Department of Applied Physics
Faculty of Engineering and Technology
M.J.P. Rohilkhand University, Bareilly

Minutes of the Board of Studies (BOS) in Department of Applied Physics (2015-2016)

The meeting of BOS was held today i.e. 14/12/2015
Following members were present:

1. Dr. M. Saleem Khan	Convener
2. Dr. Archana Gupta	Internal Member
3. Dr. Sushil Kumar	External Expert (Ch. Devi Lal University Sirsa Haryana)

Following decisions were taken:

1. BOS considered the names of examiners for various Lab courses of M.Sc. (Applied Physics) and B. Tech. and the list enclosed herewith was finalized and approved.
2. BOS considered the list of examiners for Pre Ph. D programme and approved.
3. Syllabi of M. Sc. (App Physics) papers Advanced Quantum Mechanics I (PH- 601) and Advanced Quantum Mechanics II (PH-602) were revised and approved.

14.12.15
(Dr. Archana Gupta)
Internal Member

14.12.15
(Dr. Sushil Kumar)
External Expert

(Dr. M. Saleem Khan)
Convener BOS

Phy/1028/25.09.12

Applied Physics Department,
Faculty of Engineering and Technology
M.J.P. Rohilkhand University, Bareilly

Minutes of the Board of Studies (BOS) in Physics (2012 - 2013)

The meeting of BOS was held today i.e 19/09/2012
Following members were present:

1.	Dr. Sudhir Kumar	Convener
2.	Dr. M. Saleem Khan	Internal Member
3.	Dr. Archana Gupta	Internal Member
4.	Prof. Ram Gopal	External Expert (Allahabad University)
5.	Prof. Balak Das	External Expert (Lucknow University)

Following decision were taken:

1. BOS considered the modified syllabus (M.Sc.) as per notification of the Registrar RU/Teach,/sem./F-/2012/1156 dated 24-07-2012.

2. BOS considered the names of examiners for different theory papers of M. Sc. (I, II Semester and Final year) and B. Tech. Physics courses (Theory) as well as various Lab courses and the list enclosed herewith was finalized and approved (List of Examiners enclosed)
3. BOS also considered the syllabus for course work (as prerequisite for Ph.D registration).

(Dr. S. Kumar) (Dr. M. S. Khan) (Dr. Archana Gupta)

(Prof. Ram Gopal) (Prof. Balak Das)

M.Sc –APPLIED PHYSICS

Semester I

PH 501 - Mathematical Physics I

Complex Variables:
Branch points, Branch lines, Multivalued function, Derivative of complex function, Analyticity, Analytic function, Cauchy- Riemann equations, construction of a complex function, singular points, Couchy's integral theorem, Couchy's integral formula, Derivative of a Analytic function, singularities of an analytic function, Evaluation of definite integrals.

Vectors & Matrices:
Orthogonal curvililinier coordinates, Lineare Vector space, Linear independeance and Dependance of vectors, Basis and expansion theorem, Inner – product and unitary space.
Special types of matrices, Hermition and skew Hermition matrices, Orthogonal unitary matrices, Eigen values, Eigen Vectors, Caley Hamilton theorem, characteristic of matrix, Trace of matrix.

Books:
1.Mathematics for Engineers & Physicist- L.A.Pipes and L.R.Harvill.
2.Mathematical methods for Physics by G. Arfken.
3.Theoritical Physics vol. I & II – P.M. Morse and H. Feschback.
4.Special Functions by W.W. Bell.
5.Methods of Mathematical physics by R.Courant and D. Hilbert.
6.Mathematical for Physics by Mary I, Boas.
7.Mathematical methods by P.K. Chattopadhyay.

PH 503 – Classical Mechanics

Lagrangian formulation:
Generalized co-ordinates, D'Alembert's principle and Lagrange's equation of motion, Velocity – dependent potentials and Rayleigh's dissipation function, Simple applications of the Lagrangian formulation, Hamilton's principle, some techniques of calculus of variations, Derivation of Lagrange's equation from Hamilton's principle, Extension of Hamilton's principle non- holonomic systems, Conservation theorems and symmetry properties.

The Hamilton's equations of motion:
Legendre transformation and the Hamilton's equation of motion, cyclic co-ordinates and conservation theorems, Derivation of Hamilton's equation from a variational principle, The principle of least action, The equation of canonical transformation, Poisson brackets and other canonical invariants, Equation of motion, Infinitesimal canonical transformations and conservation theorems in the Poisson bracket formulation, The angular momentum Poisson bracket relations.

Hamilton Jacobi Theory:
The Hamilton Jacobi equation for Hamilton's principle function, The harmonic oscillator problem, The Hamilton Jacobi equation for Hamilton's characteristic function, action angle variables.

Small Oscillations:

Types of oscillations, Small oscillations using generalized coordinates, Normal modes and normal coordinates, Normal modes and normal co-ordinates, Coupled pendulum, Triatomic molecule and particles on a string.

Rigid Body Motion:
Transformation from space fixed axis to body fixed axis, Euler's equation of motion, coriolis force, Moment of inertia tensor.

Books:

1. E.S.R.Gopal - Statistical Physics
2. Patharia - Statistical Mechanics
3. L.D.Landau & I.M.Lifshitz - Statistical Mechanics
4. Goldstein - Classical Mechanics

PH 505 - Quantum Mechanics I

Introduction to Quantum Mechanics:
Historical development of Quantum Mechanics, Fundamental concepts: Uncertainty principle, wave function, Schrödinger equation, eigen value and eigen functions. One dimension potential problems, spherically symmetric cases, application to Simple harmonic oscillator and Hydrogen atom.

General Formalism of Quantum Mechanics:
Representation of states and dynamical variables and observables, Hermitian operators, completeness and closure property, commutability, commuting observables, simultaneous diagonalization of commuting operators, commutator algebra, Dirac bra and ket notations, matrix representation of an operator, change of basis, unitary transformation and projection operator, Equation of motion, Schrödinger, Heisenberg and interaction pictures.

Books:

1. Powell & Crasemann: - Introduction to Quantum Mechanics
2. Schiff: - Quantum Mechanics
3. Rains:-Wave Mechanics
4. E. Merzbacher: - Quantum Mechanics
5. A.Messiah:- Quantum Mechanics
6. B.K.Agarwal & Hari Prakash - Quantum Mechanics
7. Eisberg - Quantum Mechanics

PH 507 - Nuclear and Particle Physics I

Basic Nuclear Properties:
Mass, Charge, Size and density of nucleus, Nuclear radius and its measurement, Constituents of nucleus and their properties, Distribution of nucleons. Mass defect, packing fraction and binding energy, Semi-empirical mass formula, Mass parabolas for isobaric nuclei, Quantum numbers for individual nucleons, Parity and Isospin, nuclear magnetic moment, Quadrupole moment and Quadrupole interaction energy.

Particle Radioactivity:
Emission of α-particles, Range and energy relationship for α-particles ,Gamow theory ,Hindrance and Formation factors ,Fine structure of α-ray spectra, idea of β-decay, Beta ray spectroscopy, Fermi theory of β-decay. Allowed and forbidden transitions, Selection rules in β-decay, Parity non conservation in β-decay, γ-ray emission, γ-ray spectra and nuclear energy levels.

Nuclear Fission and fusion:
Types of nuclear fission, Fission cross section, Mass and energy distributions in fission fragments, Neutron Emission Spontaneous fission, Fission product radioactivity, Bohr, Wheelar theory of nuclear fission, Nuclear fusion and thermo nuclear reactions, Controlled thermonuclear reactions, Thermonuclear (hydrogen) bomb.

Books:
1. Segre: Nuclei and Particle
2. Cohen: Nuclear Physics
3. Enge: Nuclear Physics
4. Preston and Bhaduri: Physics of Nucleus
5. Elton: Introductory Nuclear Theory
6. Bethe: Nuclear Physics
7. Blatt and Weiscopff: Nuclear Physics
8. Kaplan: Nuclear Physics
9. W.E.Burcham and M.Jobes: Nuclear and Particle Physics

PH 509 - Solid State Physics I

X-ray Diffraction:
Introduction to Crystal Structure, Structure factor for a basis, Atomic from factor, Calculation of structure factor for BCC, FCC and Diamond Structure, Laue derivation of scattered wave (Laue condition), Diffraction condition in terms of reciprocal lattice vector

Phonons and Lattice Vibration:
Vibrations of a monoatomic lattice (concept of Brillouin zone should be introduce) Vibration of a diatomic lattice. Acoustic and optical modes of vibration, Quantization of lattice vibration, Phonons phonon momentum, Lattice heat capacity(Einstein and Debye models), Inelastic scattering of neutrons by phonons, Anharmonic crystal interaction , Thermal conductivity and resistivity.

Crystal Binding:
Types of solids; Vander Walls solid, Ionic and covalent solids, metals, semiconductors; intrinsic and extrinsic semiconductors, Law of mass action, Electron and hole mobilities, impurity levels, p-n junction.

Free Electron Theory:
Sommerfeld free electron theory of metals, Energy level and density of states in one and three dimensions, Chemical potential of a free electron gas, Heat capacity of free electron gas, DC and AC electrical conductivity of metals, Plasma-transverse and longitudinal; modes, Transparency of metals in UV region, Widemann-Franz law, Failure of free electron theory of metals.

Books:
1. Introduction to solid state physics: C.Kittel (John Wiley and Sons)
2. Solid State Physics: N.W. Ashcroft and Mermin (Saunders college, Philadelphia:CBS publishing Asia Ltd.)
3. Solid State Physics: C.M. Kachhava (Tata Mc Graw-Hill publishing Company, New Delhi)
4. Solid State Physics: Adrians J.Dekker (MC.Millon, N.D.)
5. Solid State Physics: Ibach and H.Luth (Springer Verlag, Berlin 1990)
6. Introductory Solid State Physics: H.P.Myers (Taylor & Francis)

PH 511 - Solid State Electronics I

Network Theorems:
Thevenin's, Norton's, Millman's, Compensation and Superposition Theorems, Decible notations, Impedance Matching

Semiconductor Devices:
Shottky Diode, Tunnel Diode, UJT, LED, Liquid Crystal Diode and SCR. Operation of an N-Channel JFET, Transfer and Output Characteristics of a JFET, Parameters of JFET, JFET as an Amplifier, Biasing of JFET, Principle and Operation of MOSFET in Depletion and Enhancement mode.

Operational Amplifier:
Difference Amplifier, Circuit details of Op-Amp 741, Inverting and Noninverting Configurations, Measurement of Op-Amp parameters, Frequency Response of Op-Amp, Op-Amp Applications- Mathematical Operations, Solution of Differential Equations, High Resistance Voltmeter

Books:
1. Operational Amplifier and other Application: Kumar & Sarkar
2. Digital Principles and Application: Malvino Leach
3. Integrated Electronics: Milman & Halkias
4. Operational Amplifier & Linear Integrated Circuit Coughlin, Driscol
5. Electronic Devices and Circuit Theory Robert L. Boylestad,
Louis Nashelsky
6. Physics of Semiconductor Devices M. Shur
7. Electronic Principles Malvino

Semester II

PH 502 - Mathematical Physics II

Tensors:
Introduction, Covariant and Contravariant tensors, Indicial and summation convention, Dummy and real indices, Kronecker delta symbol, Tensors of higher ranks, Algebric operations of tensors, Fundamental tensors, Tensors form of gradient, Divergence, Laplacian and curl, Divergence of a tensors, Tensors in Elasticity.

Special Function:
Bessel, Legender, Hermite, Laguerre's, Differential Equations and Polynomials, Gauss Hyper geometriv and Confluent Hyper geometric functions.

Integral Transforms:
Laplace transforms, Convolution first and second shifting theorem, Inverse Laplace transform by partial fraction, LT of derivatives.
Fourier series, FS of arbitrary period, Fourier integral and transforms, Applications of Laplace transforms to the initial and boundary value problems.

Dirac Delta and Greens Functions:

Dirac Delta function, derivative of Dirac Delta functions, Greens functions, Three dimensional Green's functions, Greens's functions for Laplace and Poission's equations. Green's functions for wave equations.

PH 504 – Statistical Mechanics

Basics Concepts:
Statistical formulation of the mechanical problem, Macroscopic and microscopic states, Phase space, Concept of ensembles, Postulate of equal probality, Behavior of density of states, Density distribution in phase space, Liouville's theorem, thermal, mechanical and general interactions, Distribution of energy between macroscopic systems, approach to thermal equilibrium, Entropy and it's properties.

Classical Stastical Mechanics:
Microcanonical ensemble, Canonical ensemble and Grand canonical ensemble, Calculation of mean values and fluctuations, Thermodynamical variables in terms of partition, ideal gas , Gibb's paradox, The equipartitian theorem and it's applications, Paramagnatism, law of atmosphere, Maxwell's velocity distribution, Calculation of average, r.m.s. and most probable speed.

Quantum Statistical Mechanics:
Quantum distribution functions (Bose Einstein & Fermi Dirac), Boltzmann limit for Bosons and Fermions, partition function for ideal gas, Equation of states, Partition function for diatomic molecule.

Ideal Bose System:
Photon gas, Specific heat from lattice vibrations, Bose-Einstein condensation

Ideal Fermi System:
Fermi energy, Mean energy of Fermions at T = 0 K, Fermi gas in metals, Fermi energy as a function of the temperature, Electronic specific heat, Compressibility.

PH 506 - Quantum Mechanics II

Angular Momentum:
Parity or space inversion, rigid rotator as application of parity operator, rotation operators, angular momentum, eigen values and eigen functions of L^2 and Lz operators, ladder operators, Pauli theory of spins, spin polarisation, addition of angular momentum, computation of Clebsch-Gordan coefficients.

Identical Particles & Spin:
Physical meaning of identity, symmetric and anti-symmetric wave functions, construction from unsymmetrized functions, Pauli's exclusion principle.

Approximate Methods:
Variational method, application to harmonic oscillator and helium atom (two electron system), Time–independent perturbation theory non-degenerate and degenerate cases, stark effect
Time dependent perturbation theory, harmonic perturbation, transition probability, Fermi's Golden rule.

PH 508. Nuclear Physics II

Nuclear forces and Two Body Problem:
Elements of two body problem, Ground state of deuteron, wave function and solution, Excited state of deuteron, Radius of deuteron, low energy neutron proton scattering, spin dependence n-p interaction (nuclear forces), Meson theory of exchange forces.

Nuclear Reactions:
Conservations laws governing nuclear reactions, Various types of nuclear reactions, Nuclear reaction kinematics, Q value, threshold energy, Compound nucleus, Descrete levels of compound nucleus, Breit Weigner formula, Direct reactions, Stripping and Pick up reaction.

Elementry Particles:
Various types of interactions existing in nature, Classification and important properties of elementary particles and their quantum numbers (charge, spin, parity, isospin, strangeness, hyper charge) Leptons, Baryons, Mesons, Hypesons .Particle and anti particles. Conservation Laws governing fundamental interactions, Invariance under charge parity CP and time (CPT), Excited states and resonance particle, Gellmann Nishijima formula, Elementry particle symmetries, Basic idea of quarks

Books:
1. Segre: Nuclei and Particle
2. Cohen: Nuclear Physics
3. Enge: Nuclear Physics
4. Preston and Bhaduri: Physics of Nucleus
5. Elton: Introductory Nuclear Theory
6. Bethe: Nuclear Physics
7. Blatt and Weiscopff: Nuclear Physics
8. Kaplan: Nuclear Physics
9. W.E.Burcham and M.Jobes: Nuclear and Particle Physics

PH 510 - Solid State Physics II

Band Theory of Solids:
Nearly free electron theory, Origin of energy gap, Electron in a periodic potential, Bloch function and theorem (with proof), Properties of Bloch function, No. of allowed states in a band, reduced zone scheme, Extended Zone Scheme, Repeated (periodic) zone scheme, Crystal momentum.

Diamagnetism and Paramagnetism:
Classical Theory of Diamagnetism, Langvin theory of paramagnetism, Quantum theory of paramagnetism, Paramagnetic susceptibility of conduction electrons.

Ferromagnetism, Ant. Ferromagnetism and ferrimagnetism:
Ferromagnetism-Wiess theory, Curie point, Exchange integral, Saturation magnetization and its temperature dependence, Saturation magnetization at absolute zero, Ferromagnetic domain, antistrophic energy, Transition region between domains(concept of Bloch wall), Spin waves(magnons), Thermal excitation of magnons,Magnetic properties of rare ions and iron group ions, Crystal field splitting, Quenching of angular momentum, Antiferromagnetism-Neel temperature, Anti ferromagnetic magnons, Ferrimagnetism-Ferrimagnetic order.

Superconductivity:
Electrical and magnetic properties of superconductor, Occurrence of superconductivity, Meissner effect, Heat capacity, Energy gap, Microwave properties, isotope effect, type I, II, superconductors, thermodynamics of superconductivity, London equation, London penetration depth, Coherence length, Outlines of BCS theory, Flux Quantization in a superconducting ring, New super conducting materials.

PH 512 – Solid State Electronics II

Digital Electronics:
Boolean Algebra, Kranaugh Map, Karnaugh Simplifications, Don't Care Conditions, Multivibrators-Astable and Monostable, Bistable, Schmidt Trigger, Flip Flops: D, RS, JK, Master Slav JK, Register and Counters: Shift Register, Ripple Counter, Up-Down Counter, Asynchronous and synchronous Counter, Ring Counter and Sequence Generators, Memories: C-MOS, ROM, MOS, RAM, D/A and A/D Converters.

Wave Propagation:
Brief idea of Space Wave, Ground Wave and Sky Wave Propagation and Earth's Ionosphere. Modulation: Amplitude Modulation, Angular, Frequency and Phase Modulation, PPM, PDM, PWM. Radiation and Antenna (Brief idea), Transmitters and Receivers (Basics)

Semester III

PH 601 -Advanced Quantum Mechanics I

Scattering Theory:
Differential scattering cross section, incoming and outgoing solutions, Expression for the scattering amplitude, Born approximation and its validity, Green's function, partial wave analysis, optical theorem, relation between phases shift and potential, Ramsauer- Townsend effect, scattering by a square well potential, scattering by a hard sphere.

Relativistic Quantum Mechanics:
The Klein – Gordan Equation ,Charge and Current densities, the Klein-Gordan equation with potentials, Two component form of Klien Gordan equation.
The Dirac Equation, Dirac Matrices, Solution of the free particle, Dirac Equation with potentials, Equations of Continuity, Spin of the electron , Non realistic limit, Dirac equation for Hydrogen atom, spin orbit coupling, covariance of the Dirac Equation , Bilinear covariants, hole theory, charge conjugation for the Dirac and Klein-Gordan equation.

PH 603 - Classical Electrodynamics I

Maxwell's equations and conservation laws:
Maxwell's equations, vector and scalar potentials, Guage transformations, Lorentz gauge,
Coulomb gauge, Green functions for the wave equation, Poynting's theorem and conservation of energy and momentum for a system of charged particles and electromagnetic fields, Transformation properties of electromagnetic fields and sources under rotations, Spatial reflections and time reversal.

Plane Electromagnetic Waves and Wave Propagation:
Plane waves in a nonconducting medium, Linear and circular polarization, Stokes' parameters, Reflection and refraction of electromagnetic waves at a plane interface between two dielectrics, Polarization by reflection, total internal reflection, Goss-Hanchen effect, frequency dispersion characteristics of Dielectrics, Conductors and plasmas, Waves in a conducting medium, Illustration of the spreading of a pulse as it propagates in a dispersive medium, Kramers Kronig relations.

Wave Guides and Resonant Cavities:
Cylindrical cavities and wave guides, Modes in a rectangular waveguide, Energy flow and Attenuation in Waveguides, Resonant Cavities, Power losses in a cavity, Q of a cavity.

Radiating Systems, Multipole Fields:
Fields and radiation of a localized oscillating source, Electric dipole fields and radiation, magnetic dipole and Electric Quadrupole fields

Books:
1.Classical Electrodynamics – J.D.Jackson.
2.Classical Electromagnetism-Jerrold Franklin

PH 605– Atomic and Molecular Physics I

Hydrogen atom gross structures:
Schrödinger's equation, stationary states, solution of Schrödinger's equation for Coulomb field, quantum numbers n, l, m, comparison with Bogr's model, the hydrogen spectrum.
The Hydrogen atom fine structure: Electron spin, Stern-Gerlach experiment, the interaction terms, relativistic correction, spin-orbit interaction, vector model, spectroscopic terms and selection rules, lamb shift, summary of the hydrogen spectrum.

Two electron system:
Electrostatic interaction and exchange degeneracy, ground and excited states of helium. Electron spin functions and Pauli's exclusion principle, periodic table.
The central field approximation; the central field Thomas Fermi-potential, The gross structure of alkalis atoms.

Angular problems in many electron atoms:
The L-S coupling approximation, allowed terms in L-S coupling, fine structure in L-S coupling, J-J coupling, hyperfine structures, Interaction with external field: Zeeman, Paschen-Back and Stark effects.

Books:
1. G. K. Woodgate : Elementary Atomic Sturucture, Mc Graw Hill
2. H. S. Mani : Introduction to Modern Physics, East West Press
3. G. Herzberg : Molecular Spectra
4. C. N. Banwell : Fundamentals of Molecular Spectroscopy
5. W. Demtroder : Laser Spectroscopy
6. O. Sevelto : Principle of Lasers
7. K. Shunoda : Introduction to Laser Physics
8. H. E. White : Introduction to Atomic Spectra

PH 607- Nanophysics & Technology I

Introduction:
Review of Nanotechnology, Ideas about building things with atom, Possible applications in science & Technology.

NanoPhysics:
Physics of low dimension system: Length scale, Quantum confinement, Particle in a 1D, 2D spherical box, Particle in a circle, Density of states of quantum well, quantum wire and quantum dot.

Books:
1. Introduction to Nanotechnology by C.P. Poole, Wile, Interscience (2003)
2. Nano-Technology by Gregrory Timp (Editor) AIP Press Springer (1998)
3. Carbon nanotubes Synthesis structure, Properties and Applications by M.S. Dresselhaus, G. Dresselhaus Avouris (Springer Berlin 2001)

PH 609- Material Science I

Experimental methods for Crystal Growth:
Growth for melt: Bridgman -Stockbarger and Czocharalski method , zone melting technique Growth by vapour : Sputtering technique Growth from liquid solution : Hydro thermal method

Atomic Imperfections in Crystals:
Point imperfections in crystals: substitutional impurity, vacancy, interstitial etc. Line imperfections: Edge and screw dislocation, Burger vector and Burger circuit, dislocation motion, energy of dislocation, dislocation multiplication, slip planes and slip directions, perfect and imperfect dislocation reaction Surface imperfections: Tilt and twist boundary, Stacking faults Color centers

Atomic diffusion in crystals:
Mechanism of diffusion, Fick's second law, steady state solution- diffusion through a plane surface, diffusion through a cylinder , diffusion through a sphere; non steady-state solution, some applications of diffusion- experimental determination of diffusion coefficient , corrosion resistance of duralumin, decarburization of steel; doping in semiconductors , the Kirkendall effect, the atomic model of diffusion , diffusion in alkali halides , ionic conductivity in alkali halide crystals, diffusion and ionic conductivity.

Books:
1. Solid State Physics - M.A. Wahab
2. Amorphous Mterials - S.R. Elliot
3. Material Science - W.F. Smith

PH 611- Advanced Solid State Physics I

Lattice Dynamics:
General theory of lattice dynamics, Normal co-ordinate description, Quantization of lattice vibrations, Phonon concept, Inelastic scattering of slow neutrons by crystals for study of phonons, Calculations of phonons in different types of crystals.

Electronic energy band:
Calculations of energy bands and Fermi surfaces and other related properties like density of states, Tight binding method, Cellular method, Muffin tin potentials, Augmented plane wave method (APW), Green's functions (KKR) method, Orthogonalized plane wave (OPW) method, Correlation.

Books:
1. J.M. Ziman: Princiles of Solid State Physics
2. M. Born and K. Huang: Theory of Lattice Dynamics
3. G. Venkatraman: Dynamics of perfect Crystals
4. Band Structure Theory: J. Callaway
5. Lattice Dynamics Vol. II: Academic Press

Semester IV

PH 602 -Advanced Quantum Mechanics II

Quantization of fields:

The principles of canonical quantization of fields, Lagrangian density and Hamiltonian density, Second quantization of the Schrodinger wave field for Bosons and fermions, quantization of the electromagnetic fields, second quantization of the Dirac and Klien – Gordon fields, the Weyle's equation for the neutrino, non conservation of parity.

The Quantum Theory of Radiation:
Quantum radiation field, Emission and absorption of photons by atoms, Kramers –Heisenberg formula, Rayleigh and Thompson scattering, Radiation damping, dispersion relation and causality, Lamb shift

Book:
1. B. K. Agarwal & Hari Prakash- Quantum Mecahnics
2. E. Merzbacher- Quantum Mechanics'
3. Schiff- Quantum Mechanics
4. Sakurai- Advanced Quantum Mechanics

PH 604 - Classical Electrodynamics II

Special Theory Of Relativity:
Lorentz Transformations and Basic Kinematic Results of Special Relativity, Addition of velocities; 4-velocity, Relativistic momentum and energy of a particle, vector and tensor calculus, matrix representation of Lorentz transformations, Infinitesimal generators, Invariance of Electric charge, Co-variance of Electrodynamics, Transformation of Electromagnetic fields, Lagrangian and Hamiltonian for a relativistic charged particle in external electromagnetic fields, canonical and symmetric stress tensors conservation laws, solution of the wave equation in co-variant form, Invariant green functions.

Radiation by Moving Charges:
Lienard-Wiechert potentials and fields for a point charge, Total power radiated by an acceleratedcharge:Larmor's formula and its relativistic generalization, Angular distribution of radiation emitted by an accelerated charge, Thomson scattering of radiation, Radiative reaction force from conservation of energy, Abraham- Lorentz evaluation of the self force, Level Breadth and level shift of a radiating oscillator, scattering and absorption of radiation by an oscillator.

PH 606 – Atomic and Molecular Physics II

Observed molecular spectra and their representation by Empirical formula:
Spectra in visible and ultraviolet regions, spectra in the infrared region, Radio frequency spectra, Raman spectra.

Interpretation of Infrared and Raman Spectra:
Interpretation of the Principle features of infrared and Raman spectra by means of the models of the Rigid Rotator and of the harmonic oscillator, interpretation of the line details of infrared and Raman spectra by means of the models of an harmonic oscillator, Non rigid rotator vibrating rotator and symmetric top, Intensities in rotation-vibration spectra, symmetry properties of rotational levels.

Electronic states and Electronic transitions:
Electronic energy and total energy, vibrational structures of electronic transitions, rotational structures of electronic bands, intensity distribution in the vibrational structure, Frank-Condon principle

Lasers:
Spontaneous and stimulated emission , optical pumping, population inversion, coherence (temporal and spatial) , three level-four level system, optical resonators, CO_2 a nd He-Ne lasers and Excimer

laser.

PH 608 - Nanophysics & Technology II

Techniques used in Nanotechnology:
X-ray crystallography, Particle size determination, Surface structures. Microscopy: TEM, SEM, STM & AFM, Nuclear Magnetic Resonance, Chzochralski technique, CVD, Oxidation Diffusion ion implantation, Photolithography, Etching, Metalization.

(a) Properties of Individual Nanoparticles:
Metals nanoclusters, Semiconducting nanoparticles.

(b) Bulk Nanostructured Material:
Solid disordered nanostructures: Method of synthesis, Failure mechanism of conventional
rain-size materials, mechanical properties, Nanostructured multilayers, Electrical properties, Metals nanocluster composite glass, Porous silicon.

(c) Quantum wells, Wires and Quantum Dots:

Nanotechnology in Carbon Materials:
Fullerenes and Carbon Nanotubes, Fullerene as nano structures of C-C and higher fullerene, Electronic properties of fullerene and carbon tubes as Nano-structures, Structure of carbon Nano tubes, Electronic structure of C-Nano tubes

PH 610 – Material Science II

Atomic Packing in Crystals:
Close packing of spheres, Axial ratio and lattice constants, Voids in close -packing, cordination of voids, Rules governing the packing of atoms, Effect of radius ratio, Application of Pauling rules to actual structures, Representation of closest packing, polymorphic and polytypic structures, Polytypic notations, stacking faults in fcc, hcp crystals.

Phase Diagrams:
Definition, explanation of Phases, phase diagram of pure substances (water, and iron) Gibb's phase rule, Binary amorphous alloy systems, the Lever rule, Binary eutectic alloy systems , binary peritectic alloy systems, binary monotectic systems, invariant reactions, their representations and examples.

Characterization Techniques:
Principles, analysis and applications of (i) I.R spectroscopy (ii) Spin resonance spectroscopy (iii) Transmission electron microscopy (TEM) (iv) Scanning electron microscopy (SEM) (v) X-ray photo electron spectroscopy (vi) Auger electron spectroscopy (AES) (vii) Raman spectroscopy

Miscellaneous Materials:
Amorphous materials , Polymers, Semiconductors -III-V and II - VI compounds, Giant magneto resistance (GMR) materials, colossal magneto resistance (CMR) materials, piezo electric and ferroelectric materials.

PH 612 – Advanced Solid State Physics II

Optical Properties:
Phonon-Phonon interaction, Kramers-Kronig relations, Polarizability and dielectric constant of ionic crystals, Raman scattering by crystals, Interaction of Electromagnetic radiation of with solids, Dielectric function, Absorption of Electromagnetic radiation, Dielectric function for a harmonic oscillator, longitudinal and transverse normal mode, surface waves on a dielectric, Reflectivity of a dielectric half space, Interband transition, Excitons, Dielectric energy losses of electrons.

Excitations in imperfect crystals:
Elementary ideas of Green's function method for a vibrational spectrum for point defects in imperfect crystals, ionized gap modes and resonance modes.

Many electrons system:
Fermion fields, Hartree and Hartree-Fock approximation, self -consistent field method, Dielectricrelation analysis, Dielectric screening random phase approximation, Dielectric constant of electron gas, Dielectric screening of a point charge impurity.