

## **M.Sc. (Previous) Physics Syllabus (Year 2008-09 onwards)**

### **PAPER – I : MATHEMATICAL PHYSICS**

#### **UNIT – I :**

##### **GENERALIZED CO-ORDINATE, TENSORS AND GROUP THEORY :**

Generalized co-ordinates, expression for gradient, divergence, curl and Laplacian operator in generalized co-ordinate, Spherical co-ordinate as a special example of generalized co-ordinate.

Tensor analysis : introduction, definitions, contraction, direct product, summation convention, quotient rule, pseudotensors, Levi-Civita Symbol, Irreducible tensors, Metric tensor, Christoffel Symbols, Christoffel Symbols as derivatives of the metric tensor, Covariant derivative, geodesics.

Definition of the group axioms, multiplication table, classes, subgroups, G sets, Homomorphism, Representation general and irreducible, Schur's lemma, characters, character table, few simple groups  $C_4$   $V$  permutation group, Rotation group  $SO(3)$ , Lie groups and Lie algebra, special unitary (SU) groups,  $SU(2)$  group.

#### **UNIT – II : COMPLEX VARIABLES :**

Analytical functions and Cauchy-Riemann conditions, Poles-Taylor and Laurent series, contour integral and Cauchy's representation, Residue theorem, evaluation of residue at  $n^{\text{th}}$  order pole, Jordan's Lemma Evaluation of definite integral, Principle value of the integral, Multi-valued function, branch point, branch cut and integration around branch cut, Conformal mapping and its applications.

Dispersion relations : symmetry relations and optical relations.

#### **UNIT – III : CALCULUS OF VARIATIONS AND THEORY OF TRANSFORMS:**

Calculus of variations: The Euler-Lagrange equation, First integral geodesics, The brachistochrone, Minimum surface of revolution, Several dependent variable, parametric representation, Ritz method.

Expression of the Piecewise continuous periodic function in finite interval, properties, simple problems, applications, Fourier transform, Convolution, Parseval's theorem, Momentum representation, Laplace, transform, their inverse transform, Dirac delta function, convolution product, solving different equation with given boundary conditions with transform.

#### SECOND ORDER DIFFERENTIAL EQUATION WITH VARIABLE CO-EFFICIENTS:

Regular point; Simple pole, Series solution-identical equation, Recurrence relation, Convergence of the series, Existence and evaluation of the second order solution, Self adjoint, differential operators and eigen value problem, Hermite polynomials and their properties.

#### UNIT – IV : SOME SPECIAL FUNCTIONS AND PARTIAL DIFFERENTIAL EQUATIONS

##### LEGENDRE, LAGURRE AND BESSEL DIFFERENTIAL EQUATIONS:

Legendre polynomials, Associated Legendre polynomials, spherical harmonics ( $Y_{lm}(\theta, \phi)$ ) Laguerre polynomials, Associated Laguerre polynomials, Bessel function, spherical Bessel function, their properties, Recurrence relations, Orthogonality and Generating functions, Applications.

##### PARTIAL DIFFERENTIAL EQUATION:

Boundary condition: Dirichlet, Neumann and Cauchy's condition, Classification of differential equation in elliptical, Hyperbolic and Parabolic form, Laplace's equation, Heat diffusion equation and wave equation in Physics, Separation of variable technique to solve them, Green's function technique in general and especially for Poisson's equation. Introduction to approximate solutions of non-linear differential equations.

##### Text book :

1. Mathematical methods for physicists: G.B. Arfken and H.J. Weber, 5<sup>th</sup> edition, Academic press/Elsevier science, India, 2000.
2. Mathematical methods for physics and engineering : K.F. Riley, M.P. Hobson and S.J. Bence, Cambridge University Press, 1998 (Low-price edition).
3. Advanced Mathematical Methods for Scientists and Engineers: Carl M. Bender and Steven A. Oraszag, Springer, 1999.
4. Elements of Group Theory for Physics: A.W. Joshi, 4<sup>th</sup> Edition Reprint 2002, New age international publishers, New Delhi.

##### References book :

1. Mathematics of Classical and Quantum Physics Vol.I & II by Robert W. Fuller, Frederics W. 1992, Courier Dover Publications, NY, USA.
2. Advanced Engineering Mathematics Kreyzing 8<sup>th</sup> edition, 2006, John Wiley & Sons (Asia Pvt.), Singapore.
3. Mathematical Physics P.K. Chattopadhyay, 1990, New age international publisher,

New Delhi.

4. Mathematical Methods for Physical Sciences by M.L. Boas, 3<sup>rd</sup> edition 2006, John Wiley and sons, New York (2<sup>nd</sup> Ed. 1983).

## **M.Sc. (Previous) Physics Syllabus (Year 2008-09 onwards)**

### **PAPER – II CLASSICAL MECHANICS AND QUANTUM MECHANICS**

#### **UNIT – I**

##### **Mechanics of a particles and two body central force problem**

( Review: mechanics of a system of particles, system subjected to different constraints and various examples, generalized coordinates)

D' Alembert's principle, Lagrange's equations, problems, deduction of Lagrange's equation from D' Alembert's principle, applications of Lagrange's equation, generalized momenta and energy. (Review: Cyclic or Ignorable coordinates), techniques of calculus of variation,

##### **HAMILTONIAN FORMULATION:**

Hamilton's principle, Lagrange's equation from Hamilton's principle, Rayleigh's dissipation function, integral of motion, symmetry properties of space and time and conservation theorems.

Reduction to one body problem, center of mass and relative motion, equation of motion and first integrals, equivalent one dimensional problem, Principle of least action, Hamiltonian principle, derivation of Hamiltonian equation of motion for holonomic systems from Hamilton's principle and characteristic functions.

Brief Introduction to classical chaos: Introduction, periodic motion, perturbations, Kolmogorov-Arnold-Moser theorem, attractors, chaotic trajectories, Liapunov exponents.

#### **UNIT – II**

##### **RIGID BODY :**

(Review: number of degree of freedom, Euler's angles and Euler's theorem), infinitesimal rotation, rate of change of vector, ( Review: coriolis force, angular momentum and kinetic energy of a rigid body) , the inertia tensor and moment of inertia, principle axis transformation, Euler's equation of motion. Precession of a charged body in a magnetic field.

### **CANONICAL TRANSFORMATION AND HAMILTONIAN – JACOBI THEORY:**

Canonical transformation and its examples, generating functions, Poisson brackets, equation of motion, invariance of Poisson brackets under canonical transformations, angular momentum, Poisson brackets relations, infinitesimal canonical transformation, problems, Hamilton's principle and characteristic function, separation of variables in H – J method, action angle variables interpretation (for/with one degree of freedom), small oscillations, normal modes and coordinates, transition from a discrete to a continuous system, the Lagrangian formulation for continuous system. Constant of motion and symmetry properties.

### **UNIT – III**

**(a) Vectors, Matrices and Heisenberg mechanics:** Review of different types of matrices and matrix algebra, transposition, complex conjugation and adjoint of matrices, review of determinant and its properties, vectors and vector space, Dirac notations, Linearly independent, orthogonal and orthonormal vectors, abstract representation of vectors, inner and outer product of vectors, Gram-Schmidt method of orthogonalization of vectors, Schwarz inequality, linear transformation of vectors, eigenvalues and eigenvectors of a matrix and properties of eigenvalues and eigenvectors, inversion and diagonalization of a matrix-analytical and numerical methods, special type of matrices:- orthogonal, unitary and hermitian matrices and their properties, diagonalization of hermitian matrix, change of basis and unitary transformations, bi-linear, quadratic and hermitian forms, Cayley-Hamilton theorem, infinite dimensional Hilbert space, basis in Hilbert space, vector representation of a vector and matrix representation of an operator, Schrodinger equation in matrix form, statement of assumptions of Heisenberg quantum mechanics, general uncertainty principle for non-commuting variable, treatment of one dimensional harmonic oscillator problem with use of operator and matrix formalism.

**(b) Transformations, Conservation laws and Symmetries:** Translation in space and conservation of linear momentum, translation in time and conservation of energy, rotation in space, quantum generalization of the rotation operator and conservation of angular momentum, conservation of charge, reflection, parity and space inversion, **Time-Reversal Operator:-** Properties of anti-linear operator, time reversal for spin less particle, time reversal operator for non-zero spin particle.

### **(c) SCHRODINGER WAVE EQUATION AND ITS EXACT SOLUTION FOR ONE DIMENSION :**

(Review : admissibility condition for wave functions), observables as dynamical variables and their expressions as hermitian operator, general principle of uncertainty relations for non commuting variables, Dirac delta function, Solution of one dimensional harmonic oscillator problem with the use of operator and matrix formalism.

## UNIT – IV

### SCHRODINGER EQUATION IN THREE DIMENSION:

Schrodinger equation in three dimensions, spherically symmetric different potentials, angular momentum, commutation amongst  $L_x$ ,  $L_y$  and  $L_z$ , eigen value spectrum of  $L^2$  and  $L_z$ , Legendre polynomials and spherical harmonics, bound state solutions for square well and coulombic potential (H – atom)

### MANY PARTICLES SYSTEMS:

Identical particles (fermions/bosons), symmetric and anti symmetric wave function, multiplicity and degeneracy.

### APPROXIMATE METHODS:

Time independent perturbation theory for non degenerate case (1<sup>st</sup> and 2<sup>nd</sup> order) and for degenerate case (1<sup>st</sup> order only), removal of degeneracy, application of perturbation theory, an harmonic oscillator, stack effect. Variational method, upper bound to excited states, trial wave function in variational method, WKB approximation; turning point solution, validity, WKB connecting formula, Bohr – Sommerfeld quantum condition, application of variational method and WKB approximation.

### TEXT BOOK

1. Introduction to Classical Mechanics by Goldsein Poole & Safko (Pearson education, Asia) 1<sup>st</sup> edition, 2002 (Low Price Edition)
2. Classical Mechanics – N.C. Rana and P.S. Jog 1991, Tata McGraw-Hill Pub. Co. Ltd., New Delhi.
3. Introduction to Classical Mechanics R.G. Takwale and P.S. Puranik, 1979, Tata McGraw-Hill Pub. Co. Ltd., New Delhi.
4. Quantum mechanics by L P Schiff, McGraw Hill International, 1968.
5. Quantum mechanics by J I Powell & B Crasemann 2<sup>nd</sup> edition, B.I. Publication, Delhi, 1971.
6. Quantum mechanics by Ghatak & Loknathan
7. Quantum mechanics by G. Aruldas, Prentice-Hall of India Pvt. Ltd., 2002.

**M.Sc. (Previous) Physics Syllabus (Year 2008-09 onwards)**

**PAPER – III : ELECTRONICS AND SOLID STATE PHYSICS**

***SECTION – I: ELECTRONICS***

**UNIT – I:**

**SEMICONDUCTOR DEVICE PHYSICS:**

Energy distribution of electrons in a semi conductors, The Fermi-Dirac function, The density of states, Carrier concentration in an intrinsic semiconductor, Fermi level in a semiconductor having impurities, Band structure of open circuit p-n junction, Basic semiconductor equations, The p-n diode volt-ampere equation.

**DIGITAL CIRCUITES:**

Concept of Binary and Hexadecimal number systems, BCD codes, Introduction to RTL, DTL, TTL and COMOS logic families, FAM-IN and FAN-OUT, Boolean algebra, De Morgan's theorem, Karnaugh mapping, Half adder, Full adder and subtractor.

Flip Flop circuits, RS, J-K, Master slave, D type and T type FF circuits.

**COUNTERS:**

Asynchronous and Synchronous (up and down) Mode-N-counters , ring counters and counters as frequency dividers.

**SHIFT RESISTORS:**

Basic shift resistors, Left right shift resistor, serial in and parallel out, Parallel in and serial-out, Parallel-in and Parallel-out shift resistors,

Multiplexers and De-multiplexers, Encoders, Decoders, and Buffers.

**UNIT – II:**

**APPLICATION OF OPERATIONAL AMPLIFIER:**

Review of fundamentals (Inverting and non-inverting amplifier), Analog inverter, adder, Voltage to current, current to voltage converter, Integrator, differentiator, comparators, and Schmidt, trigger.

### **Amplifiers:**

Two stage RC coupling (Potential), Inductive Coupling, Transformer Coupling, Tuned Transformer Coupling (Double Tuned Transformer), Direct Coupling, Response of two stage RC coupled amplifier, Class A amplifier, efficiency and push pull operation, AC load line and Q point, power output, Class B push pull amplifier, Cascaded stages, Tuned class C amplifier.

### **OSCILLATORS:**

Theory of oscillators, Hartley and Collpitts oscillators, phase shift oscillators, crystal oscillators, relaxation oscillator, Wein Bridge oscillators.

### **JFET:**

Basic ideas, pinch off voltage, FET volt-ampere characteristics, low frequency common source and common drain amplifier, biasing of FET/ MOSFET, and UJT.

## **SECTION – II: SOLID STATE PHYSICS**

### **UNIT – III:**

#### **Ionic bond, Point defects:**

Ionic bond, cohesive energy of ionic crystals, Madelung constant and its evaluation, Repulsive exponent from compressibility data, characteristics of ionic crystals, introduction to crystal defects, point defects, color centers and optical property of ionic crystals

#### **ENERGY BAND THEORY:**

Periodic potentials and Schrodinger equation, Bloch theorem, Kronig-Penney model, Origin of band gap, Brillouin zones, reduced zone scheme, distinction between metals, insulator and semiconductor, electron motion in one dimension, effective mass, concept of a hole, mobility and temperature dependence, cyclotron resonance and hall effect, De-Haas-Van Alfen effect.

#### **SUPERCONDUCTIVITY:**

Experimental facts and occurrence of superconductivity, elements of BCS theory, The BCS ground state and Cooper pairs, penetration depth and coherence length, London equations, Meissner effect, types I and II superconductors

## **UNIT – IV:**

### **MAGNETIC PROPERTIES:**

Classification of magnetic materials and their characteristics, origin of magnetism, Bohr magnetron, diamagnetism and Larmor precession, classical and quantum theories of paramagnetism, ferromagnetism, Weiss theory, domains and hysteresis, anti-ferromagnetism, two sub lattice model, ferrimagnetism; Electron spin resonance, paramagnetic relaxation, spin-lattice and spin-spin relaxation,

### **DIELECTRIC PROPERTIES:**

Static dielectric constant, polarization, electronic and ionic polarizabilities, orientational polarization, dielectric constant, Lorentz internal field, dielectric constant of solids, Clausius-Mosotti relation, complex dielectric constant and dielectric losses, relaxation time, electronic polarization and optical absorption; ferroelectricity, dipole theory, polarization catastrophe, introduction to piezoelectricity:

### **Text books:**

1. Integrated Electronics by Milman and Halkias, McGraw-Hill.
2. Digital Technology By Virendra Kumar , New Age International
3. Fundamental of Electronics Devices by Milman and Halkias, McGraw-Hill.
4. Digital Principles and Application by Malvino and Leach (TMH).
5. Hand Book of Electronics – Gupta and Kumar, Pragati Prakashan.
6. Digital Technology by Tokheim - TMH
7. Introduction to Solid State Physics by C. Kittel, 7<sup>th</sup> edition John Wiley & Sons, 2005.
8. Fundamental of Solid State Physics – R. L. Singhal 7<sup>th</sup> revised edition, 2001, Kedranath, Ramnath and Company Meerut.
9. Solid State Physics by Ashcroft and Mermin, Half-Saunders International, 1967.

## M.Sc. (Previous) Physics Syllabus (Year 2008-09 onwards)

### PAPER- IV SPECTROSCOPY & NUCLEAR PHYSICS

#### SECTION – I SPECTROSCOPY

##### UNIT – I:

Brief of Spectra of alkali elements, fine structure in alkali spectra, intensity rules, central field approximation, interaction energy in L-S coupling and j-j coupling (two electron system). Broadening of spectral lines, natural broadening, Doppler broadening and external effects, nuclear spin and hyperfine structure.

**Lasers** :- (Brief Review of : Absorption, spontaneous emission, stimulated emission, Einstein coefficients, optical coherence, temporal coherence, spatial coherence, degree of coherence of light waves), active medium, light amplification in an inverted active medium, methods of creating population inversion, principal pumping schemes. Quality factor, losses inside cavity, radiant loss, diffraction loss, excitation spectroscopy, laser induced fluorescence, intra cavity absorption, photo-acoustic spectroscopy, optogalvanic spectroscopy, ionization spectroscopy, stepwise excitation, multi photon absorption and emission, principles of laser Raman spectroscopy.

**Astronomy and astrophysics** : Celestial sphere and different coordinate systems (introductory), star maps, right ascension and declination, optical telescopes and their mountings, light gathering power and angular resolution of optical telescopes. Basic definitions: apparent luminosity, absolute luminosity, distance-the unit parsec. Apparent magnitude, absolute magnitude, distance modulus. Observed properties of stars – luminosity, spectral index, surface temperature, size, masses of stars, correlations between observed properties – the H-R diagram of nearby stars, classification of stars : spectral, luminosity age. Stellar evolution : Stars in formation, Virial-theorem, stellar energy generation, stellar energy cycle, evolution of stars, and end states of stars – white dwarfs, Neutron stars and black holes (qualitative), Mass radius relations, binary star (introductory).

##### UNIT – II:

**Microwave spectroscopy** :- Molecular requirement for rotational spectra, rigid rotator, non-rigid rotator, intensity of rotational lines, band head formation, intensity distribution in rotational structure, isotopic shift in rotational lines, techniques and instrumentation.

**IR Spectroscopy** :- Vibrational energy of a diatomic molecule, vibrating diatomic molecule as a harmonic oscillator and an-harmonic oscillator, vibrational frequency and force constant for an an-harmonic oscillator, progressions and

sequences, vibrating rotator, isotopic shifts in vibrational bands, techniques and instrumentation, Frank-Condon principle, Heitler and London theory of  $H_2$  molecule.

**Raman Spectroscopy:-** Nature of Raman effect, experimental arrangement of Raman spectra, classical and quantum theory of Raman effect, Raman spectra and molecular spectra, infra-red spectra versus Raman spectra.

**Spin Resonance spectroscopy :-**NMR, EPR.

## SECTION – II : NUCLEAR PHYSICS

### Unit-III

**Interaction of radiation and charged particle with matter:** Energy loss of electrons and positrons, Stopping power and range of heavier charged particles, Interaction of gamma rays with matter.

**Nuclear radiation detectors:** Gas filled detectors, Proportional and Geiger Muller counters, Scintillation detector, Solid state detectors

**Nuclear forces and two body problems:** Saturation, Charge independence and Exchange forces, Deuteron ground and excited states, Low energy n-p scattering, Scattering length, Spin dependence of nuclear forces, Effective range theory, Meson theory of nuclear force.

**Nuclear models:** Semi empirical mass formula, Single particle shell model, its validity and limitations, Collective model ( Qualitative discussion on rotational and vibrational states).

### Unit-IV

#### Nuclear reactions

Partial wave analysis of nuclear reaction (result only), Single level Breit Wigner formula, Direct reactions, Compound nucleus hypothesis, Resonances in reactions.

#### Reactor Physics

Nuclear chain reaction (four factor formula), Reactor materials, Breeder reactor.

#### Nuclear decay

Fermi theory of  $\beta$  –decay, Kurie plot, ft- values, allowed and forbidden transition, Fermi and Gamow Teller selection rules, Multipole transition and selection rules.

**Elementary particles:** Fundamental forces and fundamental particles, Symmetries and conservation laws, Space time symmetries, Space inversion, Charge conjugate and time reversal symmetries, CPT theorem and its consequences, Lepton numbers and baryon numbers, Isospin, Strangeness and Charm, Gell-Mann and Nishima relation, Hadronic spectrum and Quark model, Concept of colour and gluons.

### TEXT BOOKS:

1. Atomic and Molecular Spectra by Rajkumar., Kedarnath Ramnath
2. Molecular Spectroscopy - C.N. Banwell, McGraw Hill 1985.

3. Laser Spectroscopy by W. Demtroder, 2<sup>nd</sup> Edition, Springer, 1998.
4. Laser Fundamentals by Will-T-Silfvast, Cambridge Uni. Press 1998
5. Contemporary Astronomy by J. Pasacchoff CBS college publishing, 1981
6. Astrophysics : stars and Galaxies by K. D. Abhyankar Universities press (India) Limited 2001.
7. Experimental Nuclear Physics by R.M. Singru.
8. Atomic and Nuclear Physics by S.N. Ghoshal (Physics Vo.-II) 1<sup>st</sup> Edition, 1964, S. Chand Company Ltd., New Delhi.

#### **REFERENCE BOOKS:**

1. Atomic Spectra by H.F. White.
2. Elements of spectroscopy by S. L. Gupta, V. Kumar and R. C. Sharma
3. Laser Physics and Applications by Tarasov.
4. Astrophysics – A Modern Perspective by K.S. Krishnaswamy. New. Ag International Publishers, 1996
5. Astronomy by Robert H. Baker.
6. Concept of Nuclear Physics by Cohen.
7. Nuclear Physics by Blatt and Weisskopf.
8. Physics and Nuclei and Particles by Marimier and Sheldon.
9. Nuclear Reaction Detector by Kapoor and Ramamurthy.
10. The Atomic Nucleus by R.D. Evans.
11. High Energy Physics by Perkins.
12. Nuclear Physics by D.C. Tayal, Himalaya Publication, Delhi, 1982.
13. Nuclear Physics by Roy and Nigam, Wiley-Eastern, 1<sup>st</sup> edition, 1967, first reprint 1979.

## M.Sc. (Previous) Physics Syllabus (Year 2008-09 onwards)

### PAPER-V : COMPUTATIONAL PHYSICS

#### UNIT – I

##### COMPUTER HARDWARE:

Micro processor/ CPU and its basic terms. Different types of CPU :- 8088, 80286, 80386, 80486, Pentium systems, Cache basics, Pentium architecture – branch target buffer, micro processor support chips, ROM – BIOS, start up ROM, functioning of color monitors and display of data and graphics in different modes and colors. Hard disk: mapping, head track, sectors, cylinders, booting, logical structures and organization of disk, file area, FAT, ZBR and SMPS ( different types) in computers.

##### COMPUTER NETWORKING:

Data transmission, bit and band rates, signal encoding, different transmission media, telephone network, multiplexing of data, modems with digital modulation methods, error detection and correction, computer network architecture, OSI system, LAN topologies, media access control and routing, MAC protocol, contention access – CSMA/CD, format frames, internet working – bridge routes and gateways, internet terminologies and definitions.

#### UNIT – II

##### COMPUTER PROGRAMMING AND ALGORITHMS:

**A. Reviews of basic concepts of computer languages:** FORTRAN–90 and 95, C and C ++.

**Advance programming in FORTRAN:-** processing of a string character, procedure with array, arguments, processing of files, function and subroutine, sub-program, data statement, user defined operations, array values, functions, Do while, implicit statement, programming with complex numbers and variables. C ++ with object oriented programming (Introductory).

##### **B. Development of algorithms & Program writing:**

- Lagrange interpolation
- Millikan experiment with direct linear fit
- Derivatives with three point formulas.
- To find the Madlung energy of the alkali halide types of ionic crystals.
- To find the bond length of crystal like NaCl.
- To study Simpson's 1/3 rule and Trapezoidal rule.
- To study orthogonal polynomial generator.
- To study classical scattering.

- Solution of pendulum using Runge-Kutta Method.
- To study Bessel function generator.
- And others.

### UNIT – III

#### NUMERICAL METHODS:

(Along with its algorithm and programming)

General quadrature method, 1<sup>st</sup> and 2<sup>nd</sup> order partial differential equations, finite difference method, stability test, eigen values of matrix, matrix diagonalisation, Monte – Carlo method. Random number generator, multi-dimensional integrals.

Coffee cooling problem, computer program for Coffee cooling problem.

Motion of falling objects, numerical solution and computer programming in one and two dimensional trajectories.

Kepler's problems, equation of motion of planets, equations for circular and elliptical orbits. (Its numerical solution and programming.)

### UNIT – IV

**OSCILLATORY MOTIONS:** simple harmonic oscillators, numerical simulation, simple pendulum, damped oscillatory motion, electric circuit oscillations.

**WAVE PHENOMENA:** coupled oscillators, discrete fourier analysis, wave motion, interference, diffraction and polarization..

Boundary value and eigen value problems: stationary solution of one dimensional Schrodinger equation.

Scattering of particle by central potential (Rutherford formula & Born approximation scattering angles section and impact parameter), Application of numerical quadrature. Legendre polynomials and Bessel functions generators.

#### TEXT BOOKS:

1. IHM Pc and clones by B. Govinrajulu (TMH) 1991
2. Computer network by A.S. Tanenbaum (PHI) 2<sup>nd</sup> edition – 1990.
3. FORTRAN-90 & 95 by V. Rajaraman, 2004 Prentice Hall Pvt. Ltd., New Delhi..
4. Computer programming in C and C<sup>++</sup>
5. Computational physics by S.F. Koonin (Addison – Wesley , NY) 1986
6. An introduction to computer simulation method PART – I (Addison – Wesley , NY) , 1998 by Gould and J. Tebochaik.
7. An introduction to computation physics by Tao Pang.(Cambridge Univ-Press, 1997)

## **M.Sc. (Final) Physics Syllabus (Year 2009-10 Onwards)**

### **PAPER - I ADVANCE QUANTUM MECHANICS & STATISTICAL MECHANICS**

#### **UNIT - I : TIME DEPENDENT PERTURBATION THEORY**

Time dependent perturbation theory, Interaction picture, Transition amplitude, First-order perturbation, Harmonic perturbation, Transition probability, Second -order perturbation, Adiabatic and sudden approximation, Interaction of an atom with electromagnetic radiation (semi classical treatment), Absorption and emission of radiation.

Angular Momentum :- Relation of angular momentum with the rotation. Operator, Matrix Representation of Angular Momentum, Pauli's spin matrices and their algebra, Coupling of two angular momenta and C.G. Coefficients for  $J_1=1/2$ ,  $J_2=1/2$ , and  $J_1=1$ ,  $J_2=1/2$ .

#### **UNIT - II : SCATTERING THEORY**

Asymptotic behaviour, Differential & total cross-section, Wave mechanical picture of scattering (scattering amplitudes), Green's function: Formal expression for scattering amplitudes, Born approximation & its validity, Partial wave Analysis of Scattering: Partial waves, Asymptotic behaviour of partial waves (phase shifts), Scattering amplitudes in terms of phase shift, Differential and total cross-section (optical theorem), Relation between phase shift and potentials of finite range and formal expression for phase shift.

Many Electron Atom : Central field approximation, Hartree method of self Consistent fields, Ground states of He atom, Hartree-Fock methods : Ortho and Para states of He.

#### **UNIT - III : RELATIVISTIC QUANTUM MECHANICS**

##### **Relativistic Quantum Mechanics**

Klein-Gordon equations, charge & current densities, physical interpretations and short comings of K-G equation, Dirac equation and its derivation, Dirac matrices and their properties, constant of motion for Dirac equation (spin of Dirac particle), electron in electromagnetic field, Spin-orbital interaction energy, free particle solution of Dirac equation, negative energy states and the concept of hole, Dirac equation for spherically symmetric potential, deduction of K-operator and commutation relations for H, K and J; Eigenvalues of K, reduction of Dirac equation to a radial equation, solution of radial equation for hydrogen-like atom, fine structure corrections to energy.

##### **Quantization of Fields**

Classical radiation fields, Fourier decomposition and radiation oscillators, creation, annihilation and number operators, quantization of radiation oscillators, quantized radiation fields, photon states, quantization of non relativistic Schrödinger wave equations for Bosons as well as for Fermions, Matrix representation of creation, annihilation and number operators and their states for Fermions.

## UNIT - IV : QUANTUM STATISTICS

Review of Micro-canonical and grand -canonical ensembles, Grand canonical partition function, Derivation of BE Statistics, Weak and strong degeneracy, Application of BE statistics to BE condensation and phase transition, Thermodynamical properties of an ideal BE gas. Liquid He and its properties. Two fluid model of liquid He -II and Liquid. He-III, System of interacting bosons, superfluidity through quantization. Application of FD statistics to Pauli-paramagnetism and white dwarf, Ising model in 1-D.

### REFERENCE BOOKS :

1. Quantum Mechanics : L. I. Schiff, McGraw-Hill International New York 1968.
2. Advanced Quantum Mechanics : J.J. Sakurai, Addison-Wesley, (Reading Mass. Institute of Tech.) 1967.
3. Quantum Mechanics- by E. Merzbacher John Wiley & Sons, New York 1868.
4. Quantum Mechanics - by B. K. Agrawal & Hari Prakash (PHI EEE, 2004)
5. A Text book of Quantum Mechanics: P. M. Mathews & K. Venkatesh. Tata McGraw-Hill Publ. Company Ltd. New Delhi (10<sup>th</sup> reprint) 1986
6. Quantum Mechanics Vol.-II: A. Messiah, John Wiley & Sons, New York 1868.
7. Quantum Mechanics Vol.-II by Ghatak & Loknathan
8. Statistical Mechanics - by K. Huang 2<sup>nd</sup> Editions(John Wiley & Sons, 1987).
9. Statistical Mechanics - by F.Reif (International student ed. McGraw Hill 1988).
10. Statistical Mechanics - by Landau & Lifshitz (Reeds Educational Professional Publication Ltd. 1980, Oxford India New Delhi 1982).

## M.Sc. (Final) Physics Syllabus (Year 2009-10 onwards)

### PAPER – II : CLASSICAL ELECTRODYNAMICS & PLASMA PHYSICS

#### UNIT - I :

Different system of units in electromagnetic theory, Maxwell's equation in Gaussian and MKS system of units, Conservation laws, Energy density, Poynting vector, Maxwell stress tensor, Solution of Maxwell's equations in infinite dielectric and conducting medium, plane wave and spherical wave solution, polarisations and their properties (Stoke parameters).

Superposition of waves, kinematics of dispersion and classical theory of dispersion, Normal and anomalous dispersion, Dispersion in conducting medium, plasma frequency and reflection in ionosphere.

Dynamical boundary conditions at the interface, Reflection and refraction at the interface, Fresnel's amplitude relations for parallel and perpendicular polarizations, Reflection and Transmission coefficients for interfaces between dielectric-dielectric and dielectric-metal, polarization by reflection, total internal reflection, skin depth and metallic plasma.

#### UNIT - II :

Reflection and transmission through dielectric slab, multiple reflections and Transmissions, Wave Guide and Resonant cavities, propagation of TM, TE and TEM modes in rectangular and cylindrical wave guides and cavities, Energy flow and power losses in wave guides and cavities. Perturbation of boundary conditions.

Solution of Maxwell's equations with nonzero  $\rho$  and  $j$ , scalar and vector potentials, Gauge transformations, Lorentz and Coulomb gauges, solution of inhomogeneous wave equation, retarded and advance Green function, retarded potentials.

Non-relativistic multipole radiations: Electric dipole and quadruple radiations, Magnetic dipole radiation's, simple antenna problems, radiation resistance.

#### UNIT - III :

Radiations by moving charges: Lienard Weinchert potentials and field for a point charge, total power radiated by an accelerated charge (Larmor's Formula and its relativistic generalization). Angular distribution and frequency spectrum of the radiation power.

Thomson scattering and Rayleigh Scattering, causality and dispersion relation (Kramers-Kronig relation), Cherenkov radiations (power distribution), Brehm-strahlung (Relativistic and non-relativistic treatment), Weizscker-williams method of virtual quanta.

Covariant formulation of electromagnetic theory: Mathematical properties of space time of special relativity, Matrix representation of Lorentz transformation, Invariance of electric charge, covariance of electrodynamics, Transformation of electromagnetic field (Lorentz force)

#### **UNIT - IV :**

Magnetohydrodynamics(MHD) and Plasma Physics: Introduction and definitions, MHD equations, Magnetic diffusion, viscosity and pressure, Magnetohydrodynamic flow between boundaries with crossed electric and magnetic fields, Magnetohydrodynamical waves, pinch effects. Instability in a pinched plasma column, High frequency plasma oscillations, short wave length limit of plasma oscillations and Debye-screening distance, Particle drift in non-uniform static magnetic fields, Magnetic mirrors, adiabatic invariance of flux through orbit of a particle, Two stream instability, Kinetic treatment of plasma oscillations and Landau damping physical explanation, Potentials and problems of controlled thermonuclear fusion, Ignition temperature and Lawson criteria, Magnetic confinement, Simple discussion of Tokamak and Z-pinch, Ideas about inertial confinement and Laser fusion, Methods of plasma heating and problems of fusion.

#### **REFERENCE BOOKS :**

1. Classical Electrodynamics : Jackson J.D. 2<sup>nd</sup> Edition John Wiley & Sons New York, 1963.
2. Classical Electricity and Magnetism : Panofsky W. K. H. and M. Phillips, 2<sup>nd</sup> Edition, Reading Mass. : Addison-Wesley (AW) 1962.
3. Feynman Lectures, Vol.-II. AW, MIT reading 1965, Narosa Pub. 1995
4. Introduction to Electrodynamics: D. J. Griffiths. 3<sup>rd</sup> Ed. PHI, New Delhi 2001
5. Classical Electrodynamics: S. P. Puri, Tata McGraw-Hill Publ. Company Ltd. New Delhi 1990
6. Introduction to Plasma Physics and Controlled fusion :F. F. Chen. 2<sup>nd</sup> Edition Plenum Press, New York London 1984.

## **M.Sc. (Final) Physics Syllabus (Year 2009-10 Onwards)**

### **PAPER-III EXPERIMENTAL TECHNIQUES : MICRO/ NANO STRUCTURES**

#### **UNIT - I :**

##### **VACUUM PUMPS AND GAUGES**

Vacuum Physics

Vacuum Pumps : Rotary pump, Diffusion pump, Sputter – Ion pump, Sorption pump, Turbomolecular pump.

Gauges: Bourdon Gauge, McLeod gauge, Pirani gauge, Thermocouple gauge, Hot and cold cathode ionization gauge.

Vacuum Materials.

##### **SYNTHESIS TECHNIQUES**

Chemical wet Processing, Solgel method, Ball-milling method,

Thermal Evaporation, Chemical vapour deposition (CVD); Sputtering - RF, Pulsed Laser Beam; Molecular Beam Epitaxial Growth (MBE)

#### **UNIT - II: DIFFRACTION AND MICROSCOPIC TECHNIQUES**

X-ray diffraction Methods - Powder diffraction, Particle size Analysis Electron diffraction Methods, Low energy electron diffraction (LEED), Reflection High energy electron diffraction (RHEED), Neutron diffraction method - Hydrogen and carbon atom detection, Magnetic structure determination.

Electron microscopy- Scanning Electron Microscopy (SEM) and Transmission Electron Microscopy (TEM); Field Emission and Field Ion Microscopies (FEM & FIM), Application as Atom Probe, Atomic Force Microscopy (AFM), Scanning Tunneling Microscopy (STM).

#### **UNIT -III: QUALITATIVE AND QUANTITATIVE TECHNIQUES**

Spectroscopy - X-ray Photoelectron spectroscopy (XPS); Ultra violet photo electron spectroscopy (UPS); X-ray emission (XES) and Absorption spectroscopy (XAS-XANES & EXAFS), Mossbauer Spectroscopy

Rutherford Back Scattering (RBS), Positron Annihilation, Auger electron spectroscopy (AES) ; X-ray Fluorescence Spectroscopy (XRF).

#### **UNIT - IV: SOLID STATE TECHNIQUES**

A.C. & D.C. Conductivity Measurements; Hall-effect measurements; Thermopower measurement; A.C. & D.C. Magnetic Susceptibility measurements; dielectric constant and dielectric loss tangent measurement;

Luminescence - Thermoluminescence and Photoluminescence Techniques; Differential Thermal Analysis (DTA), Differential Scanning Calorimetry (DSC), Thermogravimetry Analysis (TGA).

## REFERENCE BOOKS :-

1. Modern Vacuum Practice - by Nigal Harris, Tata McGraw Hill Publ., New York.
2. Thin Film Technology and Applications - by K. L. Chopra & L. K. Malhotra, Tata McGraw Hill Publ., New Delhi.
3. Thin film Techniques by Joy George, Marshall Dekkar Inc. 1992
4. A.V.S. Monograph on Vacuum technology by Harland G. Tompkins, A. V. Society Publ. 2<sup>nd</sup> ed. (1991).
5. Ultra high vacuum techniques Edited by D.K. Awasthi, A.Tripathi, A. C. Gupta Allied publishers Pvt. Ltd. (2002)
6. Modern Techniques of Surface Science - by D.P. Woodruff & T.A. Delchar, Cambridge University Press, Cambridge.
7. Solid State Physics - by R.L. Singhal, 7<sup>th</sup> Ed. Kedarnath Ramnath & Co.
8. Method of surface Analysis Ed. By J.M. Walls and V.G. Ionex UK, CAMBRIDGE UNIVERSITY PRESS (1989)
9. Modern Methods of Trace Element Analysis by MAURICE PINTA, ANN ARBOR SCIENCE Publ. Inc. Michiyon USA (1978).
10. Solid State Physics - by A. J. Deeker, McMilan India.

## M.Sc. (Final) Physics Syllabus (2009-10 Onwards)

### PAPER – IV: SPECIALISATION: NUCLEAR PHYSICS – I

#### UNIT – I: Detectors, Spectrometers and Nuclear Electronics

Overview of gas filled and scintillation detectors.

Semiconductor detectors- the semiconductor junction, the depletion depth, reverse biased junctions, silicon diode detectors, Si(Li), Ge(Li) detectors, Intrinsic germanium detectors.

Nuclear Electronics-Pulse signal terminology, pre-amplifiers, amplifiers, pulse stretchers, single channel analyzer, analog-to-digital converters and multi-channel analyzer.

Gamma-ray spectrometer, pulse height selection, analysis of gamma-ray-spectra, basic coincidence technique, Alpha and beta spectrometers, charge particle identification. Solid state nuclear track detectors.

#### UNIT – II: Nuclear Spin, Moments and Mossbauer Effect

Nuclear angular momentum, nuclear magnetic momentum, gyromagnetic ratio, Larmor precession, relationship between  $I$  and  $\mu$ , nuclear statistics, measurement of magnetic moment by molecular beam resonance method, electric quadrupole momentum, extra nuclear effects of nuclear angular momentum and magnetic moment

Nuclear resonance fluorescence and absorption of gamma rays (Mossbauer Effect).

#### UNIT – III: Accelerators and Angular Correlation

Acceleration of charged particles, Tandem accelerators, Cyclotron, Betatron, Synchrocyclotron and their applications.

Angular correlation of gamma rays, Gamma-gamma angular correlations. Perturbed angular correlation, Production and measurements of high spin states in heavy ion reactions, Kinematics, Back bending phenomena in high spin states.

#### UNIT – IV: Neutron and Reactors Physics

Production and detection of neutrons, slowing down of neutrons, time of flight, energy released in fission, mean energy loss, logarithmic decrement in energy, slowing down process and moderating ratio, stability limit against spontaneous fission, chain reaction, diffusion of fast neutrons and Fermi age equation.

Reactor Theory- Condition for criticality of nuclear reactors, critical equation. Classification of reactors, nuclear power.

#### Books:

1. Techniques for Nuclear and Particle Physics Experiments by W. R. Leo.
2. Nuclear Radiation Detectors by S. S. Kapoor and V. S. Ramamurthy.
3. Experimental Nuclear Physics by R. M. Singru.
4. Radiation Detection and Measurement by G. F. Knoll
5. Atomic and Nuclear Physics Vol-II, S. N. Ghosal.
6. The Atomic Nucleus by R. D. Evans.
7. Introduction to Nuclear Physics by H. Enge.
8. Theory of Nuclear Structures by M. K. Pal
9. Basic Nuclear Physics and Cosmic Rays by B. N. Srivastava.
10. Neutron Physics by Curtis

## M.Sc. (Final) Physics Syllabus (Year 2009-10 Onwards)

### PAPER-V : SPECIALISATION : NUCLEAR PHYSICS-II

#### UNIT-I: Two body problem and Nuclear Models:

Phenomenological nucleon-nucleon potential, Meson theory, Derivation of Yukawa interaction, Electromagnetic properties of deuteron and tensor forces.

Scattering matrix, Probing charge distribution with electrons, Form factors of nuclei & nucleons.

Semi empirical mass formula and its applications, mass parabolas, The single-particle shell model, Spin-orbit interaction and magic numbers, Ground state spin and parity, Magnetic and electric moments, Deformed nuclei and nuclear electric quadrupole moments. The Nilsson model, The collective model, Vibrational levels, Rotational levels of even-even nuclei.

#### UNIT-II:Nuclear Decays:

Parity violation, General form of the weak interaction Hamiltonian, Electron capture, Two-component neutrino theory, Inverse  $\beta$ -decay and neutrino detection, Solar neutrinos, Current-current interaction and V-A theory, Universal Fermi interaction, Conserved vector current hypothesis, Intermediate boson

Gamma decay, Spontaneous decay. Transition rates, Single particle estimates, Isospin selection rules, Alpha decay.

#### UNIT-III: Nuclear Reactions

Rutherford scattering, optical model for elastic scattering, Compound nucleus reaction cross section, Coulomb excitations, Statistical model, Ghoshal experiment, Stripping and pick-up reactions using Born approximation, Thermonuclear fusion, Pre-equilibrium reaction, incomplete and complete fusion reactions, Qualitative ideas on deep inelastic electron-proton scattering, Bjorkon scaling and the parton model.

#### UNIT-IV: Particle Physics

Symmetry transformations and conservation laws: Isospin and SU(2) group-Some consequences of isospin conservation, SU(3): Generators, representation and products of representation, Light mesons and baryons in quark model, symmetry breaking – Gell-Mann-Okubo mass formula, Charm, Bottom and top quarks, Neutral kaon and CP violation.

Abelian and non-abelian gauge invariance, Spontaneous symmetry breaking and Higgs mechanism, Standard model for electroweak unification (in brief), Colour gauge invariance and QCD Lagrangian.

#### REFERENCE BOOKS :-

1. Fundamental of Nuclear Physics – N. A. Jolley (Cambridge Uni. Press,1990)
2. Nuclear Physics – Roy & Nigam (Wiley Eastern Ltd. 1979)
3. Atomic and Nuclear Physics – S. N. Ghoshal ( S. Chand & Company Ltd. 1994)
4. Nuclear and Particle Physics – Burchan & Jobes (Addison Wesley, 1990)

5. *Introductory Nuclear Physics* – S. S. M. Wong (*Printce Hall 1990*)
6. *Introduction to High Energy Physics* – D. H. Perkins (*Camb. Uni. Press.4rh Ed. 2000*)
7. *Quaks and Leptons* – Halzen & Martin (*John Wiley & Sons, 1984*)
8. *Concept of Particle physics, Vol. I* by Gottfried and Wiesskopf (*Oxford Uni. press*)

## M.Sc.(Final) Physics Syllabus (Year 2009-10 Onwards)

### PAPER-IV : SPECIALISATION : ELECTRONICS & RADIO PHYSICS

#### UNIT- I :

**Applications of Op-Amp:** Op-amps as differential, Instrumentation amplifier, comparator., Voltage to current converter, constant current source, Temperature to voltage converters, Signal Generator: Monoshot, free running, triangle and sawtooth wave generators.

- Books
1. Op-amp and Linear Integrated circuits: Ramakant Gayakwad, PHI
  2. Operational Amplifier and Linear IC, RF Coughlin and F. F. Driscoll, PHI

**Filters:** Design of Filter Circuits: Butter worth Filter, Low pass, high pass, band and notch filters, Approximation theory, Network transformations Active RC filter design: use of finite and infinite gain amplifiers. Two integrator loop and high order filter design. High frequency filter design

- Books
1. S.K.Mitra, Active Inductorless Filters, IEEE Press 1971
  2. Operational Amplifier and Linear IC, RF Coughlin and F. F. Driscoll, PHI

**Digital to analog Converter:** Basic Summing Amplifier technique, Weighted D to A , BCD D/A Converter, Ladder R-2R network, 8 bit digital to analog converter,

**D to A Converter:** Flash ADC and successive approximation ADCs, Integrating ADC/Dual Slope A/D Converter

- Books :
1. Digital Technology By Virendra Kumar , New Age International
  2. Fundamental of Electronics Devices by Milman and Halkias.

**Integrated Circuit 555 Timers:** Operating modes and functioning of 555 timer, Astable, monostable operation, counters, Frequency divider, Timers circuits and applications,

**Linear IC regulators:** 3-pin voltage regulators with unregulated power supply, Adjustable three terminal positive and negative voltage regulators with Circuit analysis.

- Books:
1. Fundamental of Electronics Devices by Milman and Halkias.
  2. Digital Technology by Tokheim - TMH
  3. Electronic Devices –Floyd , Pearson Education

**(25 Periods)**

#### Reference Books:

1. Op-amp and Linear Integrated circuits: Ramakant Gayakwad, PHI
2. Operational Amplifier and Linear IC, RF Coughlin and F. F. Driscoll, PHI
3. Digital Technology By Virendra Kumar , New Age International
4. Fundamental of Electronics Devices by Milman and Halkias.
5. Digital Technology by Tokheim - TMH
6. Electronic Devices –Floyd , Pearson Education

#### UNIT- II :

**Microprocessor Architecture and Programming:** Encoders, Decoders, Buffers, 8085 Intel microprocessor architecture, DRAM and SRAM Memory, Memory organization, types of memory, Memory mapping, 8085 control lines, ALU, Flags, registers, data and address bus. I/O mapped I/O and memory mapped I/O, status signals, 8085 Assembly language and its instruction set, basic instructions; addressing modes, data transfer,

arithmetic operations, logic operations, branch operations, 16 bit arithmetic operations, memory operation, rotate, compare operations and assembly language programs. Memory interfacing, I/O Interfacing, counters and delays Op-code Fetch operation, execution of instruction, instruction cycle, machine cycle, memory read, memory write, I/O read, I/O write, Timing diagram, stack and subroutine, 8085 interrupts, Interrupts and Interrupt service procedures, and assembly language programs based on these.

**(25 Periods)**

- 1) Microprocessor and Programming, B. Ram, Dhanpatrai Pub.
- 2) Microprocessor Architecture, Programming and Application, R. S. Gaonkar, Penram International.
- 3) Digital Principles and Application, A. P. Malvino and D. Leach, TMH

### **UNIT – III :**

**VLSI Technology :** An overview of VLSI, CMOS Technology, Silicon Logic, Logic design with MOSFET. Physical structure of CMOS Integrated circuits, Fabrication of CMOS Integrated Circuits, Elements of Physical Design Electrical characteristics of MOSFETS, Electronic analysis of CMOS Logic gates, Designing high speed CMOS Logic Networks Design of VLSI Systems, Memories and Programmable Logic, VLSI Clocking and System Design,

Books: Introduction to VLSI circuits and Systems: J.P. Ugemura, Wiley 2001

**Transducers:** Types of transducer and their responses and errors, pressure, strain gauge, photosensitive and piezoelectric transducer, Capacitive Transducer, Inductive Transducer, Scintillation detector, Hall Probe Transducer, LVDT, Load cell, pressure cell.

**(25 Periods)**

### **Books**

- 1) Microprocessor and Programming, B. Ram, Dhanpatrai Pub.
- 2) Microprocessor Architecture, Programming and Application, R. S. Gaonkar, Penram International Co. , New age International
- 3) Microcomputers and Microprocessors : - Uffenbeck - PHI 8080, 8085 and Z-80 Programming.

### **UNIT – IV :**

**Interfacing :** Interfacing Peripherals and Applications : Parallel I/O and Interfacing applications, General purpose Programmable Peripheral Devices: 8255A, 8253, 8259A, DMA and DMA Controller

**Microcontroller 8051 :** 8051 Microcontroller Design, Architecture, and basic Assembly Language Programming concepts, 8051 Operation Codes and Mnemonics

**Microprocessor Controlled Devices:** Interfacing transducer to electronic controller and measuring systems. Microprocessor compatibility of ADC and DAC circuits, Interfacing of LEDs, Strain Gauge Transducer with 8085  $\mu$ P, Interface of Traffic Light signal, Interfacing of Stepper Motor, Interfacing of ADC 0800 series and analog multiplexer ADC, Interfacing of Digital to Analog devices - 0800 series.

### **Books**

1. Microprocessor Architecture, Programming and Applications with 8085/8080A: Gaonkar, Wiley Eastern
2. Microprocessor Interfacing : Douglas Hall, McGraw Hill

3. The 8051 Microcontroller- Architecture, Programming and Applications. by- Kenneth J. Ayala – Penram International Publishing
4. Microprocessor and Programming, B. Ram, Dhanpatrai Pub.

### **M. Sc. (Final) Physics Syllabus (Year 2009-10 Onwards)**

#### **PAPER-V : SPECIALISATION : ELECTRONICS & RADIO PHYSICS**

##### **UNIT – I :**

**Introduction to communication Systems:** Effect of filtering on complex signals. Information, transmitter, channel, Noise, receiver. Description and need for Modulation, Bandwidth requirements **Noise:** Internal Noise, Noise calculations, Signal to noise (S/N) ratio, noise factor and its measurement, noise temperature.

**Modulation and Demodulation:** Amplitude modulation, modulation index, single sideband principles, Sideband power distribution of an AM wave, AM modulators, square law modulation, SSB generation and reception.

**Frequency Modulation:** Angle modulation, directly and indirectly modulated FM transmitters, angle modulation detectors, Foster Seeley discriminator, Phase locked loop discriminator. Pulse Modulation: Pulse amplitude modulation, pulse sampling theory, pulse width modulation, pulse position modulation, digital multiplexing.

**Radio:** Radio receivers, Regenerative superheterodyne for AM and FM Receivers & Receiver Characteristics.

##### **Books :**

1. Communication systems, R. P. Singh and S. D. Sapre, TMH
2. Electronics communication systems, George Kennedy & Davis, Mc.Graw., Hill.
3. Electronic Communications, Roddey & Coolen, PHI
4. Active Inductor less Filters, by S. K. Mitra, IEEE Press 1971

**(25 Periods)**

##### **UNIT – II :**

**Digital Communication:** Principle of digital communication system, layers of digital communication system, Bit transmission and signaling rate, error probability, digital filtering, pulse code modulation, bandwidth and noise in PCM, Quantization and Quantization noise, PCM encoding and system, codes for transmission.

- Books
1. Communication systems, R. P. Singh and S. D. Sapre, TMH
  2. Active Inductor less Filters, by S. K. Mitra, IEEE Press 1971
  3. Modern electronic Communication by Ajay Sharma and R K Sinha, Dhanpat Rai Pub

**Fiber Optic Communication:** Principle of light transmission in a fiber, effect of index profile on propagation, modes of propagation, number of modes in a fiber, losses in fibers, dispersion in fiber, source and detectors for fiber optic, connectors and splices,

fiber optic communication systems. **Optical sources**-LEDs and Lasers, **Photo detectors**-Pin detectors, detector responsivity, noise, optical receivers

**Books:**

1. J. Keiser, Fibre Optic communication, by J. Keiser, McGraw Hill, 2<sup>nd</sup> Edition 1992
2. Optical Fibers for Transmission, by J. E. Midwinter, John Wiley 1979
3. Understanding Optical Communications, by H. Dutton, Printice Hall

**Satellite Transmission:** Satellite uplink and Down Link, Satellite orbits, Station Keeping, Satellite Altitude, Transmission Path and its losses, Noise, Frequency and Propagation considerations, Communication link design Modulation, coding, Base band design, Multiple Access techniques, Communication satellites, Earth stations.

**Book:** Satellite Communication systems by M. Richharia, McGraw Hill, 1998

**Line of Sight (LOS) propagation:** LOS propagation on flat earth, path clearance, Effect of ground, effect of nature of earth's surface, effect of atmosphere, ground based LOS, LOS microwave systems.

**Books :**

1. Communication systems, R. P. Singh and S. D. Sapre, TMH
2. Principle of Communication Engineering By Anoke Singh , ( S. Chand & Co. 1994)

**(25 Periods)**

**UNIT-III :**

**Transmission Lines:** Wavelength and velocity of propagation, waveform distortion, distortion less lines, reflection of lines, characteristics impedance, open and short transmission lines, reflection factor and loss, standing wave and its ratio, Input impedance of distortionless lines, Power and impedance measurements.

**Wave Guides:** Plane parallel wave guide, modes of transmission, characteristics of modes of transmission, propagation constant, phase and group velocity, skin effect, TM modes, specific wave impedance, cut off and characteristics power transmitted, Rectangular wave Guide,

**Radio wave Propagation:** Character of Ionosphere, effect of frequency on transmission, effect of ground on transmission, skip distance, Ionospheric refraction, maximum usable frequency, Virtual height and its determination.

**Books :** 1. Network lines and fields, J. D. Ryder, Asia Pub. House.  
2. Hand Book of Electronics – Gupta and Kumar, P. Prakashan, Meerut

**Antenna:** Isotropic radiator, Antenna Action, Power gain, effective length of antenna, The Hertzian dipole, radiation resistance of an antenna, impedance matching, half wave dipole and quarterwave antenna, Brief description of- vertical antenna loop , ferrite rode, yagi-uda array, **Microwave antenna:** parabolic reflector and dielectric lens antenna.

1. Antenna Engineering Handbook, by R.C.Johnson and H.Jasik, McGraw Hill, 1984
2. Antennas and Radiowave propagation, by McGraw Hill, 1985
3. Hand Book of Electronics – Gupta and Kumar, P Prakashan, India

(25 Periods)

**UNIT – IV :**

**Data Communication and Computer Network:**

**Data Communication system:** character codes, Digital data rates, Asynchronous and Synchronous data, binary data signal, serial Vs parallel communication, Parity check:- Pulse modulation: sampling theory, quantizing of analog signals, quantization error, Time division multiplexing, Frequency Division Multiplexing

**Digital modulation Techniques:** various types of phase shift keying: ASK FSK and PSK, BPSK,DPSK, Network hardware and Software-LAN, protocol hierarchies, design issues for the layers, TCP/IP model

Different Layers and its functions : OSI reference model, Physical Layer, Data Link Layer: Services provided to Network layer, Elementary ideas of framing, Ethernet, protocols, Token Bus, Token ring, Packet Switching, Integrating Services Digital Network (ISDN) system, its functioning and applications, Repeaters, Bridges and Gateways

**Reference Books**

1. Modern digital and analog communication systems, by B.P. Lathi,  
Digital Communications, by Proakis J.J. , Mcgraw Hill  
Computer Networks, by S. Tannenbaum, PHI  
Data Communication by P. Gupta, Tata McGraw Hill

## **M.Sc. (Final) Physics Syllabus (Year 2009-10 Onwards)**

### **PAPER - IV : SPECIALISATION : SOLID STATE PHYSICS - I**

#### **UNIT – I :**

##### **CRYSTALLOGRAPHY AND X-RAY DIFFRACTION :**

Symmetry operations, Plane symmetry groups, point groups, space groups and their nomenclature. Crystal systems and Bravais lattices, Indices of planes and directions, Crystallographic Projections - Spherical, Gnomonic and Stereographic Projections, their properties and applications, Point group representation using Stereographic Projection, Space group representation on plane diagrams, Three Trace analysis.

##### **X-RAY DIFFRACTION**

Reciprocal lattice and its vector algebraic properties, its applications in geometric Crystallography, the Bragg's Law of X-ray diffraction in terms of reciprocal lattice, Brillouin Zones, Scattering by electron, Scattering by an atom, Scattering by unit cell, Geometric structure factor and atomic form factor. Laue, Single crystal rotation and powder methods and their basic interpretation.

**(25 Periods)**

##### **UNIT -II : POINT DEFECTS AND IONIC CONDUCTIVITY AND DISLOCATIONS**

Types of point defects and configurational entropy, antisite defects, Concentration of vacancies and interstitials as a function of temperature, Diffusion and diffusion constant, Interstitial diffusion in metals, self diffusion, Lattice defects in ionic crystals, Their equilibrium concentration, Activation energy for formation of vacancy, Self diffusion and diffusion constant in alkali halides, Ionic conductivity of pure and divalent doped alkali halides

##### **Dislocations**

Elastic strength of crystals, Slip and plastic deformation, Types of dislocations, Burger's vector, Stress field and strain energy of dislocations, Interpretation of slip deformation, Forces on dislocation, Low angle grain boundaries, Dislocation multiplication and Frank Read Mechanism, Techniques for observation of dislocations, The phenomenon of Creep and Creep activation energy, Dislocations and crystal growth.

#### **UNIT –III ELASTIC CONSTANTS AND ELASTIC WAVES, THERMAL PROPERTIES AND PHONONS**

**ELASTIC CONSTANTS AND ELASTIC WAVES :** Geometric theory of strain, Displacement and strain components, Longitudinal and shearing strains, Finite strain, Dilational strain, Stress components, Elastic compliance constants and stiffness constants, Elastic energy density, Reduction of number of elastic constants, Elastic constants of cubic crystals, Cauchy's relation, Elastic waves along principal directions in cubic crystals, Measurement of elastic constants.

### **THERMAL PROPERTIES AND PHONONS :**

Concept of specific heat of solids, Dulong & Petit's law, drawback of dulong & Petit's law, Einstein's model of lattice specific heat, Low & high temperature cases, Draw back of Einstein's model, Debye's model of lattice specific Heat, Debye's temperature, low & high temperature cases, Draw back of Debye's model. Concepts of Phonons, Phonon momentum, In elastic scattering of Photons by Phonons, In elastic scattering of X-rays by Phonons, In elastic scattering of Neutrons by Phonon, Thermal expansion, Gruneisen's constant, Anharmonicity, lattice thermal conductivity.

### **UNIT: IV**

**ELECTRONIC CONDUCTIVITY:** Drude theory of conduction, Temperature dependence of Electrical Resistivity, Relaxation time approximation (RTA), Non-equilibrium distribution function, DC and AC conductivity by RTA, Collision and relaxation times, Boltzman equation, Impurity scattering, Wiedemann - Franz Law, Mathiessen's rule.

**BAND THEORY :** Electron motion in periodic potential, Bloch theorem with proof, Cyclic boundary condition, Density of states, Weak potential case, Energy levels at cell boundaries, Geometric construction of Fermi surfaces, Tight binding approximation, Concepts of APW, OPW, and LCAO methods, Pseudo-potential theory, De Haas Van Alphen effect,

**(25 Periods)**

### **REFERENCE BOOKS :**

1. Essentials of Crystallography - Y. Flint, (Mir Publication)
2. Introduction to Crystallography - F. C. Phillips 4<sup>th</sup> Ed. Pubs: ELBS.
3. An Introduction to Solid State Physics and Its Applications - R.J. Elliot and A.F. Gibson.
4. Solid State Physics - N.W. Ascroft and N. D. Mermin, Thomson Learning Mumbai (Poly), 2003.
5. Introduction to Solid State Physics - C. Kittel, 7<sup>th</sup> Ed. Wiley Eastern Ltd.
6. Theoretical Solid State Physics Vol.II -Jones and March, John Wiley & Sons New York 1973.
7. Solid State Physics - A.J. Dekker, McMillan, India
8. Solid State Physics - Saxena, Gupta and Saxena, 12<sup>th</sup> Ed. Pragati prakashan.
9. Solid State Physics - R.L. Singhal, 7<sup>th</sup> Ed. Kedarnath Ramnath & Co.

## **M.Sc.(Final) Physics Syllabus (Year 2000 Onwards)**

### **PAPER-V : SPECIALISATION : SOLID STATE PHYSICS-II**

#### **UNIT-I : ALLOYS AND PHASE DIAGRAMS**

Interstitial and substitutional solid solutions, Mutual solubility as a function of temperature, Hume-Rothery rule, Super lattices, Long-range order theory, Short range order theory, Order-disorder phenomena, Equilibrium phase diagram of binary system, Phase rule, Construction of phase diagrams of homogeneous and non homogeneous binary solid solutions, Preparation of homogeneous alloy.

#### **CRYSTAL GROWTH AND TECHNIQUES**

Nucleation kinetics, Homogeneous and Heterogeneous Nucleation, Interface controlled growth, Atomic theory of growth of perfect crystals, Surface nucleation and layer growth mechanisms, Real crystals and role of screw dislocations.

Solution, Melt and vapour growth methods, Zone melting method, Bridgman method, Czochralsky method.

#### **UNIT - II : : PHYSICS OF SEMICONDUCTORS**

Intrinsic conductivity, Fermi level, Band gap, Direct and indirect band gaps, Temp. Dependence of intrinsic carrier concentration, Mobility in Intrinsic region, Extrinsic semiconductor and impurity states, Extrinsic carrier concentration, Magneto resistance, Cyclotron resonance and effective mass, Optical absorption and band gap; Fundamental, Exciton and free carrier absorption, Mobility and scattering mechanisms, Fermi surface and effective mass, intermetallic compound semiconductors.

P-N Junction, Homo and Heterojunctions, Schottky barrier cell, Photovoltaic effect, Solar radiation and solar cell, MIS solar cell, Thin film solar cell, Amorphous Si solar cell. Ohmic and non ohmic contacts, conductivity measurement techniques; Van der pauw & linear four probe techniques.

#### **UNIT III : MANY ELECTRON PROBLEM IN SOLIDS**

Hartree equations, Hartree-Fock equation, Hartree-Fock theory of free electrons, Screening effects, Thomas Fermi theory of screening, Quasiparticles and Fermi-liquid theory (elementary).

**SUPERCONDUCTIVITY:** Electron-phonon interaction, Electron-electron interaction via exchange of bosons, binding energy of a cooper pair, ground state of superconducting electron gas, gap-equation, transition temperature and isotope effect, Josephson tunneling, elements of high  $T_c$ - Superconductivity.

#### **UNIT - IV : LUMINESCENCE**

Types of Luminescence, Fluorescence and Phosphorescence, Phosphors, Activators, Killers, Excitation and emission, Franck-Condon principle, Radiationless transition, Temperature dependence of luminescence, Decay mechanism, Thermoluminescence and glow curves, Thallium activated alkali halides: Absorption and emission spectra,

Sulphide phosphors: Charge compensation and Co-activators, The mechanism of electroluminescence : Deistruie and Gudden-Pohl effects, Mechanism.

### **THIN FILMS AND PROPERTIES**

Stages of growth, Thickness measurement by interference techniques: Tolansky technique, Thickness monitoring by crystal Oscillator, Film adhesion to the substrate and its measurement, Thin film resistors, thin film capacitors. Commonly Measured quantities for thin films: sheet resistant, TCR, Influence of Thickness on the resistivity of a structurally perfect film. Hall effect & Magneto resistance in thin films, Negative TCR in films.

### **REFERENCE BOOKS :**

1. Solid state physics - N.W.Aschroft and N.D.Mermin, Thomson Learning, 2003 (Poly) Mumbai.
2. Solid State Physics-Saxena,Gupta and Saxena. 12<sup>th</sup> Ed. Pragati Prakashan.
3. Intermediate Quantum Theory of Solids - Alexander O.E.Animalu
4. Theoretical Solid State Physics Vol.II -Jones and March, John Wiley & Sons New York 1973.
5. Solid State Physics - C. Kittel, 7<sup>th</sup> Ed. Wiley Eastern Ltd.
6. Solid state physics -A.J.Dekker, McMillan India.
7. Physical Metallurgy Principles By Robert E. Reed-Hill 2<sup>nd</sup> Ed. East-West Press. Ltd.
8. Art and Science of Growing crystals - J.J. Gilman, John Wiley & Sons, NY (1963).
9. Engineering Physical metallurgy - Y. Lakhtin. Mir Publication, Moscow (1970).
10. Handbook of Thin Film Technology. - Meissel and Glang (Eds). McGraw Hill New York 1970.
11. Thin Film Phenomena - K.L Chopra, Tata McGraw Hill, New Delhi (1969).
12. Solid State Physics -R.L. Singhal, 7<sup>th</sup> Ed. Kedarnath Ramnath & Co.

## M. Sc. (Final) Physics Syllabus (Year 2009-10 onwards)

### SPECIALISATION : SPECTROSCOPY

#### Paper- IV: ATOMIC & LASER SPECTROSCOPY

##### UNIT- I :

Spectroscopic terms and their notations, Stern - Gerlach experiment, Spin-orbit interaction, relativistic mass correction, hydrogen fine structure, Pauli's exclusion principle, determination of spectral terms for L-S and j-j coupling (atoms with one optical electron, atoms with two or more non-equivalent optical electrons and atoms with two or more equivalent electrons), order of terms and fine structure levels, selection rules for multi electron atoms in L-S and j - j coupling , Energy in one and two valence electron systems, Doublet splitting and intensity ratio, Normal and inverted terms. [28 Hours]

##### UNIT-II:

Explanation of normal and anomalous Zeeman effect, examples of Zeeman splitting in some transitions ( $^1F \rightarrow ^1D$ ,  $^2D \rightarrow ^2P$  and  $^3P \rightarrow ^3S$ ), Paschen-back effect, spin -orbit correction, transition between weak and strong fields , Stark effect in hydrogen (weak and strong field), Transition probabilities.

Nuclear spectroscopy : Hyper fine interactions, Intensity ratio and determination of nuclear spin, Zeeman effect in hyperfine structure (inclusive quantum mechanical treatment), Back-Goudsmit effect in hyperfine structure, 21cm line due to nuclear spin transition line and its detection (natural population inversion).

Origin of X-radiation, Characteristic X- ray spectra, X-ray emission spectra and Moseley's law, X-ray absorption spectra, Fine structure in X-ray emission spectra, screening doublets and spin- relativity doublets, spin - relativity doublets and regular doublets law, spin - relativity doublets and irregular doublets law, satellites, structure of absorption edges, X- ray spectra and optical spectra. [28 Hours]

##### UNIT-III:

Brief introduction and general properties, Laser spectral ranges, temporal coherence, spatial coherence (with analysis), mono-chromaticity of spectral lines, stimulated absorption and emission, calculation of Einstein's coefficient and condition for sustain emission population inversion, meta stable state, three level and four level system pumping processes, laser rate equation, threshold power, mode switching Shawlow - Townes condition, optical resonator, laser amplifier and laser oscillator, properties of laser, laser safety, types of lasers:-  $CO_2$  laser, dye laser, semi conductor diode laser, injection laser, free electron laser, applications of laser in medicine, industry, communication, holography and laser induced fusion. [28 Hours]

##### UNIT-IV:

Intra cavity control of spectral characteristics, Single mode operation, Multi mode operation, Methods of Q-Switching – Acousto-optic and passive, Pulsed lasing, Mode locking for ultra short pulses, Ultra short light pulses, Methods of mode locking, Mode pulling, Hole burning, Harmonic generation, second harmonic generation, phase

matching, third harmonic generation, optical mixing, Wave front correction of laser output, Light beam manipulation, High - sensitivity methods of absorption spectroscopy, frequency modulation, intra-cavity absorption, Fluorescence excitation spectroscopy, Opto-thermal spectroscopy, Thermal lensing and photo deflection spectroscopy. [28 Hours]

**TEXT BOOKS:**

1. Atomic Spectra by H.E. White, McGraw Hill.
2. Atomic and Molecular Spectra by Rajkumar, Kedar Nath Ram Nath, 2008.
3. Elements of Spectroscopy by Gupta, Kumar, Sharma, Pragati Prakasan, 2007.
4. Laser Spectroscopy by W. Demtroder, 2<sup>nd</sup> Edition, Springer, 1998.
5. Laser Physics and Applications by L. Tarasov, Mir Publishers, Moscow, 1986.
6. Lasers and Non- Linear Optics by B B Laud, Wiley Eastern Ltd

## M.Sc. (Final) Physics Syllabus (Year 2009-10 onwards)

### **SPECIALISATION : SPECTROSCOPY** **PAPER – V: MOLECULAR SPECTROSCOPY**

#### **UNIT-I:**

Electronic spectra of diatomic molecules, Hund's coupling cases (a), (b), (c), Symmetry properties of rotational levels, Evaluation of vibrational constants, Combination relations and evaluation of rotational constants for a single headed and double headed band, isotopic effect in electronic bands, vibrational and rotational temperatures. Determination of term manifold from the states of separated atoms, united atoms and electron configuration, Types of electronic transitions, Vibrational and Rotational perturbations, diffuse molecular spectra, Auger process, Radiation less decomposition processes in molecules, Pre-dissociation. [28 hours]

#### **UNIT-II:**

Importance of molecular symmetry, symmetry elements and different types of symmetry operations - identity operation, rotation operation, reflection operation, centre of inversion operation, rotation - reflection operation, molecular point groups, symmetry class, classification of point groups - non-axial, axial and dihedral.

IR Spectra of diatomic and poly atomic molecules, stretching frequency, vibration of polyatomic molecules, energy levels and spectral transition, overtone and combination bands, normal mode of vibrations:- band stretching, angle deformation, rocking, wagging, twisting, out of plane and in-plane deformation, spectra of some simple molecules( $\text{H}_2\text{O}$ ,  $\text{CO}_2$ ,  $\text{NCS}^-$ ,  $\text{OCF}_2$ ,  $\text{HNF}_2$ ), Fermi resonance, skeletal and group frequency concept, coupled vibrations, interpretation of IR spectra, instrumentation, sampling technique, FTIR Spectroscopy. [28 hours]

#### **UNIT-III:**

Electronic spectra of polyatomic molecules, types of electronic transitions, fluorescence Spectroscopy, determination of LCAO Coefficients, overlap and resonance integrals, Intensity and oscillator strength of vibronic spectra, vibronic interaction (Renner-Teller effect), Jahn-Teller effect.

Raman Spectra: selection rules, depolarization ratio, Raman band intensities, rotation and vibration-rotation Raman spectra, resonance Raman effect, non- linear Raman effects - stimulated Raman effect, hyper Raman effect, Coherent anti-Stokes Raman Scattering(CARS), instrumentation, sample handling techniques, interpretation of Raman spectra. [28 hours]

#### **UNIT-IV :**

Radio astronomy: Introduction, Basic definitions, Radio telescopes, Determination of the structure of radio source, Radiation processes, Radio emission in our galaxy, Brief of the milky way, radio galaxies, Quasars and Blazars, Pulsars, Radio spectra and structure, Radio astronomy and Cosmology, introduction to cosmological models (Fredmann and Robertson Walker), Hubble's law, red-shift, cosmic microwave background radiation (CMBR), WMAP (Wilkinson Microwave Anisotropy probe).

[28Hours]

#### **TEXT BOOKS:**

1. Molecular Spectra and Molecular Structure, Vol.- I, II & III by G. Herzberg, Van

- Nostrand Co., N.Y.1950.
2. Introduction to Infrared and Raman Spectroscopy, by N B Colthup, L H Daly & S E Wiberley, 3<sup>rd</sup> Ed , Academic Press, 1990.
  3. Vibrational Spectroscopy- Theory and Applications by D N Sathyanarayana, New age international publishers, 2000.
  4. Infrared Spectroscopy: Fundamentals and Applications by B Stuart, John Wiley & sons. Ltd , 2004.
  5. Astrophysics - A Modern Perspective by K. S. Krishnaswamy, New Age International Publishers, 1996.
  6. Introduction to cosmology by J V Narlikar 3<sup>rd</sup> Cambridge Indian Edition, 2003.
  7. Astrophysics: Stars and galaxies by K D Abhyankar, Univ. press, H'bad, 2001.

**M.Sc.(Final) Physics Syllabus (Year 2000 Onwards)  
(Non-revised)**

**PAPER-V : SPECIALISATION- THEORETICAL ATOMIC &  
MOLECULAR PHYSICS**

**UNIT-I :**

Classical methods of inelastic and rearrangements processes, impact parameter methods for electronic transitions.

**UNIT-II :**

Excitation and ionization, electron capture shall be included.

**UNIT-III :**

Computer programming includes FORTRAN-77, Programming in C languages. Second order differential equations using Numerical method, Runge-Kutta method and numerical methods for coupled differential equations.

**UNIT-IV :**

Numerical integration includes Gaussian-quadrature method, Simpson rule etc..

**REFERENCE BOOKS :**

1. Introduction to the theory of Ion-Atom Collision by M.R.C. Mc.Dowell and J.P.Collman.
2. Quantum Mechanics by Messiah. A.
3. Electronic and Ionic Impact Phenomena by Massey and Burhop (Vol.-I).
4. FORTRAN-77 by Samuel Shields (Schaum Series).
5. FORTRAN-77 by Rajaraman.
6. Introduction to C-Language by Kochan.
7. Manual of C - Compiler.

## ***M.Sc. (FINAL) PHYSICS PRACTICALS***

### **LIST OF EXPERIMENTS IN SOLID STATE PHYSICS :**

1. Stereographic Projection – Basic Exercises
2. Preparation of Standard Stereogram - Crystal Models
3. Stereographic Analysis of Crystal Surface Features
4. Electron Diffraction
5. Single Crystal Rotation
6. Laue Method
7. X-Ray Powder Method
8. Intensities of X-Ray Diffraction (Powder Pattern)
9. Optical Band Gap
10. Three Trace Analysis
11. Electrical Conductivity of Graphite
12. Valde's Four Probe Method (Thermal Band Gap)
13. Specific Heat of Graphite
14. Hall Effect
15. Magnetic Susceptibility
16. Ionic Conductivity of NaCl Crystal
17. Dielectric Constant
18. Step Height of Mica
19. Creep of Metals
20. Thermionic Emission
21. Dislocation Etching

## ***M.Sc. (FINAL) PHYSICS PRACTICALS***

### **LIST OF EXPERIMENTS IN ELECTRONICS AND RADIO PHYSICS:**

1. PCB Designing and Electronic Components Familiarization.
2. FET Characteristics.
3. Operational Amplifier (LS 741) Characteristics.
4. Logic Gates Exp. Set-I.
5. Logic Gates and Boolean Algebra Exp. Set-II.
6. Design of Regulated Power Supply (+5 & -5 Volt) & Level Detector.
7. UJT Characteristics & UJT as Relaxation Oscillator.
8. Network Theorems.
9. Study of Different Applications of Operational Amplifier (LS 741) Ser-I.
10. Study of Various Flip Flops using only NAND Gates & Clock.
11. Analog to Digital Conversion & Study of Shift Registers.
12. Microprocessor (8085) Programming Ser-I.
13. Study of Integrating, Differentiating and Clamping Circuits (Wave Shaping).
14. Circuit Designing Exp.-I.
15. Study of DC & AC Gate Control Characteristics of SCR (2N 1599 Thyristor).
16. Study of Two Stage RC Coupled Transistor Amplifier.
17. Study of FET Amplifier.
18. Half & Full Adder and Subtractor Circuit Using XOR, AND, NOR and NOT IC's.
19. Design Up & Down Counters Using JK Flip Flop IC and Clock (Modulo 3, 10).
20. Study of Active Filters (Low, High, Band and Notch) Circuits.
21. Study of Various Circuits Application of NE 555 Timer IC.
22. Study of Multiplexing and Demultiplexing Circuits using 74150 & 74154 IC's (Data Communication & RAM).
23. Study of Operational Amplifier (LS 741) Advanced Circuit Application Set-II.
24. Study of Frequency and Amplitude Modulation and Demodulation.
25. Microprocessor (8085) Advanced Level Programming Ser-II.
26. Study of Interfacing Peripherals 8255, 8279 & 8253/8251 IC's of 8085 Microprocessor.
27. Study of Strain Gauges as Transducers in Load Cell Pressure Cell and LVDT Applications.
28. Circuit Designing Exp.-II.

## ***M.Sc. (FINAL) PHYSICS PRACTICALS***

### **LIST OF EXPERIMENTS IN SPECTROSCOPY:**

#### **List of experiments.**

1. Michelson's Interferometer ( $\lambda$ ,  $d\lambda$  and  $t$ )
2. Rayleigh's Refractometer
3. Zeeman Effect
4. Electronic Spectrum of  $I_2$  molecule.
5. Rotation - Vibration spectrum of AlO molecule
6. Vibrational Analysis of CN molecule
7. 1<sup>st</sup> & 2<sup>nd</sup> order spectrum of Ne /He - atom
8. Identification of elements in Brass
9. Study of intensity variation in a diffraction pattern
10. Divergence of Laser beam
11. Study of polarization of light by optical elements
12. Absorption spectrum of  $KMnO_4$ .
13. Solar limb darkening
14. Vibrational spectrum of MgCl molecule.
15. Isotopic shift in AgCl molecule.
16. Rotational analysis of CN molecule.
17. Salt analysis by spectroscopic method.
18. Waist of laser.
19. Study of FTIR spectrum.
20. Rotational temperature of PbO molecule.
21. Doppler broadening.
22. Balmer series of hydrogen atom.
23. Brightness of night sky.
24. Study of lunar craters and sun spots.
25. FP interferometer.

## ***M.Sc. (FINAL) PHYSICS PRACTICALS***

### **LIST OF EXPERIMENTS IN NUCLEAR PHYSICS:**

#### **LIST OF EXPERIMENTS :**

1. Resolving Time of a G.M. Counting Set Up
  - i) Two Source Method
  - ii) Single Source Method
2. Study of Absorption of Gamma Rays (GM Counter) in Different Materials - Linear Absorption Coefficients and Mass Absorption Coefficients.
3. Study of Absorption of  $\beta$ -Rays in Different Materials-Range Energy Relations (GM Counter).
4. Study of Back Scattering of  $\beta$ -Rays (GM Counter).
5. Determination of Absolute Strength of  $^{60}\text{Co}$  Source (GM Counter).
6. Resolving Time of a Coincidence Circuit (GM Counter).
7. Study of
  - i) Relation Between Photopeak resolution and energy of Gamma Ray.
  - ii) Ratio of Photoelectric Cross Section to Compton Cross Section as a Function of Energy ( Scintillation).
8. Study of gamma-gamma Angular Correlation Function (Scintillation).
9. Compton Scattering-Shift in the Wavelength of Gamma Rays (Scintillation).
10. Range of  $\alpha$ -Particles by Spark Chamber.
11. Surface Barrier Detector -  $\alpha$  Spectrum.
12. Mossbauer Spectrum of Natural Iron - Analysis.
13. Scintillation Spectrum - Differential and Integral Mode.
14. Operational Amplifier - Applications
  - i) Differentiator
  - ii) Integrator
  - iii) Summing Amplifier
15. RC Pulse Shaping Circuits.
16. Schmidt Trigger Circuit.
17. A/D and D/A Converters.
18. Study of Decade Counters.