Minutes of the Board of Studies of the Department of Applied Physics, Z.H. College of Engg. & Tech., A.M.U., Aligarh, held on 1.5.2008 at 10:30 AM in the department.

The following members were present:
1. Prof. Jayed Hussain
2. Dr. M.K. Bhardwaj
3. Prof. Afzal Ahmad
4. Prof. Rahimullah Khan (Dept. of Physics, AMU, Aligarh)
5. Dr. M.A. Suhail
6. Dr. Ameer Azam
7. Dr. Shahaad Khan
8. Prof. Alimuddin (in the Chair)

The Chairman welcomed the members of the B.O.S. before taking up the agenda.

The following decisions were taken:

1. Confirmed the minutes of the last B.O.S. held on 21.2.2008.

Under Any Other Item,
detailed discussion was held on the question of appointment of the supervisor from outside the Department of Applied Physics. During the discussion following points were considered:

1. The Ordinance (Academic) Chapter XXV of the University dealing with the Ph.D. programme of the University allows the appointment of the Supervisor of Research Scholar registered in a Department from Department other than the parent Department in the University when adequate facilities for carrying out the research work exists.
2. The Department of Applied Physics has recently started the research and teaching programme in Nanotechnology and related areas in a big way. It is a well known fact that the Nanotechnology is interdisciplinary area in which the expertise is needed from biological science, biotechnology and all sort of disciplines in science & Engineering.

Contd...
Syllabi of the Courses of
M.Tech.( Nanotechnology)

SEMESTER -I

PAPER I (AP-610)
FUNDAMENTALS OF NANOTECHNOLOGY (AP-610)

Introduction
Review of Nanotechnology, Ideas about building things with atom, possible application in Science & Technology, Ethical aspects of Nanotechnology

Self Assembly and Catalysis
Process of Self-Assembly, Semiconductor Islands, Monolayers, nature of Catalysis, Surface Area of Nanoparticles, Porous Materials, Pillared Clays, Colloids

Biological Materials
Introduction, Biological Building Blocks, Size of building Blocks and Nanostructures, Polypeptide Nanowires and Protein Nanoparticle, Nucic Acids, DNA Double Nanowire, Genetic Code and Protein Synthesis, Biological nanostructures, Examples of Proteins, Miscells and Vesicles, Multilayer Films.

Quantum Wells, Wires and Dots
Introduction, Size and Dimensionality Effects, Size Effects, Conduction Electrons and Dimensionality, Fermi gas and Density of States, Potential Wells, Partial Confinement, Properties dependent on Density of States, Exitons

Nanotechnology in Carbon Materials
Fullerenes and Carbon Nanotubes, Fullerenes as nano-structures, structures of C60, C70 and higher fullerenes, Electronic properties of fullerenes, Carbon Tubules as Nano-structures, Observation of Carbon Nanotubes, Structure of carbon Nanotubes, Electronic structure of C-Nanotubes.

Books and References
3. Encyclopaedia of Nanotechnology by hari Singh Nalwa.
UNIT 1: Introduction
Wave-particle duality, Schrödinger equation and expectation values, Uncertainty principle

UNIT 2: Basics Of Quantum Mechanics
Solutions of the one-dimensional Schrödinger 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 3: 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 4: 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 5: Quantum Computation
Concept of quantum computation, Quantum Qbits etc.

Books And References
1. Modern Physics - Beiser
2. Quantum Mechanics - Bransden and Joachen
4. Quantum Physics – A. Ghatak
5. Principles of Quantum Mechanics 2nd ed. - R. Shankar
6. Quantum Mechanics - Vol 1&2 - Cohen-Tannoudji
PAPER III
PHYSICS AND CHEMISTRY OF SOLIDS (AP-612)

Structure Of Matter
Amorphous, crystalline, crystals, polycrystals, symmetry, Unit Cells, Crystal Structures (Bravais Lattices), Crystallographic Directions, Crystallographic Planes, Miller Indices, Bragg's Law, Single Crystal and Powder X-ray Diffraction

Chemical Bonding
Atomic Bonding in solids, Types of bond: Metallic, Ionic, Covalent and Venderwaals bond; Hybridisation; H-bonding
Molecular orbital theory for simple molecules such as diatomic molecule etc.

Types Of Material
Different types of materials: Metals, Semiconductors, Composite materials, Ceramics, Alloys, Polymers.

Imperfections In Solids
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.

Books And References
1. Introduction to Solid State Physics - C. Kittel
4. Elements materials science - Van Vlack
5. The Physics and Chemistry of Solids - Stephen Elliott & S. R. Elliott
PAPER IV
ELEMENTS OF PHYSICAL CHEMISTRY (AP-613)

Introduction To Thermodynamics
The first and second laws of thermodynamics. Thermodynamic functions, heat capacity, enthalpy, entropy. Equilibrium in one phase system, real gasses, the reactions between gases, reactions of solid-state phases, Phase rule, Phase diagram, reaction kinetics, rate equations.

Elementary Statistical Mechanics

Theory Of Solution And Related Topics

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.

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.

Books And References
1. Thermodynamics and Statistical Mechanics - A N Tikhonov, Peter T Landberg, Peter Theodore Landsberg
2. Thermodynamics and Statistical Mechanics by John M. Seddon, J. D. Gale
3. Thermodynamics by ZymanskyStatistical Physics by K. Huang
5. Physical Chemistry – Atkins Peter, Paula Julio
6. Physical Chemistry, 1st Edition -Ball

Page 4 of 15
PAPER V
SYNTHESIS AND CHARACTERIZATION OF NANOMATERIALS (AP-614)

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 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

Characterization Techniques
X-ray diffraction, Scanning Probe Microscopy, SEM, TEM, 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 measurements, Magnetic and electrical measurements.

Lithographic Techniques

Books And References
2. Introduction to Nanotechnology - Charles P. Poole Jr. and Franks. J. Owens
3. Novel Nanocrystalline Alloys and Magnetic Nanomaterials- Brian Cantor
5. Springer Handbook of Nanotechnology - Bharat Bhushan
6. Instrumental Methods of Analysis, 7th edition- Willard, Merritt, Dean, Settle
7. Processing & properties of structural nanomaterials by Leon L. Shaw (editor)
8. Chemistry of nanomaterials : Synthesis, properties and applications by CNR Rao et.al.
9. Scanning Probe Microscopy: Analytical Methods (NanoScience and Technology) - Roland Wiesendanger
10. Advanced X-ray Techniques in Research and Industries - A. K. Singh (Editor)
14. 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

CHAIRPERSON
Dept. of Applied Physics
Aligarh Muslim University
Aligarh
PAPER I

NANOBIOTECHNOLOGY (AP-615)

Introduction
Structure and organization of typical animal cell, dimensions of biomolecules and cells, structure and conformational properties of protein, nucleic acid and other biomolecules, cell surface receptor and their specific ligands, antigen antibody interaction, blood brain barrier

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 nanostructures for mechanics and computing and DNA based computation; DNA based nanomechanical devices. Biosensor and Biochips.

Drug Delivery, Therapeutic Action Of Nanoparticles And Nanodevices
Targeted, non-targeted delivery; controlled drug release; exploiting novel delivery routes using nanoparticles; gene therapy using nanoparticles; Nanostructures for use as antibiotics; Diseased tissue destruction using nanoparticles;

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

Books And References
1. Nanobiotechnology: 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

CHAIRPERSON
Dept. of Applied Physics
Z.H. College of Engg. & Tech.
A.M.U., Aligarh

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PAPER II
PROPERTIES OF NANOMATERIALS (AP-616)

Introduction
Properties of materials & nanomaterials, role of size in nanomaterials.

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

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
Polarization, ferroelectric behaviour.

Magnetic Properties

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

Thermal Properties
Concept of phonon, Thermal conductivity, Specific heat, Exothermic & endothermic processes.

Mechanical Properties

Books And References
1. Novel Nanocrystalline Alloys and Magnetic Nanomaterials- Brian Cantor
3. Encyclopedia of Nanotechnology- Hari Singh Nalwa
4. Introduction to Nanotechnology - Charles P. Poole Jr. and Franks. J. Owens
6. Physics of Magnetism - S. Chikazumi and S.H. Charap
7. Physical Theory of Magnetic Domains - C. Kittel
8. Magnetostriiction and Magnetomechanical Effects - E.W. Lee
9. Springer Handbook of Nanotechnology - Bharat Bhushan
10. Electronic transport in mesoscopic systems, Supriyo Datta
PAPER III
NANOCOMPOSITES (AP-617)

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.

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

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

Books and References:
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 Vepriek (Review Article) JVST A, 1999
5. Electromagnetic and magnetic properties of multi component metal oxides, hetero
7. Diblock Copolymer, - Aviram (Review Article), Nature,
SEMESTER III
PAPER I
NANOSENSORS AND NANODEVICES (AP-719)

Micro and Nano-Sensors
Fundamentals of sensors, biosensor, micro fluids, MEMS and NEMS

Packaging and Characterization of Sensors
Method of packaging at zero level, dye level and first level.

Sensors
Sensors for aerospace and defense: Accelerometer, Pressure Sensor, Night Vision System, Nano tweezers, nano-cutting tools, Integration of sensor with actuators and electronic circuitry, Sensor for bio-medical applications: Cardiology, Neurology and as diagnostic tool, For other civil applications: metrology, bridges etc.

Biosensors
Clinical Diagnostics, generation of biosensors, immobilization, characteristics, applications, conducting Polymer based sensor, DNA Biosensors, optical sensors

Biochips
Metal Insulator Semiconductor devices, molecular electronics, information storage, molecular switching, Schottky devices

Quantum Structures and Devices
Quantum layers, wells, dots and wires, Mesoscopic Devices, Nanoscale Transistors, Single Electron Transistors, MOSFET and NanoFET, Resonant Tunneling Devices, Carbon Nanotube based logic gates, optical devices. Connection with quantum dots, quantum wires, and quantum wells

Books and References
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

CHAIRPERSON
Dept. of Applied Physics
Z.H. College of Engg. & Tech.
A.M.U., Aligarh
PAPER II
CARBON NANOTUBE AND ITS FUNCTIONALIZATION (AP-720)

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, Covalent Functionalization
-Oxidative Purification, Defect Functionalization – Transformation and Modification of Carboxylic Functionalization like Amidation, Thiolation, Halogenations, Hydrogenation, Addition of Radicals, Addition of Nucleophilic Carbenes, Sidewall
Functionalization through Electrophilic Addition, Cycloadditions, Carbenes Addition, Addition of Nitriles, Noncovalent
Exohedral Functionalization, Endohedral Functionalization

Other Important Carbon Based Materials
Preparation and Characterization Fullere and other associated carbon clusters/molecules, Graphene-preparation, characterization and properties, DLC and nanodiamonds.

Books And References
1. Nanoscale materials -Liz Marzan and Kamat
2. Synthesis functionalization and surface treatment of nanoparticles - Marie Isabelle Baraton
3. Physical properties of Carbon Nanotube-R Satio
6. CARBON NANOTECHNOLOGY- Liming Dai

Page 10 of 15
OPEN ELECTIVES:
MOLECULAR NANOELECTRONICS (AP-721)

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 transistors

Books and References:
1. Nanoelectronics & Nanosystems : From Transistor to Molecular & Quantum Devices: Karl Goser, Jan Dienstuhl and others
2. Concepts in Spintronics- Sadamichi Mackawa
3. Spin Electronics – David Awschalom
4. From Atom to Transistor- Supriyo Datta
(AP-723)

SEMICONDUCTOR NANOSTRUCTURES & NANO-PARTICLES

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

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.

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.

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

Books and References:
1. Encyclopedia of Nanotechnology- Hari Singh Nalwa
2. Springer Handbook of Nanotechnology - Bharat Bhusan
3. Handbook of Semiconductor Nanostructures and Nanodevices Vol 1-5- A. A. Balandin, K. L. Wang
4. Nanostructures and Nanomaterials - Synthesis, Properties and Applications - Cao, Guozhong
(AP-722)

OPTICAL PROPERTIES OF NANOMATERIALS, NANOPHOTONICS AND PLASMONICS

Metal Nanoparticles
Metal Nanoparticles, Alloy Nanoparticles, Stabilization in Sol, Glass and other media, Change of bandgap, Blueshift, Colour change in Sol, glass and composites, Plasmon Resonance.

Physics of Linear Photonic Crystals

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)

Application of Photonic Crystals Devices
1-D Photonic Crystals, Couplers, Waveguides, High-Q- Cavities, etc 2-D Photonic Crystals, Photonic Crystal Fibers, Tunable Photonic Crystal Filters.

Physics of Nonlinear Photonics 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: 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.

Books and References:
1. Springer Handbook of Nanotechnology by Bharat Bhushan
2. Encyclopedia of Nanotechnology- Hari Singh Malwa
3. The Handbook of Photonics By Mool Chand Gupta John Ballaoo
5. Nanoplasmonics, From fundamentals to Applications Vol 1 & 2 – S. Kawata & H. Masuhara
6. Optical Properties of Photonic Crystals- K. Sakoda
7. Applied Photonics by Chai Yeh
8. Silicon Photonics: An Introduction by Graham T. Reed, Andrew P. Knights.
NANO - ENTREPRENEURSHIP

Proprietorships, Partnerships, and Companies
Proprietorship versus Partnership versus Cooperative versus Private Limited Company versus Public Limited Company. Relative advantages and disadvantages Partnership Act; Franchising; Industrial cooperatives; Funding sources for small and medium scale sectors; Angel Investors; Venture Capital; Limited Liability Partnership; Salient features of the Companies Act as amended up to date; Proposed amendments to the Companies Act; Independent Directors; Shares; Initial Public Offer; Stock Market; Online stock trading

Other business considerations
Import Scenario in India; Contract Law; Advertising; Marketing; Consumer Protection Act; E-Commerce; Dealing with banks; Negotiable Instruments; Different types of Accounting and their advantages and disadvantages; Annual Reports; Sales Tax; Service Tax; Patents, Designs, Trade Marks, Copyrights, etc.; Business Insurance; Insolvency; Arbitration; Labour welfare; Special Economic Zones; Manufacturing Investment Regions; Corporate Social Responsibility; Comparison of Indian business laws with the business laws of other countries; Areas of reforms needed in Indian business laws

Business of Nano Technologies
Currently available nanotechnology products and products likely to be commercialized in future; Survey of nanotechnology companies in the world, in India and in Delhi and Aligarh areas; Proposed mega-size nanotechnology projects in Andhra Pradesh, Haryana and Karnataka; Ace Nanotech Pvt Ltd, Ace Nanocepts Technologies Pvt. Ltd., I Cube Nanotech India Pvt. Ltd, Nano Works Developers Pvt Ltd, Nanobiosym Technologies India Pvt Ltd, Nano Electrotech Pvt Ltd, Om Nanotech Pvt Ltd, Vrinda Nano Technologies Pvt Ltd, Facilitatory efforts for such companies by the Central and State Governments and by major business bodies in India; ASSOCHAM Nanotech Governing Council; CII Nanotechnology Initiative; Nano Science & Technology Consortium; Nanotechnology Business Group; Business models for Rs. 1-10 lakh, Rs. 10 lakh-1 crore, Rs 1-10 crore, Rs 10-100 crore, above Rs 100 crore. Need for Nanotechnology Act
MEMS AND THEIR APPLICATIONS

MEMS (An Introduction)
Triology of MEMS, diaphragm, beams, cantilever; mems based devices, pressure sensors, capacitive sensors, actuators, transducers, accelerometers, inertial sensors, bio-sensors, optical sensors, rf switch, resonators, gas sensors, vacuum sealed cavity, absolute pressure sensors.

Materials And Processing (1)
Single crystalline silicon. Microelectronic processes; chemical cleaning, oxidation, diffusion, ion-implantation pattern delineation, RIE, LPCVD. PECVD and APCVD of silicon, SiO₂ and Si₃N₄, mask layout using l-edit and mask fabrication. Wet and dry etching processes; isotropic etching, anisotropic etching. Anisotropic etching of crystalline silicon in aqueous koh; effect of temperature and KOH concentration, etching of silicon in KOH near boiling point.

Materials And Processing (2)
Micromachining; bulk, surface and front-side etching; convex and concave compensation. Back to front alignment; tools and processes. Thin film processes; e-beam evaporation, electro deposition, sputtering; rf, dc and magnetron. Polysilicon; sacrificial layer and piezo-resistive materials grain growth mechanism, doped polysilicon.

Processes And Tools
Compatibility of MEMS with microelectronics; neutralisation of koh traces, process sequence optimization. Deep reactive ion etching (DRIE) and liga processes. Microfluidics. MEMS-CAD tools; convector, ansys, intellisuit, smart sensors, design methodology of polysilicon piezo resistive pressure sensor. Anodic bonding of silicon to glass. Packaging of sensor chips. Materials for sensing applications in high temperature and harsh environment. Kelvin probe.

Books And References
Minutes of the meeting of the Board of Studies of the Department of Applied Physics, Z.H. College of Engg. & Tech., A.M.U., Aligarh, held on 17.1.2008 at 11:00 A.M. in the staff-room of the Department.

The following members were present:
1. Prof. Javed Husain
2. Prof. S. Alim Husain Naqvi
3. Dr. Ameer Azam
4. Dr. Shakesh Khan
5. Dr. M.A. Suhail
6. Dr. M.K. Bharadwaj
7. Prof. Alamuddin (in the chair)

The following decisions were taken:
1. Confirmed the minutes of the last B.O.S. held on 5.9.2007.
2. Allocated the teaching load of B.Tech. 1 year, Advanced P.G. Diploma in Nanotechnology and M.Tech. in Nanotechnology (even semester), Appendix-A
3. Appointed paper setters, examiners and moderators for B.E. 1st year Theory EAP-101 and Physics Lab. EAP-191, Appendix-B. (Not for circulation)
4. Approved the syllabus of 2nd Semester M.Tech. in nanotechnology.

Under Any Other Item:
1. Recommended the change of name of the Department from Department of Applied Physics to the Department of Applied Physics and Nanotechnology.
2. Approved thrust areas of the department.
3. It was reported by Prof. Alim Husain Naqvi that a proposal for DST support for M.Tech. (Nanotechnology) under the Department of Applied Physics, duly forwarded to DST by the Chairman, Dean (I&O) Engg., and Vice-Chancellor, AMU, was presented by him as Coordinator along with Dr. Ameer Azam (Reader), before a high level expert group of DST at JNCASR (Bangalore) on December 24, 2007. The Additional Mission Director (Nano Mission), Govt. of India, has communicated vide letter D.No. SR/NM/PG-11/2007 dated 10.1.2008, that the DST has approved the proposal in principle with a budget outlay of about Rs. 1.5 Crore (copy enclosed).

The DST approval letter was placed before the B.O.S. and the members of B.O.S. were pleased and welcomed the DST's approval and unanimously agreed to implement the DST recommendation w.e.f. the session 2008-2009.
4. Considered the request of Dr. M.K. Bharadwaj to appoint Prof. Pratibha Prasad Co-Supervisor of M.A. Mohd. Shakir Khan.

The meeting then came to an end.

[Signature]
CHAIRMAN

[Signature]
Prof. Alamuddin
Unit I Structure and organization of typical animal cell, dimensions of biomolecules and cells, structure and conformational properties of protein, nucleic acid and other biomolecules, cell surface receptor and their specific ligands, antigen antibody interaction, blood brain barrier (10 lectures).

Unit II Pharmacokinetics and pharmacodynamics of drug molecules, bio-distribution of drug molecules, factors affecting absorption, excretion and elimination of drug molecules in vivo system, nanoparticle based drug/antigen delivery systems (10 lectures)

Unit III Nano particles, nano tubes, nano shells, dendrimers as drug delivery system, Nano particles in cancer therapy, Nano particles in treatment of infectious diseases, Nano particles in tissue engineering. Nano particles in imaging, Nano particles in bio-sensors, nano wires and cantilevers, Nanoscale cantilevers - microscopic, flexible beams resembling a row of diving boards, detection of specific molecules with the help of specific substrates - DNA complementary to a specific gene sequence (10 lectures)

Unit IV Potential application of nano particles in biotechnology, diagnostics, medicine, agriculture, food industry and cosmetics (10 lectures)
EMERGENT TECHNOLOGIES
(AP-616)
Syllabus of course for M.Tech. in Nanotechnology
(3 credits)

Unit I: New Ideas in Mechanical Engineering:
Mechatronics; Mechanosynthesis; Future of automobile/Alternative propulsion
Robotics

Unit II: New Ideas in Civil Engineering:
Ground-penetrating imaging; Radar; Trenchless technology; New building
materials; Recycling; Water leak detection; Prevention of water intrusion in
concrete; Structural health monitoring; Intelligent Buildings; Green Buildings;
Energy efficient Buildings; Autonomous Buildings

Unit III: New Ideas in Chemical and Petroleum Engineering
Green chemistry; Self-Assembly; Fuel cells; Future energy development.
Petroleum engineering; Alternative fuels; Microfluidics; Lab-on-a-Chip

Unit IV: New Ideas in Electrical Engineering:
New batteries; Battery powered vehicles; Supercapacitors; Light emitting
diodes; Organic LED based light sources; Future of energy

Unit V: New Ideas in Electronic Engineering:
Radio frequency identification; Wireless Sensor Networks; System on chip;
Plastic and flexible electronics; Spintronics; Photonics; Molecular Electronics;
New television; New displays; New cameras

Unit VI: New Ideas in Computer Engineering:
Grid computing; Supercomputers; Artificial Neural Networks; Future of
personal computers; Wearable computers; New types of processors; New types
of memories; Unconventional Computing; Quantum computers; Quantum
encryption; Wireless mesh networking; New internet; Semantic Web;
Unsolved problems in computer engineering

References:

1) http://www.wikipedia.com
2) http://www.howstuffworks.com
3) http://www.encyclopedia.com
4) http://www.encyclopedia.com
5) http://www.wisegEEK.com
6) http://www.answers.com
7) http://www.techweb.com
8) http://emertech.blogspot.com
9) http://www.emergic.org
10) http://www.globalspec.com
11) http://www.new-technologies.org
12) http://www.accessscience.com
13) http://www.nap.edu/catalog
14) http://www.sciencedaily.com
15) http://www.highetchpublishing.com
16) http://www.zfrtimes.com

CHAIRPERSON
Dept. of Applied Physics
Z.H. College of Engg. & Tech.
A.M.U., Aligarh
EMERGENT TECHNOLOGIES
(AP - 617)
Syllabus of course for M.Tech. in Nanotechnology

AP-617
MEMS AND THEIR APPLICATIONS

UNIT I: MEMS (An introduction)
Tribology of MEMS, Diaphragm, beams, Cantilever; MEMS based
devices, pressure sensors, capacitive sensors, actuators, transducers,
accelerometers, inertial sensors, bio-sensors, optical sensors, RF switch,
resonators, gas sensors, vacuum sealed cavity, absolute pressure sensors.

UNIT II: Materials and Processing (1)
Single crystalline silicon. Microelectronic processes; chemical cleaning,
oxidation, diffusion, ion-implantation pattern delineation, RIE, LPCVD.
PECVD and APCVD of Silicon, SiO₂ and Si₃N₄. Mask layout using L-
edit and mask fabrication. Wet and dry etching processes; Isotropic
etching, Anisotropic etching. Anisotropic etching of crystalline silicon in
aqueous KOH; effect of Temperature and KOH concentration, Etching of
silicon in KOH near boiling point.

UNIT III: Materials and Processing (2)
Micromachining; bulk, surface and front-side etching; Convex and
concave compensation. Back to front alignment; tools and processes. Thin
film processes; c-beam evaporation, electro deposition, sputtering; RF, DC
and magnetron. Polysilicon; Sacrificial layer and Piezo-resistive materials
grain growth mechanism, doped polysilicon.

UNIT IV: Processes and Tools
Compatibility of MEMS with microelectronics; Neutralisation of KOH
traces, process sequence optimization. Deep Reactive Ion Etching (DRIE)
and LIGA Processes. Microfluidics. MEMS-CAD tools; Conventor,
Ansyl, Intellisuit, Smart Sensors, Design methodology of polysilicon
piezoresistive pressure sensor. Anodic bonding of silicon to glass.
Packaging of sensor chips. Materials for sensing applications in high
temperature and harsh environment. Kelvin Probe.

[Signature]
CHAIRPERSON
Dept. of Applied Physics
B.M. College of Engg & Tech.
A.M.U. Allahabad
Minutes of an ordinary meeting of the Board of Studies of the Department of Applied Physics, Z.H. College of Engg. & Tech., A.M.U., Aligarh, held on 11.05.2007 at 10:30 A.M. in the Staff Room of the Department.

The following members were present:

1. Prof. V.K. Rastogi (C.C.S. Univ. Meerut)
2. Prof. Javed Husain
3. Prof. S. Alam Husain Naqvi
4. Dr. Ameer Azam
5. Dr. Shakeel Khan
6. Dr. M.A. Suhail
7. Dr. M.K. Bhardwaj
8. Prof. Alimuddin (in the chair)

The following decisions were taken:

1. Confirmed the minutes of the last B.O.S. meetings, respectively, held on 10.02.2007 and 22.03.2007.
2. Allocated the teaching load of B.Tech 1yr, Odd semester 2007-2008 (Appendix – A).
3. Under any other item:
   (a) Approved the syllabi of New Courses (i) Advanced P.G. Diploma in Nanotechnology (ii) M.Tech. in Nanotechnology (Appendix – B).
   The Department of Applied Mathematics, Z.H. College of Engg. & Tech, A.M.U., Aligarh, be requested to teach the course AM-671, Advanced Mathematics to M.Tech. students.
   (b) Allocated the Teaching load of Advanced P.G. Diploma in Nanotechnology and M.Tech. in Nanotechnology. (Appendix – A).
   (c) Recommended inclusion of ‘Ali Garh Movement and Sir Syed Ahmad Khan’ in Humanities course (a few lectures).
   (d) The B.O.S. approved the organization of one-day workshop on Nanotechnology in the month of July or August 2007.
   (e) Recommended that the Academic Ordinances of M.Tech. should be brought into alignment with the Academic Ordinances of B.Tech. This will facilitate B.Tech. final year & M.Tech. students to attend the same classes of Open Elective papers and will considerably help to solve the problem of overloading of some of Departments of our College.

The meeting then came to an end.

[Signatures] 14/8/07

(CHAIRMAN)

(Prof. Alimuddin)

CHAIRMAN

Deptt. of Applied Physics
Z.H. College of Engg. & Tech.
A.M.U., ALIGARH
INTRODUCTION TO NANOPHYSICS AND NANOENGINEERING

1. **Introduction:**
   Review of Nanotechnology, Ideas about building things with an atom, possible application in Science & Technology Crystal Structure, Face Centered Cubic nanoparticles, Tetrahedrally bonded semiconductors, Lattice vibrations, Reciprocal space lattices and Brillouin zones.

2. **Nanostructured Materials:**
   Introduction, Methods of synthesis: Ball milling, sol-gel and chemical route, DC/RF sputtering, ion beam based methods.

3. **Biological Materials:**
   Introduction, Biological Building Blocks, Size of building blocks, Nanostructures, Polypeptide Nanowires and Protein Nanoparticle, Nucleic Acids, DNA Double Nanowire, Genetic Code and Protein Synthesis, Biological nanostructures, Examples of Proteins, Miscells and Vesicles, Multilayer Films.

4. **Nanotechnology in Carbon Materials:**
   Fullerenes and Carbon Nanotubes, Fullerenes as nano-structures, structures of C_{60}, C_{70} and higher fullerenes, Electronic properties of fullerenes, Carbon Tubules as Nano-structures, Observation of Carbon Nanotubes, Structure of carbon Nanotubes, Electronic structure of C-Nanotubes.

**Books Recommended:**

1. *Introduction to Nanotechnology* by C.P. Poole Jr. and F.J. Owens
   Wiley Interscience (2003)

2. *Nano-Technology* by Gregory Timp (Editor)
NANOSCALE FABRICATION & CHARACTERIZATION

1. Lithography
   Basic principles of optical lithography, Electron beam lithography, X-ray lithography and Nanolithography

2. Self assembly and Catalyst
   Process of Self-Assembly, Semiconductor Islands, Monolayers, nature of Catalysis, Surface Area of Nanoparticles, Porous Materials, Pillared Clays, Colloids

3. Microscopy I

4. Microscopy II
   Basics of SPM, Scanning Tunneling Microscope (STM), Atomic Force Microscope (AFM), Other Scanned Probe Microscopes.

Books Recommended:

3. Introduction to Nanotechnology by C.P. Poole Jr. and F.J. Owens
   Wiley Interscience (2003)
1. **X-ray Spectroscopy**
   X-ray diffraction (XRD), Auger electron spectroscopy (AES), X-ray photo electron spectroscopy (XPS), X-Ray Fluorescence, Secondary ion mass spectroscopy (SIMS)

2. **Emission Spectroscopy**
   Emission sources, Prism and grating spectrographs, Constant deviation systems, Monochromators, Resolution and dispersion in various spectrographs, determination of wavelengths.

3. **Absorption spectroscopy**
   Continuum sources for absorption studies, single-beam and double beam instruments, NMR.

4. **Optical and Vibrational Spectroscopy:**

**Book Recommended:**
1. *Introduction to Nanotechnology* by C.P. Poole Jr. and F.J. Owens
   Wiley Interscience (2003)
2. *Experimental Spectroscopy* by R.A. Sawyer
Unit I:

Types of amorphous solids with their structures optical properties of amorphous semiconductors, some case studies and applications of important amorphous materials, hydrogenated amorphous silicon, metallic glasses.

Unit II:


Unit III:


Unit IV:

Demagnetisation factor, Antiferromagnetism, Neutron diffraction, Magnetism in Rare Earths and Antiferromagnetic Alloys, Helimagnetism, Ferrimagnetism, Spin Glasses, Magnetostriiction, Domains and magnetization process, Single Domain Particles, Coercivity in fine particles, Superparamagnetism, Spintronics, Magnetoresistance, Measurements of Critical currents and Magnetic Properties, Critical State Models, Ginzberg-Landau and BCS Theory, Josephson effects, SQUIDs, Type-II Superconductivity; Pinning of Vortices, High Temperature Superconductors, Flux Flow, Flux Creep, Fluctuation effects, Levitation and Electrical/Power Applications of HTSC.

Books Recommended:

1. **Initials of Quantum Mechanics**

2. **Approximate Methods for Bound States**
   The WKB wave functions, Application to bound states, Time independent perturbation theory, The variational method, Helium atom, Hydrogen molecule

3. **Angular Momentum, Spin and Isospin**
   Quantum mechanical definition of angular momentum, Ladder operators, Allowed values of $j$ and $m$, Matrix elements of angular momentum operators, Construction of angular momentum matrices, Angular momentum state vectors, System of two spin-$\frac{1}{2}$ particles, Coupling of two angular momenta, Isospin formalism

4. **Time Dependent Perturbation Theory**
   The interaction picture, First order perturbation, constant perturbation, transition to the continuum, Elastic scattering, Harmonic perturbation, Adiabatic and Sudden approximations.

**Books recommended:**

1 A Text Book of Quantum Mechanics, By P. M. Mathews. (1976)
2 Quantum Mechanics By Leonard I. Schiff (1968)
3 Quantum Mechanics By V. Devanathan (2005)