PANDIT DEENDAYAL UPADHYAYA SHEKHAWATI UNIVERSITY, SIKAR

SYLLABUS

M.Sc Physics(Previous)
Only for Regular Students
(ANNUAL SCHEME)
SESSION 2022-23
EXAMINATION-2023

Papers	Max. Marks:	Duration
Paper-I: Classical Mechanics and Mathematics	: 100	3 hrs.
Paper-II: Classical Electrodynamics	: 100	3 hrs.
Paper-III: Quantum Mechanics Atomic and Molecular Physics	: 100	3 hrs.
Paper-IV: Electronics, Numerical Methods and Computer Programming	:100	3 hrs.

Dy. Registrar
Pandit Deendayal Upadhyaya
Shekhawati University,
Sikar(Rajasthan)

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M.Sc. PHYSICS
(EXAMINATION- 2023)
Scheme of examination

1. The Number of paper and the maximum marks for each paper practical shall be shown in the syllabus for the subject concerned. It will be necessary for a candidate to pass in the theory part as well as in the practical part (Whenever Prescribed) of a subject/Paper separately.
2. A candidate for a pass at each of the previous and the Final examination shall be required to obtain (i) at least 36% marks in the aggregate of all the paper prescribed for the examination and (ii) at least 36% marks in practical (s) whenever prescribed the examination, provided that if a candidate fails to at least 25% marks in each individual paper at the examination, and also in the test dissertation/Survey report/Field work. Wherever prescribed, he shall be deemed to have failed at the examination not withstanding his having obtained the minimum percentage of marks required in the aggregate for the examination. No division will be awarded at the Previous Examination. Division shall be awarded at the end of the Final Examination combined marks obtained at the Previous and the Final Examination taken together, as noted below.

   First Division : 60% of the aggregate marks taken together
   Second Division : 40% of the Previous and the Final Examination
   All the rest will be declared to have passed the examination.
3. If a candidate clears any paper (s) Practical (s)/Dissertation Prescribed at the Previous and or/final examination after a continuous period of three years, then for the purpose of working out his division the minimum pass marks only viz 25% (36% in the case of practical) shall be taken into account in respect of such paper (s) Practical(s) Dissertation are cleared after the expiry of the aforesaid period of three year, provided that in case where a candidate more than 25% marks in order to reach the minimum aggregate as many marks out of those actually secured by him will be taken into account as would enable him to make the deficiency in the requisite minimum aggregate.
4. The Thesis/Dissertation/Survey Report/Field Work shall typewritten and submitted in triplicate so as to reach the office of Registrar at least 3 week before the commencement of the theory examination. Only such candidate who shall be permitted to offer Field work/Survey Report/Thesis (if provided in the scheme of examination) in lieu of a paper as have secured at least 55% marks in the aggregate of all the paper prescribed for the previous examination in the case of annual scheme irrespective of the number of paper in which a candidate actually appeared at the examination.

   N.B (i) Non-collegiate candidate are not eligible to offer dissertation as per provisions of Q.170-A.

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PAPER-I: CLASSICAL MECHANICS AND MATHEMATICAL METHOD 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 Lagaragain formulation. Generalized momentum, Legendre transformation, Hamiltonian, Hamilton's Canonical equation. Calculus of variations and its Application to simple problems, Hamilton's variational principle, Derivation of Lagrange's and Hamilton. Canonical equation from Hamilton's 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 homogeneity 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, Orthogonal transformation, 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 derivative and integrals of Laplace transform, Laplace, Convolution theorem, Impulsive function application of Laplace transform in solving liner differential equations with constant coefficient with vriable coefficient and liner partial differential equation.

Unit-IV

Fourier Transforms: Development of the Fourier integral from the Fourier seriese, Fourier and inverse Fourier transform: Simple applications: Finite 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: Contra variant and covariant tensor, Jacobian. Relative tensors, pseudo tensors (Example: change density, angular momentum) Algebra of tensors, Metric theorem, Associated tensors, Riemannian space (Example: Euclidian space and 4-D Minkowski space) christoffelas symbols,Covariant differentiation. Ricci's theorem, Divergence, Curl and Laplacian in tensor form. Stress-and Strain tensors. Hook's lawin tensor form. Lorentz Covariance of Maxwell equation. Group, Normal subgroup, direct product of groups. Isomorphism and Homomorphism. Representation theory of finite groups, Invariant subspace and reducible representations. Irreducible representations, Crystallographic point groups. Irreducible representation of C4v Translation group and the reciprocal lattice.

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PAPER-II: CLASSICAL ELECTRODYNAMICS

Unit-I

Electrostatics: Electric field; Gauss law, 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 solution of Electrostatic Boundary value problem with Green's function, Electrostatic potential energy and energy density, capacitance. Boundary-Value's Problem in Electrostatics: Method of Images, Point charge in the presence of a grounded conducting sphere point charge in the presence of a charge insulted conducting sphere, Point near a conducting sphere at fixed potential, conducting sphere in a 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

Magnetostatics: Introduction and definition, 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. Method of solving Bouddary-value problems in magnetostatics, Uniformly magnetized sphere, Magnetized sphere in an external field, Permanent magnets, Magnetic shielding, spherical shell of permeable material in an uniform field.

Unit-III

Multipoles, Electrostatic 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 polarizablility and electric susceptibility. Models for molecular polarizability, Elector-static energy in dielectric media.

Time varying fields, Maxwell's equation Conservation Laws: Energy in magnetic field, Vector and Scalar potentials. Gauge transformations, Lrentz gauge, Coulomb gauge, Green functions for the wave equation, Derivation of the equation of Macroscopic Electromagnetism, Poyntings theorem and conservations of energy and momentum for a system of charged 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

Plane Electromagnetic Waves and Wave Equation: Plane wave in a nonconduting 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. Covariant Form of Electrodynamics Equation: 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, Larmous'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.

Unit-V

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

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.

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 basic, products of linear operators, language of quantum mechanics, 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 function, 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 angular momentum, time dependence 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 representation of the angular momentum operators and their Eigen states, co-ordinate representations of the orbital angular momentum operators and their Eigen states, (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 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 states system, diagonalizing of energy matrix, time independent petriburbation 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 Helium atom, Variational method and its use in the calculation of ground state and excited states energy, Helium atom. The Hydrogen molecule, Heitler-London for molecule, WKB method for one dimensional problem, application to bound states (Bohr-Summerfield quantization) and the barrier penetration (alpha decay, problem).

Unit-V

Hydrogen Atom: Gross structure energy spectrum, probability distribution of radial and angular (1=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-singlet, doublet and triplet characters of emission spectra, general features of Alkali spectra, rotation and vibration band spectrum of a molecule, PQ and R branches, for rotational and vibrational transitions, comparison with infra red spectra. General features of electronic spectra. Frank and Condon's principle.

PAPER-IV: ELECTRONICS, NUMERICAL AND COMPUTER PROGRAMMING

Unit-I

Operational Amplifiers: Differential amplifier –circuit configurations-dual input, balanced output differential amplifier. DC analysis –AC analysis, inverting and non-inverting 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 resistance, 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 frequency responses. 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, switching regulators.

Unit-III

Digital Electornics: Combinational Logic: The transistor as a switch; circuit Realization of OR,AND NOT, NOR and NAND gates, Exclusion OR gate, Boolean algebra-Demorgan's theorems Adder, Subtractor, Comparator, Decoder/De-multiplexer, Data selector/multiplexer-Encoder.

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

Basic concept about fabrication and characteristics of integrated circuits. Fortan 77: Variable Expression, jumping. Branching an looping statement, Input/output statement, Statement for handing Input / Output Files, Subroutine, External, function, Special statements, COMMON, ENTRY FORMAT, PAUSE, Equivalence. Programming of simple problems involving use of interpolation differentiation, matrix in 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 symmetric matrices. Solution of Nonlinear equation: Bisection method, Newton's method, modified Newton's method, method of Iteration, Newton's method and method of iteration, for a system of causation Newton's method for the case of complex roots.

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Unit-V

Integration of 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 elermentary information about Computer: CPU, Memory, Input/output devices, Super, Mini and Micro systems, MS-DOS operating system, High Level Languages, Interpreter and Complier. Programming: Algorithm and Flowchart.

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