NIMS UNIVERSITY, JAIPUR

SYLLABUS

M. Sc. PHYSICS PREVIOUS

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YEAR - I

Classical Mechanics and Mathematical Method in Physics	**70**	**30**	**100**
Classical Electrodynamics	**70**	**30**	**100**
Quantum Mechanics, Atomic and Molecular Physic	**100**	**-**	**100**
Electronics, Numerical Methods and Computer Programming	**100**	**-**	**100**

PAPER - I:

CLASSICAL MECHANICS AND MATHEMATICAL METHODS IN PHYSICS

UNIT - I

Holonomic and nonholonomic constraints: D-Alembert's Principle, Generalized.coordinates,Lagrangian, lagrange's equation and its applications, Velocity dependant:potential in Lagaragian formulation.Generalized momentum, Legendre transformation, Hamiltonian, Hamilton's Canonical equation.

Calculus of variations and its ilpplication to simple problems, Hamilton's variational principle, Derivation of Lagrange's and Hamilton. Canonical equation from Hamiltons variational principle. Extension of Hamilton's Principle for nonconservative and nonholonomic systems. Method of Lagrange's multipliers,

UNIT - II

Conservation principle and Noether's theorem. Conservation of energy, linear momentum and angular momentum as a consequence of homogencity of time and scope and isotropy of space respectively.

Canonical transformation, integral in variants of Poincare: Lagrange's and Poisson brackets as canonical invariants. Equation of motion in Poisson bracket formulation, Infinitesimal contact transformation and generators of symmetry, Liouville's theorem, Hamilton Jacobi equation and its applications.

UNIT - III

Action angle, variable adiabatic invariance of action variable : The Kepler problem in action angle variables,theory of small oscillation in Lagrangian formulation,normal coordinates and its applications,Orthgonal transfonnation,Eulerian angles,Euler theorem, Eigen values of the inertia tensor, Euler equations. Force free motion of a rigid body.

Laplace transforms, and their properties, Laplace transform of derivatives and integrals of Laplace transform, Laplace, Convolution theorem, Impulsive function Application of Laplace transform in solving liner differential equations with constant coefficient with variable coefficient and liner partial differential equation.

UNIT - IV

Fourier Transforms: Development of the Fourier integral from the Fourier series, Fourier and inverse Fourier transform: Simple applications: Finite wave train, wave train with Gaussian amplitude, Fourier transform of Derivatives, Solution of wave equation as an application, Convolution theorem, intensity in term of spectral density for quasi-monochromatic EM waves, momentum representation. Application of Hydrogen Atom and Harmonic Oscillator

problems. Application of Fourier Transform to Diffraction Theory; Diffraction pattern of one two slits.

UNIT - V

Coordinate transformation in N-dimensional space: Contrarian and covariant tensor, Jacobian. Relative tensors, pseudo tensors (Example: change density, angu1ar momentum) Algebra of tensors, Metric theorem, Associated tensors, Riemannian space (Example: Euclidian space and 4-D Mmkowski space), Christoffelas symbols, transformation of Christoffelas symbols, Covariant differentiation. Ricci's theorem, Divergence, Curl and Laplacian in tensor form. Stress-and Strain tensors. Hook's law in tensor form. Lorentz Covariance of Maxwell equation.

Group of transformations. (Example: symmetry transformation of square), Generators of a finite group, Normal subgroup, Direct product of groups.. Isomorphism and Homomorphism. Representation theory of finite groups, Invariant subspace and reducible representations, irreducible representation, Crystallo-graphic point groups. Irreducible representation of C_{4v} Translation group and the reciprocal lattice.

REFERENCE BOOKS:

1. Goldstein - Classical Mechanics.
2. Landau.and Lifshitz - Classical Mechanics.
3. A. Raychoudhary - Classical Mechanics.
4. Mathematical Methods for Physicists: George Arkfen (AcademicPress). .
5. Applied Mathematics for Engineers and Physicists: L. A. Pipe (McGraw Hill)
6. MathematicalMethods-Potter and Goldberg (Prentice Hall of fudia).
7. Elements of Group Theory for Physicists: A. W. Joshi (Wiley Eastern Ltd.)
8. VectorAnalysis (Schaum Series) (Mc Graw Hill).

PAPER -II:
CLASSICAL ELECTRODYNAMICS

UNIT - I

1. **Electrostatics: Electric field;** Gauss law, Differential form of Gauss law. Another equation of electrostatics and the scalar potential, surface distribution of charges and dipoles and discontinuities in the electric field and potential, Poisson and-Laplace equations, Green's Theorem, Uniqueness of the solution with Dirichlet or Neumann Boundary conditions, Formal so1ution of Electrostatic Boundary value problem with Green's Function, Electrostatic potential energy and energy density, capacitance.

Boundary- Value'Problems in Electrostatics: Methods of Images, Point charge in the presence of a grounded conducting sphere point charge in the preseqce of a charge insulated conducting sphere, Point charge near a conducting sphere at fixed potential, conducting sphere in a unifonn electric field by method of images, Green function for the sphere, General solution for the potential, Conducting sphere with Hemispheres at different potential, orthogonal functions and expansion.

UNIT - II

1. Magneto statics: Introduction and defmition, Biot, and Savart law, the differential equation of magnetostatics and Ampere's law, Vector potential and Magnetic induction for a circular current loop, Magnetic fields of a localized current distribution, Magnetic moment, Force and torque on and energy of a localized current distribution in an external magnetic induction, Macroscopic equations. Boundary conditions on B and H. Methods of solving Boundary-value problems in magneto statics, Unifonnly magnetized sphere, Magnetized sphere in an external field, Permanent magnets, Magnetic shielding, spherical shell of permeable material in an unifonn field.

UNIT - III

1. **Multiples', Electrostatics of Macroscopic Media Dielectrics:** Multiple expansion, multipole expansion of the energy of a charge distribution in an external field, Elementary treatment of electrostatics with permeable media, Boundary value problems with dielectrics. Molar polarizability, and electric susceptibility. Models for molecular polarizability, Electro-static energy in dielectric media. .

2. Time varying fields, Maxwell's eqllations Conservation Laws: Energy in a magnetic field, Vector and Scalar potentials. Gauge transformations, Lorentz gauge, Coulomb gauge, Green functions for the wave equation, Derivation

of the equations of Macroscopic Electromagnetism, Poyntings theorem and conservations of energy and momentum for asystem ofcharged particles. And EM fields. Conservation laws for macroscopic media. Electromagnetic field tensor. Transformation of .four, potentials.and four currents. Tensor description of Maxwell's equation.

UNIT - IV

1. Plane Electromagnetic Waves and Wave Equation: Plane wave in a nonconducting medium. Frequency dispersion characteristics of dialectics, conductors and plasmas, waves in a conducting or dissipative medium, superposition of waves in one dimension,group velocity,casualty connection between D and E. Kramers-Kroning relation. .

2. Covariant Form of Electrodynamic Equations: Mathematical properties of the space-time special relativity, Invariance of electric charge covariance of electrodynamics, Transformation of electromagnetic fields.
Radiation by moving.charges : Lienard-wiechert Potentials for a point charge, Total power radiated by an accelerated charge ,Larmour's formula and its relativistic generalization, Angular distribution of radiation emitted by an accelerated charge, Radiation emitted by a charge in arbitrary extremely relativistic motion. Distribution in frequency and angle of energy radiated by accelerated charges, Thomson scattering and radiation, Scattering by quasi free charges, coherent and incoherent scattering, Cherenkov radiation.

3. Magnetohydrodynamics and Plasma Physics: Introduction and definitions, MHD equations Magnetic diffusion viscosity and pressure; Pinch effect. Instabilities in a pinched plasma column. Magnetohydrodynamic waves; Plasma oscillations, short wave length limit of plasma oscillations and Debye shielding distance.

4. Radiation damping, self fields. of a particle, scattering and absorption of radiation by a bound system: Introductory considerations, Radioactive reaction force from conservation of energy, Abtaham Lorentz evaluation of the self force, difficulties with Abraham Lorentz model; Integro-differential equation of motion including radiation damping,. Line Breadth and level shift of an oscillator, Scattering and absorption of radiation. by an oscillator, Energy transfer to a harmonically bound charge.

REFERENCE BOOKS:

1. J.D. Jackson-.-Classical Electrodynamics
2. Panofsky and Philips Classical Electricity and Magnetism'
3. Introduction to Electrodynamics- Gritfiths
4. Landau and Lifshitz--Classical Theory of Field
5. Landau and Lifshitz.:.Elec trodynamics of Continuous Media

PAPER -III:
QUANTUM MECHANICS, ATOMIC AND MOLECULAR PHYSICS

UNIT - I

States, Amplitudes and Operators: States of a quantum mechanical system, representation of quantum,- mechanical states, properties. Of quantum mechanical amplitude; operators and change of state, a complete set of basis states, Products of linear operators, language of quantummechanics, postulates, essential definitions and commutation relations.

Observable and description of system: Process of measurement,expectation values,time dependence of quantum mechanical amplitude, observables with no classical analogue, spin. dependence of quantum-mechanical amplitude on position. the wave fimction, super-position of amplitudes, identical particles.

The Co-ordinate Representation: Compatible observables, quantum conditions and uncertainty relation, Co-ordinate representation,of operator&; position,momentum and angularmomentum, time dependencef of expectation values, the Ehrenfest's theorem; the time evolution of wave function, the Schrodinger equation, energy quantization, ,periodic potential as an example.

UNIT - II

Symmetries and Angular momentum: (a) Compatible observables and constants of motion, symmetry' transformation and conservation laws, invariance,under space and time translations and space rotation and conservations of momentum, energy and angular momentum.

Angular momentum operators and, their eigen values, matrix representations of the angular momentum operators and their eigenstates, co-ordinate representations of the orbital angular momentum operators and their eigen state (spherical harmonics), composition of angular momentum, Clebsch-Gordon coefficients tensor operators and Winger Expert theorem,

commutation relations, of Jx, Jy, Jz with reduced spherical tensor operator, matrix elements of vector operators, time reversal invariance and vanishing of static electric dipole moment of a stationary state.

UNIT - III

Hamiltonian matrix and the time evolution of Quantum mechanical States: Hemriticity of the Hamiltonian matrix, Time independent perturbation of an arbitrary system, simple matrix examples of time-, independent perturbation, energy given states of a two state system, diagonalizing of energy matrix, time independent perturbation of two state system the perturbative solution: Weak field and strong field cases, general description of two state system. Pauli matrices. Ammonia molecule as an example of two state systems.
Interaction with External Fields: Non degenerate first order stationary perturbation method, atom in a weak uniform external electric field and first and second order Stark effect, calculation of the polarizability of the ground state of H-atom and of an isotropic harmonic oscillator, Degenerate stationary perturbation theory. Linear Stark effect for H-atom levels, inclusion of spin-orbit and weak magnetic, field, Zeeman Effect, strong magnetic field and calculation of interaction energy.

UNIT - IV

Transition between Stationary States: Transitions in a two state system, Time independent perturbations-The Golden rule, phase space, emission and absorption of radiation, induced dipole transition and Spontaneous emission of radiation. Energy width of a quasi stationary state.
Systems with Identical Particles: In distinguish ability and , exchange symmetry, many particle wave functions and Pauli's exclusion principle, spectroscopic terms for atoms. The Helimn atom, Variation method and its use in the calculation of ground state and excited state energy, Helimn atom. The Hydrogen molecule, Heitler-London method for molecule, WKB method for one dimensional problem, application to bound states (Bohr-Summerfield quantization) and the barrier penetration (alpha decay, problems.

UNIT - V

Hydrogen Atom : Gross structure energy spectnuil, probability distribution of radial and angular (l=1,2) wave ,functions (no derivation), effect of spin, relativistic correction to energy levels and fine structure, magnetic dipole interaction and hyperfine structure, the Lamb shift (only an qualitative description)
Spectroscopy(qualitative) : General features of the spectra of one and two electron system-sin.glet,doublet and triplet characters of emission spectra, general features of Alkali spectra, rotation and vibration band spectrum of a molecule, P,Q and R branches, Raman spectra for rotational and vibrational transitions, comparison with infra red spectra. General features of electronic spectra. Frank and Condon's principle.

REFERENCEBOOKS:

1. Ashok Das and A.C. Melissionos. Quantum Mechanics-A modern Approach (Gordon and Breach Science Publishers).
2. P.A.M.Dirac, Quantum Mechanics.
3. E. Merzbaker, Quantum Mechanics, Second Edition (John Willey and Sons).
4. L.P.Landau aridH.M. Lifshitz, Quantum Mechanics-Non relativistic theory (pergamon Press)
5. A..Ghatak and S. Lobnathan.- Quantum Mechanics: Theory and , Applications,Third Edition(Mac Millan India Ltd.) ,
6. G. K. Woodgate,ElementaryAtomic Structure, Second Edition Clarendon Press, Oxford.
7. T.A. Littlefield- Atomic and Molecular Physics.
8. Eistanberg and Rasmik-QuantumPhysicsof Atoms. Molecules, Solids and Nuclear Particles.
9. White - Atomic Spectra.
10.Herzberg- Molecular Spectra.

PAPER IV:
ELECTRONICS, NUMERICAL METHOD AND COMPUTER PROGRAMMING

UNIT- I

Operational Amplifiers: .Differential amplifier - circuit configurations-dual input, balanced output differential amplifier. DC analysis - AC analysis, inverting and nonninverting inputs, CMRR - constant current bias level translator.

Block diagram of a typical Op-Amp-analysis. Open loop configuration, inverting and non-inverting amplifiers.Op-amp with negative feedback - voltage series feedback -effect of feedback on closed loop gain, input rersistence, output resistance, bandwidth and output offset voltage - voltage follower.

Practical op-amp-input offset voltage -input bias current -input offset current, total output offset voltage, CMRR frequetency response. DC and AC

amplifier, summing, scaling and averaging amplifiers, instrumentation amplifier, integrator and differentiator.

UNIT - II

Oscillators and Wave Shaping Circuits: Oscillator Principle- Oscillator types, Frequency stability, response, The Phase shift oscillator, Wein bridge OScillator,LC tunable oscillators, Multivibrators-Monostable and Astable, Comparators, Square wave and Triangle wave generation, Clamping and Clipping.

Voltage regulators- Fixed regulators, Adjustable voltage regulators, switching regulators.

UNIT - III

Digital Electronics: Combinational Logic :The transistor as a switch; circuit Realization of OR,AND,NOT, NOR and NAND gates, Exclusive OR gate, Boolean algebra - Demerger's theorems Adder, Subtract or, Comparator, Decoder / Demultiplexer ,Data selector/ multiplexer -Encoder.

Sequential Logic: Flip -Flops: one-bit memory; The RS Flipflop, JK Flip- Flop, JK master slave Flip -Flops, T Flip -Flop, D Flip- Flop, Shift resisters - synchronous and asynchronous counters- cascade counters, Binary counter, Decade counter.

Basic concepts about fabrication and characteristics of integrated circuits. Fortran 77: Variable, Expression, jumping. Bracching an looping statement ,Input / Output statement for handling Input / Output Files, Subroutine, External, Function ,Special statements ,COMMON,ENTRY FORMAT,PAUSE,Equvalence . Programming of simple problems involving use of interpolation differentiation, Integration, matrix inversion and least square analysis.

UNIT - IV

Errors in numerical analysis: Source of error, Round off error, Computer Arithmetic, Error Analysis, Condition and stability, Approximation, Functional and Error analysis, the method of, Undetermined Coefficients. Use of interpolation formula, Iterated interpolation. Inverse interpolation,Hannite interpolation and Spline interpolation, Solution of Linear equations , Direct and Iterative methods, Calculation of eigen value and eigen vectors for sysmmetric matrices.

Solution of Nonliner equation: Bisection method, Newton's method,.modified Newton's method, method of Iteration, Newton's method and method of iteration for a system of cosuation Newton's method for the case of complex roots.

UNIT - V

Integration of a function: Trapezoidal and Simpson's rules. Gaussian quadrature formula, Singular integrals, Double integration.

Integration of Ordinary differential equation: Predictor - corrector methods, Runga-Kutta method, Simultaneous and Higher order equations Numerical Integration and Differentiation of Data, Least-Squares

Approximations, Fast Fourier Transform. .

Some elementary information about Computer: CPU, Memory, Input/ Output devices, Super, Mini and Micro systems, MS-DOS operating system, High Level Languages, Interpreter and Compiler. Programming: Algorithm and Flowchart.

REFERENCE BOOK: -

1. Ryder-Electronic Fundamentals and applications.
2. Millman and Thub-Pulse, Digital and Switching waveforms.
3. Millman and Helkias-Integrated Electronics.
4. Ryder-network Lines and Fields.
5 Bapat-Electronics Devices and Circuitrs.
6. A Ralston and P. Rabinowitz, A First Course in Numberical analysis Mc Graw Hill (1985)
7. S.S. Sastry, Introductory Methods of Numerical Analysis. Prentice hall of India (1979).
8. Ram Kumar, Programming with FORTRAN 77, McGraw-Hill (1986).
9. "Electronic'Devicesand circuit theory by Robert Boylested and Louis Nashdsky PHI, New Delhi. 1100001, 1991 .
10."OPAmps& Linear integratedcircuits, by Ramakanth A. Gayakwad PHI, Second Edition, 1991.
11. Digital principles and Applications by A.P. Malvino and Donald P.Leach, Tata Megraw - Hill company, New Delhi, 1993.
12. Microprocessor Architecture, Programming and applications with 8085/8086 by Ramesh S. Gaonkar,Wiley - Eastern Ltd., 1987.

LIST OF EXPERIMENTS FOR M.Sc. PREVIOUS

List of Experiments (any eighteen):

1. To design a single stage amplifier of a given voltage gain and lower cut of frequencies.
2. To determine Lo. Co. and Rf of a given coil and to study the variations of Rf with frequency.
3. To design a RC coupled two stage amplifiers of a given gain and the cutoff frequencies.
4. To study Hartley oscillator.
5. To Study Transistor bias Stability.
6. To design a Multiv~bratorof given frequency and study its wave shape.
7. To study the characteristics ofFET and use it 0 design a relaxation oscillator and measure its frequency.
8. To study the characteristics of an operational amplifier.
9. To study the characteristics of a UJT and use it to design a relaxation oscillator and measure its frequency.
10. To study the addition, integration and differentiation properties of an operational amplifier.
11. Determine Plack constant using solar Cell.
12. To determine Plack constant and work function by a photo-cell.
13. To study regqlated power supply using (A) Zener diode only (b) Zener diode with a series transistor (c) Zener diode with a shunt transistor.
14. To verify Fresnel's formula;
15. To study the percentage regulation and variation of Ripple factor, withload for a full wave rectifier. .
16. To study analog to digital and digital to analog conversion.
17. To study a driven mechanical oscillator.
18.To verify Hartmann's formula using constant deviation spectrograph.
19. To find e/m of electron using Zeeman effect.
20. To find Dissociation energy to I.
21. Study of CH Bands.
22. Salt Analysis / Raman effect (Atomic).
23. Design and study of pass filters.
24. Michelson Interferometer.
25. Fabry parot Interferometer.
26. Determination of velocity of Ultrasonic waves.
27. Study of Eliptically polarised light by Babinet Compensator.
28. Veafication of Cauchey's Dispersion relation.
29. Study of DC gatecontrol characteristics and Anode current characteristics of SCR.