FACULTY OF SCIENCES

SYLLABUS FOR

M. Sc. Physics

(Semester: I-IV)
Session: 2016 - 17

KHALSA COLLEGE, AMRITSAR

Eligibility:

The candidate having passed B.Sc. Degree (10+2+3 system of education) (with Physics, Chemistry and Mathematics) or (Physics, Mathematics and Computer Sciences) or (Physics, Mathematics and Electronics) or who has studied Physics as compulsory subject in all the three years of the B.Sc. Degree class with at least 50% marks from Guru Nanak Dev University or any other examination recognized equivalent there to by the University/college.

COURSE-SCHEME

Semester-I

Course No.	*Course Title*	*Teaching Hours /Week*	*Assesment*	*Max. Marks*	*Total Marks*
Phy.101	Electronics	4	20	80	100
Phy.102	Mathematical Physics	4	20	80	100
Phy.103	Classical Mechanics	4	20	80	100
Phy.104	Computational Techniques	4	20	80	100
Phy.105	Electronics Lab.	6	20	80	100
Phy.106	Computer Lab	6	20	80	100
					600

Semester-II

Course No.	*Course Title*	*Teaching Hours /Week*	*Assesment*	*Max. Marks*	*Total Marks*
Phy.201	Quantum Mechanics-I	4	20	80	100
Phy.202	Electrodynamics-I	4	20	80	100
Phy.203	Condensed Matter Physics-I	4	20	80	100
Phy.204	Atomic & Molecular Spectroscopy	4	20	80	100
Phy.205	Condensed Matter Lab-I	6	20	80	100
Phy.206	Spectroscopy Lab	6	20	80	100
					600

Semester-III

Course No.	*Course Title*	*Teaching Hours /Week*	*Assesment*	*Max. Marks*	*Total Marks*
Phy.301	Quantum Mechanics-II	4	20	80	100
Phy.302	Electrodynamics-II	4	20	80	100
Phy.303	Condensed Matter Physics-II	4	20	80	100
Phy.304	Nuclear Physics	4	20	80	100
Phy.305	Condensed Matter Lab-II	6	20	80	100
Phy.306	Nuclear Physics Lab	6	20	80	100
					600

Semester-IV

Course No.	***Course Title***	***Teaching Hours /Week***	***Assesment***	***Max. Marks***	***Total Marks***
Phy.401	Particle Physics	4	20	80	100
Phy.402	Statistical Physics	4	20	80	100
Phy.403	*Seminar and Assignment	4	20	80	100

And any **TWO** of the following papers to the availability of teacher:

Phy.404	Physics of Material	4	20	80	100
Phy.405	Radiation Physics	4	20	80	100
Phy.406	Reactor Physics	4	20	80	100
Phy.407	Plasma Physics	4	20	80	100
Phy.408	Geophysics	4	20	80	100
Phy.409	Nano Technology	4	20	80	100
					500

*The student will have to prepare an assignment and will deliver a Seminar on an advanced research topic of current scientific interest, and will be evaluated by the external examiners from the University.

ELECTRONICS

Course No. PHY-101 **Course Hrs 60**
Time: 3 Hrs.
Max. Marks:80

Note for the Paper Setters:
There will be five sections. Section A will consist of eight short answer type questions covering the whole syllabus and is compulsory. Sections B, C, D and E will consist of two questions each. The candidates are required to attempt one question from each of these sections. All questions carry equal marks.

Electronic Devices: MESFETs and MOSFETs, Charge Coupled(CCDs) devices, Unijunction transistor (UJT), four layer (PNPN) devices, construction and working of PNPN diode, Semiconductor controlled rectifier (SCR) and Thyristor.

Lectures 14

Microwavedevices: Gunn diode, Gunn effect, two valley model, principle and operation of Reflex Klystron and Magnetron.

Lectures 10

Electronic Circuits: Multivibrators (Bistable Monostable and Astable), Differential amplifier, Operational amplifier (OP-AMP) Ideal, Internal circuit &Practical, OP-AMP as inverting and non-inverting, scalar, instrumentation amplifier, summer, integrator, differentiator. Schmitt trigger and logarithmic amplifier, Electronic analog computation circuits.

Lectures 12

Digital Principles: Binary and Hexadecimal number system,Binary arithmetic, Logic gates, Boolean equation of logic circuits, Karnaugh map simplifications for digital circuit analysis, and design, Encoders & Decoders, Multiplexers and Demultiplexers, Parity generators and checkers, Adder-Subractor circuits.

Lectures 12

Sequential Circuits: Flip Flops, Registers, Up/Down counters, Basics of semiconductor memories: ROM, PROM, EPROM, and RAM,D/A conversion using binary weighted resistor network, Ladder, D/A converter, A/D converter using counter, Successive approximation A/D converter.

Lectures 12

Books:

1. Electronic Devices and Circuits- Millman and Halkias-Tata Mc Graw Hill, 1983.
2. Solid State Electronic Devices - Ben G Streetman-Prentice Hall, New Delhi, 1995.
3. Digital Principles and Applications- A.P.Malvino and D.P.Leach-Tata Mc Graw Hill, New Delhi, 1986.
4. Digital Computer Electronics- A P Malvino-Tata Mc Graw Hill, New Delhi, 1986
5. Microelectronics – Millman-Tata Mc Graw Hill, London, 1979.
6. Digital Electronics - W.H. Gothmann-Prentice Hall, New Delhi, 1980.
7. Microwave Devices and Circuits-Samuel Y Liao-PHI,1991

MATHEMATICAL PHYSICS

Course No. PHY-102 **Course Hrs: 60**
Time: 3 Hrs. **Max. Marks: 80**

Note for the Paper Setters:
There will be five sections. Section A will consist of eight short answer type questions covering the whole syllabus and is compulsory. Sections B, C, D and E will consist of two questions each. The candidates are required to attempt one question from each of these sections. All questions carry equal marks.

Fourier Transformation: Fourier decomposition, Fourier series and convolution theorem. Fourier transformations and its applications to wave theory.

Lectures 10

Coordinate Systems: Curvilinear coordinates, differential vector operators in curvilinear coordinates. Spherical and cylindrical coordinate systems. General coordinate transformation, Tensors: covariant, contravariant and mixed, Algebraic operations on tensors, Illustrative applications.

Lectures 10

Differential Equations: Second order differential equations. Frobenius method. Wronskian and a second solution, the Sturm Lioville problem. One dimensional Greens function.

Lectures 10

Special functions: Gamma function. The exponential integral and related functions. Bessel functions of the first and second kind. Legendre polynomials, associated Legendre polynomials and spherical harmonics. Generating functions for Bessel, Legendre and associated Legendre polynomials.

Lectures 10

Complex Analysis: The Cauchy-Reimann conditions, Cauchy integral theorem, Cauchy integral formula. Taylor, and Lorent series, singularities and residues. Cauchy residue theorem. Calculation of real integrals.

Lectures 10

Group Theory: Definition of a group, multiplication table, conjugate elements and classes of groups, direct product. Isomorphism, homeomorphism, permutation group. Definitons of the three dimensional rotation group and SU(2).

Lectures 10

Books:

1. Mathematical Methods for Physicists: George Arfken-New York Academy, 1970.
2. Advanced Mathematical Methods for Engg. and Science Students: George Stephenson and P.M. Radmore-Cambridge Uni Press, 1990.
3. Applied Mathematics for Engineers & Physicists: Pipes and Harvil

CLASSICAL MECHANICS

Course No. PHY-103 **Course Hrs: 60**

Time: 3 Hrs. **Max. Marks: 80**

Note for the Paper Setters:

There will be five sections. Section A will consist of eight short answer type questions covering the whole syllabus and is compulsory. Sections B, C, D and E will consist of two questions each. The candidates are required to attempt one question from each of these sections. All questions carry equal marks.

Lagrangian Mechanics: Newton's laws of motion, mechanics of a system of particles, constraints, D' Alembert's principle and Lagrange equations of motion. Velocity dependent potentials and dissipation function. Some applications of Lagrangian formulation, Hamiltons principle, derivation of Lagrange equations from Hamilton's principle. Conservation theorems and symmetry properties.

Lectures 15

Central Force Problem: Two body central force problem, reduction to equivalent one body problem, the equation of motion and first integrals, the equivalent one dimensional problem, and classification of orbits. The differential equation for the orbit and integrable power-law potential. The Kepler problem. Scattering in a central force.

Lectures 15

Rigid Body Dynamics: The independent coordinates of a rigid body, orthogonal transformation, the Euler's angles. Eulers 's theorem on the motion of rigid body, finite and infinitesimal rotations, rate of change of a vector, angular momentum and kinetic energy about a point for a rigid body, the inertia tensor and moment of inertia, the eigen values of the inertia tensor and the principal axis transformation. Euler's equations of motion, torque free motion of a rigid body.

Lectures 15

Canonical Transformations: Legendre transformation and Hamilton equations of motion, cyclic coordinates and conservation theorems, derivation of Hamiltons equations from a variational principle, the principle of least action. The equations of canonical transformation, examples of canonical transformations, Poisson brackets. Equations of motion, infinitesimal canonical transformations and conservation theorems in the Poisson bracket formulation

Lectures 15

Books:

1. Classical Mechanics: Herbert Goldstein-Narosa Pub. House, New Delhi, 1970.
2. Mechanics : L.D. Landau-Pergamon Press, Oxford, 1982.
3. Classical Mechanics Rana and Joag-Tata Mc Graw Hill, New Delhi, 1995.

COMPUTATIONAL TECHNIQUES

Course No. PHY-104 **Course Hrs: 60**

Time: 3 Hrs. **Max. Marks: 80**

Note for the Paper Setters:

There will be five sections. Section A will consist of eight short answer type questions covering the whole syllabus and is compulsory. Sections B, C, D and E will consist of two questions each. The candidates are required to attempt one question from each of these sections. All questions carry equal marks.

Programming (Fortran) :

Representation of integers, reals, characters, constants and variables, arithmatic expressions and their evaluation using rules of hierarchy. Assignment statements, Logical constants, variables and expressions, control structures, sequencing alternation, arrays, Manipulating vectors and matrices, Subroutines, I/O Statements

Lectures 18

Interpolation:

Interpolation, Newton's formula for forward and backward interpolation, Divided differences, Symmerty of divided differences, Newton's general interpolation formula, Lagranges interpolation formula.

Lectures 12

Numerical Differentiation and Integration:

Numerical integration, A general quadrature formula for equidistant ordinates, Simpson, Weddle and Trape rules, Monte- Carlo Method.

Lectures 10

Roots of Equation :

Approximate values of roots, Bisection Method, Regula-Falsi Method, Newton-Raphson method, Bairstow method. Simultaneous Linear Algebraic Equations: Solution of Simultaneous Linear equations, Gauss elimination method, Gauss-Jordon method, Matrix inversion.

Lectures 10

Ordinary Differential Equation :

Euler's method, Modified Euler's method, Runge-Kutta Method.

Lectures 10

Books:

1. Ram Kumar-Programming with Fortran-77 (Tata McGraw Hill), 1995.
2. R.S. Dhaliwal - Programming with Fortran-77 (Wiley-Eastern Ltd)
3. James Scarborough-Numerical Mathematical Analysis (Oxford and IBH), 1966.
4. S.D. Conte - Elementary Numerical Analysis (McGraw Hill), 1965.
5. John. H. Methews, Numerical Methods for Mathematics, Science and Engineering (Prentice Hall of India).

ELECTRONICS LAB.

Course No. PHY-105 **Max. Marks: 80**

1. To Study the D C characteristics and applications of DIAC.
2. To study the D C characteristics and applications of SCR.
3. To study the D C characteristics and applications of TRIAC.
4. Investigation of the D C characteristics and applications of UJT.
5. Investigation of the D C characteristics of MOSFET.
6. Study of bi-stable, mono-stable and astable, multivibrators.
7. Study of Op-Amps and their applications such as an amplifier (inverting, non-inverting), scalar, summer, differentiator and integrator.
8. Study of logic gates using discrete elements and universal gates.
9. Study of encoder, decoder circuit.
10. Study of arithmetic logic unit (ALU) circuit.
11. Study of shift registers.
12. Study of half and full adder circuits.
13. Study of A/D and D/A circuits.
14. Study of pulse width and pulse position modulation.

COMPUTER LAB.

Course No. PHY-106 **Max. Marks : 80**

1. Determination of Roots:

(a) Bisection Method
(b) Newton Raphson Method
(c) Secant Method

2. Matrix Manipulation

(a) Matrix Multiplication
(b) Determinant
(c) Gauss Elimination
(d) Matrix Inversion
(e) Gauss Jordan

3. Integration

(a) Trapezoidal rule
(b) Simpson 1/3 and Simpson 3/8 rules
(c) Gaussian Quardrature

4. Differential Equations

(a) Euler's method
(b) Runge Kutta Method

5. Interpolation

(a) Forward interpolation, Backward interpolation
(b) Lagrange's interpolation

6. Applications

(a) Chaotic Dynamics, logistic map
(b) One dimensional Schrondinger Equation
(c) Time period calculation for a potential
(d) Luminous intensity of a perfectly black body vs. temperature

QUANTUM MECHANICS - I

Course No. PHY-201 **Course Hrs. 60**
Time: 3 Hrs. **Max. Marks: 80**

Note for the Paper Setters:
There will be five sections. Section A will consist of eight short answer type questions covering the whole syllabus and is compulsory. Sections B, C, D and E will consist of two questions each. The candidates are required to attempt one question from each of these sections. All questions carry equal marks.

Basic Formulation and quantum Kinematics: Stern Gerlach experiment as a tool to introduce quantum ideas, analogy of two level quantum system with polarisation states of light. Complex linear vector spaces, ket space, bra space and inner product, operators and properties of operators. Eigenkets of an observable, eigenkets as base kets, matrix representations. Measurement of observable, compatible vs. incompatible observable, commutators and uncertainty relations. Change of basis and unitary transformations. Diagonalisation of operators. Position, momentum and translation, momentum as a generator of translations, canonical commutation relations. Wave functions as position representation of ket vectors. Momentum operator in position representation, momentum space wave function.

Lectures 18

Quantum Dynamics: Time evolution operator and Schorodinger equation, special role of the Hamiltonian operator, energy eigen kets, time dependence of expectation values, spin precession. Schrodinger vs. Heisenberg picture, unitary operators, state kets and observable in Schrodinger and Heisenberg pictures, Heisenberg equations of motion, Ehrenfest's theorem.

Lectures 12

One Dimenstional Systems: Potential Step, potential barrier, potential well. Scattering vs. Bounds states. Simple harmonic oscillator, energy eigen states, wave functions and coherent states.

Lectures 12

Spherical Symmetric Systems and Angular momentum: Schrodinger equation for a spherically symmetric potential. Orbital angular momentum commutation relations. Eigen value problem for L_2, spherical harmonics. Three dim harmonic oscillator, three dim potential well and the hydrogen atom. Angular momentum algebra, commutation relations. Introduction to the concept of representation of the commutation relations in different dimensions. Eigen vectors and eigen functions of J_2 and J_z. Addition of angular momentum and C.G. coefficients.

Lectures 18

Recommended Books:

1. Modern Quantum Mechnics: J.J. Sakurai-Pearson Educaton Pvt. Ltd., New Delhi, 2002.
2. Quantum Mechanics :L I Schiff-Tokyo Mc Graw Hill, 1968.
3. Feynmann lectures in Physics Vol. III-Addison Wesly, 1975.
4. Quantum Mechanics :Powel and Craseman-Narosa Pub. New Delhi, 1961.
5. Quantum Mechanics : Merzbacher-John Wiley & Sons, New York, 1970.

ELECTRODYNAMICS-I

Course No: PHY-202 **Course Hrs: 60**

Time: 3 Hrs. **Max. Marks: 80**

Note for the Paper Setters:

There will be five sections. Section A will consist of eight short answer type questions covering the whole syllabus and is compulsory. Sections B, C, D and E will consist of two questions each. The candidates are required to attempt one question from each of these sections. All questions carry equal marks.

Electrostatics: Coulomb's law, Guass's law, Poisson's equation, Laplace equation. Solution of boundary value problem: Green's function, method of images and calculation of Green's function for the image charge problem in the case of a sphere, Laplace equation, uniqueness theorem. Electrostatics of dielectric media, multipole expansion. Boundary value problems in dielectrics; molecular polarisability, electrostatic energy in dielectric media.

Lectures 18

Magnetostatics: Biot and Savart's law. The differential equation of Magnetostatics and Ampere's law, vector potential and magnetic fields of a localised current distribution. Magnetic moment, force and torque on a magnetic dipole in an external field. Megnetic materials, Magnetisation and microscopic equations.

Lectures 12

Time-varying fields: Time varying fields, Maxwell's equations, conservation laws: Faraday's law of induction, Energy in a magnetic field. Maxwell's displacement current, vector and scalar potential, Gauge transformations; Lorentz gauge and Coulomb gauge. Poynting theorem, conservation laws for a system of charged particles and electromagnetic field, continuity equation.

Lectures 15

Electromagnetic Waves: Plane wave like solutions of the Maxwell equations. Polarisation, linear and circular polarisation. Superposition of waves in one dimension. Group velocity. Illustration of propagation of a pulse in dispersive medium. Reflection and refraction of electromagnetic waves at a plane surface between dielectrics. Polarisation by reflection and total internal reflection. Waves in conductive medium, Simple model for conductivity.

Lectures 15

Books:

1. Classical Electrodynamics - J.D. Jackson-John & Wiley Sons Pvt. Ltd. New York, 2004.
2. Introduction to Electrodynamics - D.J. Griffiths-Pearson Education Ltd., New Delhi, 1991.
3. Classical Electromagnetic Radiation - J.B. Marion-Academic Press, New Delhi, 1995.

CONDENSED MATTER PHYSICS-I

Course No. PHY-203 **Course Hrs.60**

Time: 3 Hrs. **Max. Marks: 80**

Note for the Paper Setters:

There will be five sections. Section A will consist of eight short answer type questions covering the whole syllabus and is compulsory. Sections B, C, D and E will consist of two questions each. The candidates are required to attempt one question from each of these sections. All questions carry equal marks.

Dia-Para and Ferromagnetism:

Classification of magnetic materials, the origin of permanent magnetic dipoles, diamagnetic susceptibility, classical theory of para magnetism, Quantum theory of paramagnetism, Quenching of orbital angular momentum, cooling by adiabatic demagnetization. Paramagnetic susceptibility of conduction electrons. Ferromagnetism, the Weiss molecular field, the interpretation of the Weiss field. Ferromagnetic domains, Spin waves, quantization of spin waves, Thermal excitations of magnons.

Lectures 15

Antiferro-Ferrimagnetism and Superconductivity:

The two sublattice model, superexchange interaction, the structure of ferrites,saturation magnetisation, Neel's theory of ferrimagnetism, Curie temperature and susceptibility of ferrimagnets. Superconductivity, zero resistivity, critical temperature, Meissner effect, Type I and Type II superconductors, specific heat and thermal conductivity, BCS theory, Ginzsburg-Landou theory, Josephson effect: dc Josephson effect, ac Josephson effect, high temperature superconductivity (elementry).

Lectures 15

Defects and Diffusion in Solids:

Point defects: Impurities, Vacancies- Schottky and Frankel vacancies, Color centers and coloration of crystals, F-centres, Line defects (dislocations), Edge and screw dislocations, Berger Vector, Planar (stacking) Faults, Grain boundaries, Low angle grain boundaries, the Hydration energy of ions, Activation energy for formation of defects in ionic crystals, Ionic conductivity in pure alkali halides.

Lectures 15

Lattice Vibrations and Phonons:

Vibrations of one dimensional linear monoatomic lattice, Normal modes of vibrations in a finite length of the lattice, The linear diatomic lattice, Excitation of optical branch in ionic crystals – the infra red absorption, Quantization of lattice vibrations – concept of phonons, Phonon momentum, Inelastic scattering of photons by phonons, Inelastic scattering of neutrons by phonons. **Lectures 15**

Books Recommended:

1. An Introduction to Solid State Physics: C. Kittel-Wiely Estem Ltd., New Delhi, 1979.
2. Solid State Physics-A.J. Dekkar-Maemillan India Ltd., New Delhi, 2004.
3. Principles of Solid State Physics-R.A. Levy-New York Academy, 1968.
4. Introduction to Solids-Azaroff-Tata Mc Graw Hill, New Delhi, 1992.
5. Elementary Solid State Physics-Omar, Addison Wesly, 1975.
6. Solid State Physics-Aschroft and Mermin-New York Holt, 1976

ATOMIC AND MOLECULAR SPECTROSCOPY

Course No. PHY-204 **Course Hrs.60**
Time: 3 Hrs. **Max. Marks: 80**

Note for the Paper Setters:

There will be five sections. Section A will consist of eight short answer type questions covering the whole syllabus and is compulsory. Sections B, C, D and E will consist of two questions each. The candidates are required to attempt one question from each of these sections. All questions carry equal marks.

Spectra of one and two valance electron systems:

Magnetic dipole moments; Larmor's theorem; Space quantization of orbital, spin and total angular momenta; Vector model for one and two valance electron atoms; Spin-orbit interaction and fine structure of hydrogen, Lamb shift, Spectroscopic terminology; Spectroscopic notations for L-S and J-J couplings; Spectra of alkali and alkaline earth metals; Interaction energy in L-S and J-J coupling for two electron systems; Selection and Intensity rules for doublets and triplets **Lectures 15**

Breadth of spectral line and effects of external fields:

The Doppler effect; Natural breadth from classical theory; natural breadth and quantum mechanics; External effects like collision damping, asymmetry and pressure shift and stark broadening; The Zeeman Effect for two electron systems; Intensity rules for the Zeeman effect; The calculations of Zeeman patterns; Paschen-Back effect; LS coupling and Paschen –Back effect; Lande's factor in LS coupling; Stark effect **Lectures 15**

Microwave and Infra-Red Spectroscopy:

Types of molecules, Rotational spectra of diatomic molecules as a rigid and non-rigid rotator, Intensity of rotational lines, Effect of isotopic substitution, Microwave spectrum of polyatomic molecules, Microwave oven, The vibrating diatomic molecule as a simple harmonic and anharmonic oscillator, Diatomic vibrating rotator, The vibration-rotation spectrum of carbon monoxide, The interaction of rotation and vibrations, Outline of technique and instrumentation, Fourier transform spectroscopy. **Lectures 15**

Raman and Electronic Spectroscopy:

Quantum and classical theories of Raman Effect, Pure rotational Raman spectra for linear and polyatomic molecules, Vibrarional Raman spectra, Structure determination from Raman and infra-red spectroscopy, Electronic structure of diatomic molecule, Electronic spectra of diatomic molecules, Born Oppenheimer approximation- The Franck-Condon principle, Dissociation and pre-dissociation energy, The Fortrat diagram, example of spectrum of molecular hydrogen. **Lectures 15**

Books:

1. Introduction to Atomic Spectra: H.E. White-Auckland Mc Graw Hill, 1934
2. Fundamentals of Molecular spectroscopy: C.B. Banwell-Tata Mc Graw Hill, 1986.
3. Spectroscopy Vol. I, II & III: Walker & Straughen
4. Introduction to Molecular Spectroscopy: G.M.Barrow-Tokyo Mc Graw Hill, 1962.
5. Spectra of Diatomic Molecules: Herzberg-New York, 1944.
6. Molecular Spectroscopy: Jeanne L McHale-NewJersy Prentice Hall, 1999.
7. Molecular Spectroscopy: J.M. Brown-Oxford University Press, 1998.
8. Spectra of Atoms and Molecules: P.F. Bermath-New York, Oxford University Press, 1995.
9. Modern Spectroscopy: J.M. Holias

CONDENSED MATTER LAB-I

Course No. PHY-205 **Max. Marks: 80**

1. To determine Hall coefficient by Hall Effect.
2. To determine the band gap of a semiconductor using p-n junction diode..
3. To determine the magnetic susceptibility of a material using Quink's method.
4. To determine the g-factor using ESR spectrometer.
5. To determine the energy gap and resistivity of the semiconductor using four probe method.
6. To trace hysteresis loop and calculate retentivity, coercivity and saturation magnetization.
7. To determine dielectric constant.
8. To study the series and parallel characteristics of a photovoltaic cell.
9. To study the spectral characteristics of a photovoltaic cell.

SPECTROSCOPY LAB.

Course No. PHY-206 **Max. Marks: 80**

1. To find the wavelength of monochromatic light using Febry Perot interferometer.
2. To find the wavelength of sodium light using Michelson interferometer.
3. To calibrate the constant deviation spectrometer with white light and to find the wavelength of unknown monochromatic light.
4. To find the grating element of the given grating using He-Ne laser light.
5. To find the wavelength of He-Ne laser using Vernier calipers.
6. To verify the existance of Bohr's energy levels with Frank-Hertz experiment.
7. To determine the charge to mass ratio (e/m) of an electron with normal Zeeman Effect
8. To determine the velocity of ultrasonic waves in a liquid using ultrasonic interferometer

QUANTUM MECHANICS-II

Course No. PHY-301 **Course Hrs: 60**
Time : 3 Hrs **Max. Marks: 80**

Note for the Paper Setters :

There will be five sections. Section A will consist of eight short answer type questions covering the whole syllabus and is compulsory. Sections B, C, D and E will consist of two questions each. The candidates are required to attempt one question from each of these sections. All questions carry equal marks.

Perturbation Theory: First and second order perturbation theory for nondegenerate and degenerate systems. Perturbation of an oscillator and anharmonic oscillator, the variation method. First order time dependent perturbation theory, constant perturbation, Calculation of transition probability per unit time for harmonic perturbation. The Helium atom problem. Stark effect.

Lectures 18

Scattering Theory: Born approximation, extend to higher orders. Validity of Born approximation for a square well potential. Optical theorem. Partial wave analysis, unitarity and phase shifts. Determination of phase shift, applications to hard sphere scattering. Low energy scattering in case of bound states. Resonance scattering.

Lectures 18

Relativistic Quantum Mechanics: Klein Gordon equation. Dirac Equation, Lorentz covariance of Dirac equation. Positive and negative energy solutions of Dirac equation, positrons. Properties of gamma matrices. Parity operator and its action on states. Magnetic moments and spin orbit energy.

Lectures 12

Identical Particles : Brief introduction to identical particles in quantum mechanics (based on Feynmann Vol.III) symmetrisation postulates. Application to 2-electron systems. Pauli exclusion principle. Bose Einstein and Fermi Dirac Statistics.

Lectures 12

Books :

1. Modern Quantum Mechnics: J.J. Sakurai-Pearson Educaton Pvt. Ltd., New Delhi, 2002.
2. Quantum Mechanics: L I Schiff-Tokyo Mc Graw Hill, 1968.
3. Feynmann lectures in Physics Vol. III-Addison Wesly, 1975.
4. Quantum Mechanics: Powel and Craseman-Narosa Pub. New Delhi, 1961.
5. Quantum Mechanics: Merzbacher-John Wiley & Sons, New York, 1970.

ELECTRODYNAMICS – II

Course No. PHY-302 **Course Hrs. : 60**
Time: 3 Hrs **Max. Marks: 80**
Note for the Paper Setters:
There will be five sections. Section A will consist of eight short answer type questions covering the whole syllabus and is compulsory. Sections B, C, D and E will consist of two questions each. The candidates are required to attempt one question from each of these sections. All questions carry equal marks.

• **Wave Guides**: Field at the surface of and within a conductor. Cylindrical cavities and waveguides,
modes in a rectangular wave guide, energy flow and attenuation in wave guides.
Perturbation of boundary conditions, resonant cavities, power loss in cavity and quality factor.

Lectures 18

Relativistic formulation of electrodynamics: Special theory or relativity, simultaneity, length, contraction, time dilation and Lorenz's transformations. Structure of space-time, four scalars, four vectors and tensors, relativistic mechanics. Relativistic electrodynamics. Magnetism as a relativistic phenomena and field transformations. Recasting Maxwell equations in the language of special relativity, covariance and manifest covariance, field tensor. Lagrangian formulation for the covariant Maxwell equations.

Lectures 18

Radiation Systems: Fields of radiation of localized oscillating sources, electric dipole fields and radiation, magnetic dipole and electric quadrupole fields, central fed antenna, brief introduction to radiation damping and radiation reaction.

Lectures 12

• Fields of moving charges: Lienard Wiechert potential, field of a moving charge. Radiated power from an accelerated charge at low velocities, Larmour's power formula and its relativistic generalisation ; Angular distribution of radiation emitted by an accelerated charge.

Lectures 12

Books:

1. Classical Electrodynamics: J.D. Jackson-Wiley, 1967
2. Electricity and Magnetics: D.J. Griffiths-Prentice hall, 1996
3. Classical Electromagnetic Radiation: J.B. Marian-Academic Press, 1965

CONDENSED MATTER PHYSICS-II

Course No. PHY.303 **Course Hrs. 60**
Time: 3 Hrs. **Max. Marks: 80**

Note for the Paper Setters:

There will be five sections. Section A will consist of eight short answer type questions covering the whole syllabus and is compulsory. Sections B, C, D and E will consist of two questions each. The candidates are required to attempt one question from each of these sections. All questions carry equal marks.

Lattice Specific Heat and Elastic Constants:

The various theories of lattice specific heat of solids, Einstein model of the Lattice Specific heat. Density of modes of vibration, Debye model of Lattice specific heat, Born cut-off procedure, Specific heat of metals, Elastic strain and stress components, Elastic compliance and stiffness constants, Elastic constants of cubic crystals, Elastic waves in cubic crystals.

Lectures 15

Physics of Semiconductors:

Semiconductors, Chemical bonds in semiconductors, Mechanism of current flow, Forbidden, valence and conduction bands, Band structure of silicon and germanium, Mobility, drift velocity and conductivity of intrinsic semiconductors, Carrier concentration in intrinsic semiconductors, Impurity semiconductors, Thermal ionization of impurities, Impurity states and band model, Impurity states, energy band diagram and Fermi level.

Lectures 15

The conductivity of Metals and Luminescence:

Electrical conductivity of metals, Drift velocity and relaxation time, The Boltzmann transport equation, The Sommerfield theory of conductivity, Mean free path in metals, Qualitative discussion of the features of the resistivity, Mathiesson's rule. Luminescence, excitation and emission, Decay mechanisms, Thallium activated alkali halides. Electro Luminescence.

Lectures 15

Dielectrics and Ferro Electrics:

Macroscopic field, The local field, Lorentz field. The Claussius-Mossotti relations, Different contribution to polarization: dipolar, electronic and ionic polarizabilities, General properties of ferroelectric materials, The dipole theory of ferroelectricity, objection against dipole theory, Thermodynamics of ferroelectric transitions. **Lectures 15**

Books:

1. An Introduction to Solid State Physics: C. Kittle-Wiley, 1958
2. Solid State Physics: A.J. Dekker-Prentice Hall, 1965.
3. Principles of Solid State Physics: R.A. Levey-Academic Press, 1968
4. Introduction of Solid State Physics: Ashroft-Cengage Learning, 1999.

NUCLEAR PHYSICS

Course No. PHY.304 **Course Hrs. 60**

Time: 3 Hrs. **Max. Marks: 80**

Note for the Paper Setters:

There will be five sections. Section A will consist of eight short answer type questions covering the whole syllabus and is compulsory. Sections B, C, D and E will consist of two questions each. The candidates are required to attempt one question from each of these sections. All questions carry equal marks.

Nuclear Interactions and Nuclear Reactions

Nuclear Forces: Two nuclear system, deutron problem, binding energy, nuclear potential well, pp and pn scattering experiments at low energy, meson theory of nuclear forces, e.g. Bartlett, Heisenberg, Majorans forces and potentials, exchanges forces and tensor forces, effective range theory-spin dependence of nuclear forces-Charge independence and charge symmetry of nuclear forces-Isospin formalisim- Yukawa interaction.

Lectures 15

Nuclear Models

Liquid drop model, Bohr-Wheeler theory of fission, Experimental evidence for shell effects, Shell Model, Spin-Orbit coupling, Magic-Applications of Shell model like Angular momenta and parities of nuclear ground states, Quantitative discussion and estimates of transition ratesmagnetic

moments and Schmidt lines, Collective model, Nuclear vibrations spectra and rotational spectra, applications, Nilsson model.

Lectures 15

Nuclear Decay

Beta decay, Fermi theory of beta decay, shape of the beta spectrum, Total decay rate, Angular momentum and parity selection rules, Comparative half-lives, Allowed and forbidden transitions, selection rules, parity violation, Two component theory of neutrino decay, Detection and properties of neutrino, Gamma decay, Multipole transitions in nuclei, Angular momentum and parity selection rules, Internal conversion, Nuclear isomerism.

Lectures 15

Nuclear Reactions

Direct and compound nuclear reaction mechanisms, cross sections in terms of partial wave amplitudes, Compound nucleus, scattering matrix, Reciprocity theorem, Breit Winger one level formula, Resonance scattering.

Lectures 15

Books:

1. A. Bohr and B.R. Mottelson: Nuclear Structure, Vol.1(1969) and Vol.2 Benjamin, Reading, A.1975.
2. Kenneth S. Krane: Introductory Nuclear Physics, Wiley, New York, 1988
3. G.N. Ghoshal: Atomic and Nuclear Physics Vol.2, S. Chand and Co., 1997
4. P. H. Perkins, introduction to High Energy Physics, Addison-Wiley, London, 1982.
5. Introduction to Elementary particle physics by D. Grifiths.

CONDENSED MATTER PHYSICS LAB.II

Course No. PHY-305 **Max. Marks: 80**

1. To determine the energy loss in transformer and ferrite cores using B-H curve.
2. To determine Stefan's constant using Boltzmann's Law.
3. To determine temperature coefficient of junction voltage and energy band gap in a p-n junction diode.
4. To study the depletion capacitance and its variation with reverse bias in a p-n junction.
5. Experiments with Microwaves set up.
6. To determine the lattice dynamics and dispersion relation for the monatomic and diatomic lattices.
7. To determine Curie temperature of ferrites.
8. To determine the energy loss in the ferrites at room temperature.
9. Experiments on Nanotechnology.
10. Study of Thermoluminescence of f-centres in Alkali Halide Crystals.
11. Study of optical Band gap using UV-Visible spectrophotometer.

NUCLEAR PHYSICS LAB

Course No. PHY-306 **Max. Marks: 80**

1. Pulse-Height Analysis of Gamma Ray Spectra.
2. Calibration of Scintillation Spectrometer.
3. Least square fitting of a straight line.
4. Study of absorption of gamma rays in matter.
5. Study of Compton Scattering Effect.
6. To study the characteristics of a G.M. Counter.
7. To determine the Dead time of a G.M. Counter.
8. Absorptions of Beta Particles in Matter.
9. Source strength of a Beta Source.
10. Window thickness of a G.M. Tube.
11. To investigate the statistics of radioactive measurements.
12. Study of Poisson Distribution.
13. Study of Gaussian Distribution.

PARTICLE PHYSICS

Course No. PHY-401 **Course Hrs: 60**
Time: 3 Hrs **Max. Marks: 80**

Note for the Paper Setters:

There will be five sections. Section A will consist of eight short answer type questions covering the whole syllabus and is compulsory. Sections B, C, D and E will consist of two questions each. The candidates are required to attempt one question from each of these sections. All questions carry equal marks.

• ***Elementary Particles and Their Properties:*** Historical survey of elementary particles and their classification, determination of mass, life time, decay mode, spin and parity of muons, pions, kaons and hyperons. Experimental evidence for two types of neutrinos, production and detection of some important resonances and antiparticles.

Lectures 15

• ***Symmetries and Conservation Laws:*** Conserved quantities and symmetries, the electric charge, baryon number, leptons and muon number, particles and antiparticles, hypercharge (strangeness), the nucleon isospin, isospin invariance, isospin of particles, parity operation, charge conservation, time reversal invariance, CP violation and CPT theorem, the K_O - K_O doublet unitary symmetry SU(2), SU (3) and the quark model.

Lectures 15

• ***Week Interaction:*** Classification of weak interactions, Fermi theory of beta decay, matrix element, classical experimental tests of Fermi theory, Parity non conservation in beta decay, lepton polarization in beta decay, the V-A interaction, parity violation in P-decay. Weak decays of strange-particles and Cabibbo's theory.

Lectures 15

• ***Gauge theory and GUT***: Gauge symmetry, field equations for scalar (spin 0), spinor (spin ½), vector (spin-1) and fields, global gauge invariance, local gauge invariance, Feynmann rules, introduction of neutral currents. Spontaneously broken symmetries in the field theory, standard model.

Lectures 15

Books:

1 Subatomic Physics: H. Fraunfelder and E.M. Henley- N.J. Prentice Hall
2 Introduction to Elementary Particles: D. Griffiths-Wiley-VCH-2008
3 Introduction to High Energy Physics: D.H Perkins-Cambridge University Press, 2000.

STATISTICAL MECHANICS

Course No. PHY-402 **Course Hrs: 60**
Time : 3 Hrs **Max. Marks: 80**

Note for the Paper Setters:

There will be five sections. Section A will consist of eight short answer type questions covering the whole syllabus and is compulsory. Sections B, C, D and E will consist of two questions each. The candidates are required to attempt one question from each of these sections. All questions carry equal marks.

Classical Stat. Mech. I: Foundation of statistical mechanics; specification of states in a system, contact between statistics and thermodynamics, the classical ideal state, the entropy of mixing and Gibbs paradox. The phase space of classical systems, Liouville's theorem and its consequences.

Lectures 12

Classical Stat. Mech. II: The microcanonical ensemble with examples. The canonical ensemble and its thermodynamics, partition function, classical ideal gas in canonical ensemble theory, energy fluctuations in the canonical ensemble. A system of harmonic oscillators. The statistics of paramagnetism. The grand canononical ensemble, the physical significance of the statistical quantities, examples, fluctuation of energy and density. Cluster expansion of classical gas, the virial equation of state.

Lectures 18

Quantum Stat. Mech.I : Quatum states and phase space, the density matrix, statistics of various ensembles. Example of electrons in a magnetic field, a free particle in a box and a linear harmonic oscillator. Significance of Boltzamann formula in classical and quantum statistical mechanics.

Lectures 12

Quantum Stat. Mech. II : An ideal gas in quantum mechanical microcanonical ensemble. Statistics of occupation numbers, concepts and thermodynamical behaviour of an ideal gas. Bose Einstein condensation, Discussion of a gas of photons and phonons, Thermodynamical behaviour of an ideal fermi gas, electron gas in metals, Pauli paramagnetism, statistical equilibrium of white dwarf stars.

Lectures 18

Books:

1. Statistical Mechanics: R.K. Patharia-Butten Worth Heinemann, 1996
2. Statistical and Termal Physics: F. Reif-Mc-Graw Hill, 1965
3. Statistical Mechanics: Kerson Huang-Wiley, 1963.

Seminar and Assignment

Course No. PHY-403 **Course Hrs:60**
Max. Marks:80

PHYSICS OF MATERIALS

Course No. PHY-404 **Course Hrs.: 60**
Time: 3 Hrs **Max. Marks: 80**

Note for the Paper Setters:

There will be five sections. Section A will consist of eight short answer type questions covering the whole syllabus and is compulsory. Sections B, C, D and E will consist of two questions each. The candidates are required to attempt one question from each of these sections. All questions carry equal marks.

Unit I

Vacuum Technology:

Basic ideas about vacuum, Throughput, Conductance, Vacuum pumps : rotary pump, diffusion pump, ion pump, molecular pump, cryopump, Vacuum gauges : pirani gauge, penning gauge, ionization gauge (hot cathode ionization gauge, cold cathode ionization gauge).

15 Lectures

Unit II

Thin Film

Thin Film and growth process, Influence of nature of substrate and growth parameters (substrate temperature, thickness, deposition rate). Thin film deposition, techniques: thermal evaporation, chemical vapor deposition, spray pyrolysis, sputtering. Epitaxial growth, Thin film thickness measurement techniques: film resistance method, optical method, microbalance method.

15 Lectures

Unit III

Polymers, Ceramics, Liquid Crystals and Nanophase Materials: Characteristics, Application and Processing of polymers : Polymerization, Polymer types, Stress- Strain behaviour, melting and glass transition, thermosets and thermoplasts. Characteristics, Application and Processing of Ceramics, glasses and refrectories, Liquid Crystals : classification and applications, Nanophase materials: synthesis and applications.

15 Lectures

Unit IV

Characterization of Materials

Powder and single crystal X-ray diffraction, Transmission electron microscopy, Scanning electron microscopy, Low Energy Electron Diffraction (LEED), Auger electron microscopy, Atomic force microscopy.

15 Lectures

Books:

1. Vacuum Technology: A. Roth-North Holland Pub. Co., 1976
2. Thin Film Phernomeon: K.L. Chopra-R E Kriegn Pub. Co., 1979.
3. High Temperature Superconductors: E.S.R. Gopal & SV. Subramanyam-Wiley, 1989
4. Material Scienceand Engg: W.D. Callister-.Wiley, 1994
5. Nanostructured Materials: J.C. Ying-Wiley-. Academic Press, 2001
6. Methods of Surface Analysis: J.M. Walls- CUP Archive, 1990.
7. Introduction to Nanotechnology - Charles P.Pooler, Frank J. Owens- IEEE, 2003

RADIATION PHYSICS

Course No. PHY-405 **Course Hrs: 60**
Time: 3 Hrs **Max. Marks: 80**

Note for the Paper Setters:

There will be five sections. Section A will consist of eight short answer type questions covering the whole syllabus and is compulsory. Sections B, C, D and E will consist of two questions each. The candidates are required to attempt one question from each of these sections. All questions carry equal marks.

• ***Ionizing Radiations and Radiation Quantities:*** Types and sources of ionizing radiation, fluence, energy fluence, kerma, exposure rate and its measurement - The free air chamber and air wall chamber, Absorbed dose and its measurement ; Bragg Gray Principle, Radiation dose units - rem, rad, Gray and sievert dose commitment, dose equivalent and quality factor.

Lectures 15

• ***Dosimeters:***

Pocket dosimeter, films, solid state dosimeters such as TLD, SSNTD, chemical detectors and neutron detectors. Simple numerical problems on dose estimation.

Lectures 15

• ***Radiation Effects and Protection:***

Biological effects of radiation at molecular level, acute and delayed effects, stochastic and non-stochastic effects, Relative Biological Effectiveness (RBE), Linear energy transformation (LET), Dose response characteristics.

Permissible dose to occupational and non-occupational workers, maximum permissible concentration in air and water, safe handling of radioactive materials, The ALARA, ALI and MIRD concepts, single target, multitarget and multihit theories, Rad waste and its disposal, simple numerical problems.

Lectures 15

• ***Radiation Shielding:***

Thermal and biological shields, shielding requirement for medical, industrial and accelerator facilities, shielding materials, radiation attenuation calculations-The point kernal technique, radiation attenuation from a uniform plane source. The exponential point-Kernal. Radiation attenuation from a line and plane source. Practical applications of some simple numerical problems.

Lectures 15

Books *:*

1. S. Glasstone and A. Sesonke: Nuclear Reactor Engineering-Van Nostrand Reinhold, 1981
2. Alison. P. Casart: Radiation Theory
3. A. Edward Profio: Radiation Biology-Radiation Bio/Prentice Hall, 1968
4. F.H. Attix: Introduction to Radiological Physics and Radiation Dosimetry-Wiley-VCH, 1986.

REACTOR PHYSICS

Course No. PHY-406 **Course Hrs. 60**
Time: 3 Hrs. **Max. Marks: 80**

Note for the Paper Setters:

There will be five sections. Section A will consist of eight short answer type questions covering the whole syllabus and is compulsory. Sections B, C, D and E will consist of two questions each. The candidates are required to attempt one question from each of these sections. All questions carry equal marks.

Interaction of Neutrons with Matter in Bulk:

Thermal neutron diffusion, Transport and diffusion equations, transport mean free path, solution of diffusion equation for a point source in an infinite medium and for an infinite plane source in a finite medium, extrapolation length and diffusion length-the albedo concept.

Lectures 15

Moderation of Neutron:

Mechanics of elastic scattering, energy distribution of thermal neutrons, average logarithmic energy decrement, slowing down power and moderating ration of a medium. Slowing down density, slowing down time, Fast neutron diffusion and Fermi age theory, solution of age equation for a point source of fast neutrons in an infinite medium, slowing down length and Fermi age.

Lectures 15

Theory of Homogeneous Bare Thermal and Heterogeneous Natural Uranium Reactors

Neutron cycle and multiplication factor, four factor formula, neutron leakage, typical calulations of critical size and composition in simple cases, The critical equation, material and geometrical bucklings, effect of reflector,

Advantages and disadvantages of heterogeneous assemblies, various types of reactors with special reference to Indian reactors and a brief discussion of their design feature.

Lectures 15

Power Reactors Problems of Reactor Control

Breeding ratio, breading gain, doubling time, Fast breeder reactors, dual purpose reactors, concept of fusion reactors, Role of delayed neutrons and reactor period, Inhour formula, excess reactivity, temperature effects, fission product poisoning, use of coolants and control rods.

Lectures 15

Books:

1. The elements of Nuclear reactor Theory: Glasstone & Edlund-Vam Nostrand, 1952.
2. Introductions of Nuclear Engineering: Murray-Prentice Hall, 1961.

PLASMA PHYSICS

Course No. PHY-407 **Course Hrs: 60**
Time: 3 Hrs. **Max. Marks: 80**

Note for the Paper Setters:

There will be five sections. Section A will consist of eight short answer type questions covering the whole syllabus and is compulsory. Sections B, C, D and E will consist of two questions each. The candidates are required to attempt one question from each of these sections. All questions carry equal marks.

Basics of Plasmas: Occurence of plasma in nature, definition of plasma, concept of temperature, Debye shielding and plasma parameter. Single particle motion in uniform E and B, nonuniform magnetic field, grid B and curvature drifts, invariance of magnetic moment and magnetic mirror. Simple application of plasmas.

Lectures 20

Plasma Waves: Plasma oscillations electron plasma waves, ion waves, electrostatic electron and ion oscillations perpendicular to magnetic field upper hybrid waves, lower hybrid waves, ion cyclotron waves. Light waves in plasma.

Lectures 15

Boltzmann and Vlasov Equations: The fokker plank equation, integral expression for collision lern zeroth and first order moments, the single equation relaxation model for collision lern. Application kinetic theory to electron plasma waves, the physics of landau damping, elementary magnetic and inertial fusion concepts.

Lectures 15

Non-linear Plasma Theories: Non-linear Electrostatic Waves, K dV Equations, Non-linear Schrodinger Equation, Solitons, Shocks, Non-linear Landou Damping.

Lecturers 15

Books:

1. Introduction to Plasma Physics and Controlled Fusion: F. F. Chen-Springer, 1984
2. Plasma Physics: R. O. Dendy-Cfambridge University Press, 1995.
3. Ideal Magnetohydrodynamics: J. P. Friedberg-Springer edition, 1987
4. Fundamental of Plasma Physics: S. R. Seshadri-American Elsevier Pub. Co., 1973.

GEOPHYSICS

Course No. Phy-408 **Course Hrs: 60**
Time: 3Hrs **Max. Marks: 80**
Note for the Paper Setters:
There will be five sections. Section A will consist of eight short answer type questions covering the whole syllabus and is compulsory. Sections B,C,D and E will consist of two questions each and candidates are required to attempt one question from each section. All questions carry equal marks.

Seismology and Interior of the Earth:
Origin of earth, shape, size, mass and density of the earth. Theory of seismic waves. The variation of P and S wave velocity, temperature, density, pressure and elastic parameters with depth. Mineralogical and chemical composition of crust, mental and core. Formation of core. Earthquake; effects, types, mechanism, source parameter, and hazard assessment.

(Lectures 15)

Geochronology and Geodynamics:
Geological Time Scale. Radioactive dating methods; U-Pb, Th-Pb, Pb-Pb, Rb-Sr, K-Ar, and C-14. Fission Track dating. Interpretation and discordant ages, age of earth. Heat flow: thermal and mechanical structure of the continental and oceanic lithosphere. Plate tectonics theory: kinematics, dynamics and evolution of plates; types of boundaries, processes. Geodynamics of Indian plate, formation of Himalya.

(Lectures 15)

Radioactivity of Rocks: Magnetic differentiation, Browns reaction series. Radioactivity of rocks, soil, water and air. Uranium mineralization and its occurrences in India. Radiometric survey of rocks: ground and air borne surveys. Radiometer and emanometer. Role of radiometry in geophysical prospecting, gamma logging and gamma testing.

(Lectures 15)

Nuclear Techniques: Gamma-transmission method for determination of rock densitie in Laboratory and in-situ. Gamma spectrometric analysis for U, Th and K in rock/soil. Neutronactivation
analysis: Equation for build up of induced activity.

(Lectures 15)

Books:

1. The Solid Earth – C.M.R. Fowler
2. Interior of the earth – M.H.P. Bott
3. The Earth's age and Geochronology- D.York and R.M. Fraquhar
4. Physics of the Earth – F.D. Stacey.
5. Principles and Methods of Nuclear Geophysics- V. L. S. Bhimasankaran
and N. Venkat Rao.

NANO TECHNOLOGY

Course No. PHY-409 **Course Hrs: 60**

Time: 3 Hrs **Max. Marks: 80**

Note for the Paper Setters:

There will be five sections. Section A will consist of eight short answer type questions covering the whole syllabus and is compulsory. Sections B,C,D and E will consist of two questions each and candidates are required to attempt one question from each section. All questions carry equal marks.

Introduction and Synthesis of Nano Materials:

Introduction, Basic idea of nanotechnology, nanoparticles, metal Nanoclusters, Semiconductor nanoparticles, Physical Techniques of Fabrication, inert gas condensation, Arc Discharge, RF plasma, Ball milling, Molecular Beam Epitaxy, Chemical Vapour deposition, Electrodeposition, Chemical Methods-Metal nanocrystals by reduction, Photochemical synthesis, Electrochemical synthesis, Sol-gel, micelles and microemulsions, Cluster compounds. Lithographic Techniques-AFM based nanolithography and nanomanipulation, E-beam lithography and SEM based nanolithography, X ray based lithography.

(Lectures 15)

Characterization Techniques:

X-ray diffraction, data manipulation of diffracted X-rays for structure determination, Scanning Probe microscopy, Scanning Electron microscopy, Transmission Electron Microscopy, Scanning Tunneling Microscopy, Optical microscopy, FTIR Spectroscopy, Raman Spectroscopy, DTA, TGA and DSC measurements

(Lectures 15)

Carbon Nanotubes and other Carbon based materials:

Preparation of Carbon nano tubes, CVD and other methods pf preparation of CNT, Properties of CNT; Electrical, Optical, Mechanical, Vibrational properties etc. Application of CNT; Field emission, Fuel Cells, Display devices. Other important Carbon based materials; Preparation and Characterization of Fullerence and other associated carbon clusters/molecules, Graphenepreparation,
characterization and properties, DLC and nano doamonds.

(Lectures 15)

Nanosemiconductors and Nano sensors:

Semiconductor nanoparticles-applications; optical luminescence and fluorescence from direct band gap semiconductor nanoparticles, carrier injection, polymers-nanoparticles, LED and solar cells, electroluminescence. Micro and nanosensors; fundamentals of sensors, biosensor, microfluids, MEMS and NEMS, packaging and characterization of sensors.

(Lectures 15)

Books:

1. Solid State Physics: J.P. Srivastva-Prentice Hall, 2007.
2. Introduction to nanoscience and Nanotechnology: K.K. Chattopadhyay and A.N. Banerjee- PHI Learning Pvt. Ltd. 2009
3. Nanotechnology Fundamentals and Applications: Manasi Karkare, I.K.- International Publishing House, 2008.
4. Nanomaterials: B. Viswanathan- Narosa, 2009.
5. Encyclopedia of Nanotechnology: H.S. Nalwa-American Scientific Publishers, 2004.

6. Introduction to Nanotechnology: Charles P. Poole Jr. and Franks J. Qwens,-John Wiley & Sons, 2003.
7. Nanostructures and Nanomaterials, Synthesis, Properties and Applications: Guoahong Cao- Imperial College Press, 2004.
8. Springer Handbook of Nanotechnology: Bharat Bhushan-Springer, 2004.
9. Science of Engineering Materials: C.M. Srivastva and C. Srinivasan-New Age International, 2005.
10. The Principles and Practice of electron Microcopy: Ian. M. Watt-Cambridge University Press, 1997.
11. Ultrasonic Testing of Materials: J.K. Krammer and H.K. Krammer-Springer Verlag, 1996.
12. Physical Properties of Carbon Nanotube: R. Satio, G. Dresselhaus and M. S. Dresselhaus-Imperial College Press, 1998.
13. Sensors Vol. 8, Micro and Nanosensor Technology: H. Meixner and R. Jones (Editor)-John Wiley and Sons, 2000.