellular automate – quantum dot array – principles of Single Electron Transistor (SET) – SET circuit design – comparison between FET and SET circuit design.

Unit III :
Nano electronics with tunneling devices and super conducting devices – tunneling element technology RTD – circuit design based RTD –Defect tolerant circuits, Molecular electronics - elementary circuits – flux quantum devices – applications of super conducting devices - Nanotubes based sensors, Fluid flow, gas temperature ; Strain – Oxide nanowires; gas sensing (ZnO, TiO_2, SnO_2, WO_3); LPG sensor (SnO_2 powder) - Nano designs and Nano contacts – Metallic nanostructures.

Unit IV :
Memory devices and sensors – Nano ferroelectrics - ferroelectric random access memories – introduction – Fe RAM circuit design – ferroelectric thin film properties and integration – calorimetric sensors – electrochemical cells – surface and bulk acoustic devices – gas-sensitive FETs – resistive semiconductor gas sensors – electronic noses – identification of hazardous solvents and gases – semiconductor sensor array – study on smellier of aroma of food – monitoring the roasting process of food.

References:

1. Nanoelectronics and Nanosystems: From transistors to molecular devices. K.Goser, P. Glosekotter, J. Dienstuhl, Springer (2004)
2. Nanoelectronics and information technology: Advanced electronic materials and novel devices (2^{nd} edition), Rainer Waser (Ed.), Wiley-VCH Verlag, Weiheim (2005).
3. Nanotechnology: basic science and emerging technologies – Mick Wilson, Kamali Kannangara, Geoff Smith, Michelle Simmons, Burkhard Raguse, Overseas Press (2005).

Practical I

GENERAL AND ELECTRONIC PRACTICALS

1. Nanopsoitioner with interferometer
2. AFM on thin granular films
3. CB trough
4. Light scattering and particle size measurements
5. Everyday objects (Pollen grain, hair) and optical microscope
6. UV-vis absorption – surface phenomena excitation
7. PL of semi conductor nano particles
8. Raman on nanotubes
9. Micro hardness on films

III Semester

Core Paper 7 NANO LITHOGRAPHY

Unit I

Optical lithography:

Contact and proximity printing - Projection Printing – Mask alignment, Reflection and catadioptric projection - Refraction projection – Enhancement - overlay-accuracies. Positive and negative photoresists, UV – photolithography for systems of 100 nm – Nano designs for electronic circuits.

Electron Lithography:

Electron optics - Raster scan and Vector scan - Electron proximity / Projection Printing, Electron resists - Electron Beam Applications -

X – ray Lithography:

Proximity printing - X-ray masks - X-ray sources - Synchrotron radiation - X-ray projection - X-ray resists.

Unit II

Ion Lithography:

Focused ion beam - Point sources of Ion - Ion column - Beam writing - Focused Ion Beam Lithography - Masked Ion Beam Lithography - Ion Projection Lithography.

Lithography based on Surface Instabilities:

Wetting, Dewetting, Adhesion Limitations - Resolution and Achievable / line widths of each of the above techniques.

Unit III

Nanolithography techniques:

High – resolution E-beam Nanolithography - Resist Exposure Metrics - High resolution resists - Proximity Effects - Direct writing.

Unit IV

Proximal Probe Nanolithography:

STM – AFM - Dip pen Nano lithography - Resists & Imaging Layers for proximal probes - Langmuir – Blodgett Film resists – Patterned synthesis of

nanomaterials - Self-Assembled Monolayers Resists - Anodic Oxidation - Nanoscratching.

References

1. C.Y. Chang and S.M.Sze, "ULSI Technology", McGraw-Hill Companies Inc., Singapore, 1996.
2. John N. Helbert, "Hand Book of VLSI Microlithography", Noyes Publication, USA, 2001.
3. James R. Sheats and Bruce W. Amith, "Microlithography Sciences and Technology", Marcel Dekker Inc., New York, 1998.

Core Paper 8 NANO BIOTECHNOLOGY

Unit I :
Biology inspired concepts - biological networks – biological Neurons – the function of neuronal cell – biological neuronal cells on silicon modeling of neuronal cells by VLSI circuits – bioelectronics – molecular Processor – DNA analyzer as biochip – molecular electronics

Unit II :
Nano-biometrics - introduction – lipids as nano-bricks and mortar: self assembled nanolayers – the bits that do think – proteins – three dimensional structures using a 20 amino acid – biological computing – A Protein based 3D optical memory using DNA to build nano cubes and hinges - DNA as smart glue – DNA as wire template – DNA computer.

Unit III :
Natural nano composites - introduction – natural nano composite materials – biologically synthesized nano structures – biologically derived synthetic nano composites – protein based nanostructure formation – biologically inspired nano composites. Nanotechnology in Agriculture (Fertilizers and pesticides).

Unit IV :
Nanoanalytics - quantum dot biolabeling – nanoparticle molecular labels – analysis of biomolecular structure by AFM and molecular pulling-force spectroscopy– biofunctionalized nanoparticles for SERS and SPR.

References:

1. Nanoelectronics and Nanosystems: From transistors to molecular devices. K.Goser, P. Glosekotter, J. Dienstuhl, Springer (2004)

2. Nanotechnology: basic science and emerging technologies – Mick Wilson, Kamali Kannangara, Geoff Smith, Michelle Simmons, Burkhard Raguse, Overseas Press (2005).
3. Nanobiotechnology**:** Concepts, Applications and Perspectives, Christof M.Niemeyer, / Chad A.Mirkin, (eds.), Wiley-VCH, Weinheim, (2004)
4. Bionanotechnology : Lessons from Nature**,** by: David S. Goodsell, Wiley-Liss (2004)
5. NanoBiotechnology Protocols**,** Sandra J Rosenthal, David W.Wright, Series: Methods in Molecular Biology, (2005)
6. Protein Nanotechnology, Protocols, Instrumentation, and Applications, Tuan Vo-Dinh, Series: Methods in Molecular Biology (2005).

Core Paper 9 NANO-MEDICINE AND DRUG DELIVERY SYSTEMS

Unit I: Prospect of Nano-Medicine

History of the idea – The Biological and Mechanical Traditions – Nano-medicine - Taxonomy – Bio-Pharmaceuticals – Implantable Materials – Implantable Devices – Surgical Aids – Diagnostic Tools – Genetic Testing – Imaging – Nanoparticles Probe – Case Analysis – 1) Resiprocytes – Mechanical Artificial Red Cells – 2) Using DNA as a construction medium

Unit II: Nanosensors

Chemical and Molecular Sensors – Displacement and Motion Sensors – Force Nanosensors – Pressure Sensing – Thermal Nanosensors – Electric and Magnetic Sensing – Cellular Bioscanning – Non-invasive Neuroelectric Monitoring – Macrosensing – Acoustic Macrosensing – Electric and Magnetic Macrosensing – Neural Macrosensing

Unit III: Nanocarriers for Drug Delivery

Needs and Requirements – Nanoparticle Flow: Implications for Drug Delivery – Polymeric Nanoparticles as Drug Carriers and Controlled Release Implant Devices – Genetic Vaccines: A Role for Liposomes – Polymer Micelles as Drug Carriers – Recent Advances in Microemulsions as Drug Delivery Vehicles – Lipoproteins as Pharmaceutical Carriers – Solid Lipid Nanoparticles as Drug Carriers

Unit IV: Nanocapsules – A New Drug Delivery System

Nanocapsules preparation, Characterization and Therapeutic Applications – Dendrimers as Nanoparticulate Drug Carriers – Cells and Cell Ghost as Drug Carriers – Cochleates as Nanoparticular Drug Carriers – Aerosols as Drug Carriers – Magnetic Nanoparticles as Drug Carriers – Nanoparticulate Drug Delivery to the Reticuloendothelial System and to Associated Disorders – Delivery of Nanoparticles to

the Cardiovascular System – Nanocarriers for the Vascular Delivery of Drugs to the Lungs – Nanoparticulate Carriers for Drug Delivery to the Brain – Nanoparticles for Targeting Lymphatics – Polymeric Nanoparticles for Delivery in the Gastro-Intestinal Tract – Nanoparticular Carriers for Ocular Drug Delivery – Nanoparticles and Microparticles as Vaccines Adjuvants – Pharmaceutical NanoCarriers in Treatment and Imaging of Infection

References

1. Nano Medicines Edited by Dr.Parag Diwan and Ashish Bharadwaj, Pentagon Press(2006) ISBN 81-8274-139-4
2. Nanoparticulates as Drug Carriers
   Edited by Vladimir P.Torchilin, Imperial College Press, North Eastern University, USA (2006) ISBN 1-86094-630-5

NANOSCALE MAGNETIC MATERIALS AND DEVICES (Elective 4)

Unit I: Overview of Magnetism in Solids

Introduction – Magnetic fundamentals – Spontaneous Magnetization and Curie Temperature – Magnetic Parameters – Stoner-Wohlfarth threshold – Anti-ferromagnetic materials – Memory Fundamentals – Magnetic Storage Fundamentals.

Unit II: Fundamentals of Nanomagnetism

Electron Transport in Magnetic Multi-layers – Spintronics - Spin Polarized Electron Tunneling – Interlayer Exchange Coupling – Spin Relaxation in Magnetic Metallic layers and Multi-layers - Non-Equilibrium Spin Dynamics in Laterally Defined Magnetic Structures

Unit III: Fabrication and Characterization of Nanomagnetic materials

Particulate Nanomagnets – Geometrical Nanomagnets – Fabrication Techniques Scaling – Characterization using Various Techniques – Imaging Magnetic Microspectroscopy – Study of Ferromagnetic & and Antiferromagnetic Interfaces – Optical Imaging – Lorentz Microscopy – Electron Holography of Magnetic Nanostructures –Magnetic Force Microscopy

Unit IV: Applications and Devices

Magnetic Data Storage – Introduction – Magnetic Media – Properties – Materials Used – Write Heads – Read Heads – Magnetoresistance – General – in Normal Metals and in Ferromagnetic Materials – Future of Magnetic Data Storage - Magneto-Optics and Magneto-optic recording – Kerr Effect – Faraday Effect, Magnetic Semiconductors, Spintronics devices, noise reduction.

References

1. Advanced semiconductor and organic Nano-techniques - Vol I
   Hadis Morkoc, Academic Press, London (2003) ISBN 0125070616
2. Modern Techniques for Characterizing Magnetic Materials
   Edited by Yimei Zhu, Springer (2005) ISBN 1402080077
3. Magnetic Microscopy of Nanostructures
   Hans P.Oepen and H.Hopster, Springer (2004) ISBN 3540401865
4. Ultra thin Magnetic Structures III – Fundamentals of Nanomagnetism
   JAC Bland and B. Heinrich, Springer (2004) ISBN 3540219536
5. Magnetic Materials : Fundamentals and Device Applications
   Nicola Ann Spaldin, Cambridge University Press (2003) ISBN 0521016584

Practical II

NANOTECHNOLOGY PRACTICALS

1. **Preparation of ZrO_2 nanoparticle by co-precipitation method**
2. **Preparation of TiO_2 nanoparticle**
3. **Sol-gel preparation (Different compounds)**
4. **Processing of particles by plasma torch**
5. **Thin film preparation (Sputtering)**
6. **Polymer nanocomposite**
7. **Preparation of nanoparticle by ball milling**
8. **Conductivity studies of nanocomposite material – Four probe method**
9. **Synthesis of nanocomposite materials**
10. **Effect of particle on conductivity of polymer composite**
11. **Construction of solar cells with nanoparticle (TiO_2)**
12. **SnO_2 based LPG sensor**
13. **Nanoscrubing in polycarbonate (CD) using AFM (Prose – Si_3N_4)**
14. **Solvothermal method for ZnO – band edge in UV - Vis spectroscopy – size of the particle**

IV Semester
Theory Paper Related to Project

NANOSTRUCTURE CONTROL OF MATERIALS

Unit I : Processing of Nanoparticles and Films

Introduction; Particles - Nucleation and Growth - Stable Dispersion and Agglomeration - Metals, Intermetallics, Alloys, and Composites – Ceramics - Host-Derived Hybrid Materials - Stabilized Dispersions - Surfactant Membrane Mediated Synthesis; Films and Coatings– Metals - Ceramics

Unit II Structural Studies

X - ray Diffraction Method – Scanning Electron Microscopy – Transmission Electron Microscopy – Atomic Force Microscopy – Scanning Tunneling Microscopy – FT Infrared Spectroscopy – Raman Spectroscopy.

Unit III Spectroscopic Techniques

Nuclear Magnetic Resonance – Photoluminescence – UV – visible spectroscopy – Mössbauer spectroscopy – Surface Enhanced Raman Spectroscopy.

Unit IV Applications

Design of nanoparticles for oral delivery - Development of polymer-clay nanocomposites - Nanoparticle formation of DNA - Addressing of nanoparticles by using DNA molecules- Dendrimers and their application to organic electronics devices - Development of the thermoresponsive magnetic nanoparticle and its deployment in the biotechnology field - Development of fuel cells - Development of a high-performance secondary battery by controlling the surface structure - Pinpoint drug and gene delivery - Evaluation and applications of dispersing carbon nanotube in the polymers - Surface modification of inorganic nanoparticles by organic functional groups - Application of quantum dots for bio-medical engineering.

References:

1. Carl C. Koch (2002) Nanostructured Materials : Processing, Properties and Potential Applications, Noyes Publication, New York, USA.
2. C. Richard Brundle, Charles A. Evans Jr., Shaun Wilson (1992) Encyclopedia of Materials Characterization, Butterworth-Heinemann Publishers.
3. Masuo Hosokawa, Kiyoshi Nogi, Makio Naito, Toyokazu Yokoyama (2007)Nanoparticle Technology Handbook, Elsevier Publishers.

Compulsory Diploma Course

DIPLOMA IN COMMUNICATIVE ENGLISH

DIPLOMA PAPER-I: SPEAKING &WRITING –I

Speaking

Unit-I

Introduction and greetings- asking for information- offerings- requisitions- inviting – vocabulary building- asking for description.

Unit-II

Role-plays in various authentic situations-Debating various points of views- the ability to expression points of view information gathering activities concerning time, place and personal descriptions- groups and pair discussion

Writing

Unit-I

English grammar: adjectives, adverbs-conjunctions-interjections- nouns-Prepositions-pronouns- verbs-functional shift- case, gender, mood-Number-person- tense- subject-verb agreement- modifiers- pronoun.

Unit-II

Punctuation and mechanics-abbreviations - capitalization-Contractions- dates-indentation-italics, numbers- proofreading-spelling-symbols.

References

T. Balasubramanian: "A Text book of English Phonetics for India Students"

A.S. Hornby: "Oxford Advanced Learner's Dictionary of Current English"

Pickett and Laster, Technical English, Writing, Reading and Speaking, New York Harper and Row
Publications.

Swan, Michael, Basic English Usage, Oxford University Press, 1984

DIPLOMA PAPER-II: LISTENING & READING –I

Listening

Unit-I

Listening process- speaker- hearer-types of listening- transitional listening- -critical listening- recreational listening- listening for appreciation- selective listening- intensive listening- extensive listening.

Unit-II

Listening different kinds of spoken text: Announcements- interviews -Group discussions- dialogues- News items.

Reading

Unit-I

Definitions of reading- types of reading- oral reading – silent reading - reading process classification of reading-nature of reading

Unit-II

Reading comprehension- recognition unfamiliar lexical items- explicitly stated information- understanding conceptual meaning- identifying main points- distinguishing the main ideas- extracting salient points- referencing – scanning specific location.

References

T. Balasubramanian: "A Text book of English Phonetics for India Students"

A.S. Hornby: "Oxford Advanced Learner's Dictionary of Current English"

Pickett and Laster, Technical English, Writing, Reading and Speaking, New York Harper and Row
Publications.

Swan, Michael, Basic English Usage, Oxford University Press, 1984

DIPLOMA PAPER-III: SPEAKING &WRITING –II

Speaking

Unit-I

Real - life situations through role-playing - interaction with peers - Phonological aspects of language use - pronunciation, stress and intonation

Unit-II

Introducing oneself and others, narrating events - Making telephonic conversation- Giving instruction- Expressing purposes and functions- obligation and preferences, Accepting offers and Counselling,

Unit-III

Interpreting advertisements-Presenting one's ideas at meetings and conferences, Making extempore talks-Public speaking- Body language, Strategic competence.

Writing

Unit-I

Writing process- rhetoric and composition- forms of discourse-description-exposition-narration-persuasion-sentence construction, paragraph construction.

Unit-II

writing introductions-Style and language completeness and coherence- sentence variety- structure-abstract/concrete word - note-taking- formal and informal letters-Expressions of opinions

References

T. Balasubramanian: "A Text book of English Phonetics for India Students"

A.S. Hornby: "Oxford Advanced Learner's Dictionary of Current English"

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Publications.

Swan, Michael, Basic English Usage, Oxford University Press, 1984

DIPLOMA PAPER-IV: LISTENING & READING -II

Listening

Unit-I

Purpose of listening- discriminative listening-aesthetic listening-efferent listening- critical listening- therapeutic listening

Unit-II

Listening for main ideas- inference- sequences- specific information-Listening comprehension of authentic All India radiobroadcasts in English- Television New items in English- running commentaries- telephone conversation

Reading

Unit-I

Definitions of reading- purpose of reading - classification of reading- skimming- scanning- extensive reading- intensive reading- effective reading- methods of reading

Unit-II

Reading comprehension of authentic text- time-tables -schedules- advertisements- dialogues- pie-chart- communicative and decision making activities based on authentic reading materials

References

T. Balasubramanian: "A Text book of English Phonetics for India Students"

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Publications.

Swan, Michael, Basic English Usage, Oxford University Press, 1984