MECHANICS – I

Scheme of examination: *MM: 23*

1. *In all five questions are to be answered. There shall be two questions from each unit. A student has to answer one question from each unit. Fifth question will be compulsory and will cover the entire syllabus.*

UNIT-I

Physical Laws and Frames of Reference: Transformation of displacement, velocity and acceleration between different frames of reference involving translation and rotation. Uniform relative motion. Inertial frames of reference-examples, Galilean transformations and invariance of Newton's laws. Non Inertial frames and their Examples.

UNIT-II

Special Theory of Relativity: Michelson-Morley's experiment, postulates of special theory of relativity, Lorentz transformations, transformation of velocity and acceleration, Addition of velocities, time dilation and length contraction. Experimental verification of time dilation. Some important results of special theory of relativity.

UNIT-III

Relative Rotational Motion: Transformation of velocity and acceleration between rotating frames, pseudo forces, coriolis forces, Motion relative to earth, Effects of centrifugal and Coriolis force on motion relative to earth. Foucault's pendulum.

UNIT-IV

Rigid Body Dynamics: Equation of motion of a rotating body. Inertial coefficients. Moments of Inertia of a disc. Cylinder and sphere. Case of

angular momentum not parallel to angular velocity. Kinetic energy of rotation and idea of principle axes. Precessional motion of spinning top.

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ELECTROMAGNETISM – I

Scheme of examination: *MM: 23*

1. *In all five questions are to be answered. There shall be two questions from each unit. A student has to answer one question from each unit. Fifth question will be compulsory and will cover the entire syllabus.*

UNIT-I

Vector Fields: Partial derivative. Gradient of a scalar function. Line intergral of vector field. Potential difference and potential function. Potential energy of a system, Application: energy required to build a uniformly charged sphere, classical radius of an electron, potential and field due to short dipole, torque and force on a dipole in a Z external field.

UNIT-II

Divergence and Curl of a vector field: Divergence of a vector field. Divergence in the Cartesian coordinates, concepts of solid angle. Gauss divergence theorem, Gauss law in differential form, Gauss law from inverse square law, physical meaning of divergence of a vector, the Laplacian operator. Poision's and Laplace's equations. Curl of a vector field, Curl in Cartesian coordinates, Stoke's theorem, physical meaning of Curl.

UNIT-III

The Field of Moving Charge: Magnetic force, Measurement of charge in motion, Invariance of charge. Electric field measured in different frames of reference. Field of a point charge moving with constant velocity, Force on a moving charge, Interaction between a moving charge and other moving charges.

UNIT-IV

Electric Field in Matter: The Moments of a charge distribution. Atomic and molecular dipoles. Atomic polarizability. Permanent dipole moment, dielectrics. The Capacitor filled with a dielectric. The potential and field due to a polarized sphere. Dielectric sphere places in a uniform field, the field of charge in dielectric medium and Gauss's Law. The connection between electric susceptibility and atomic polarizability. Polarization in changing field. The bound charge (polarization) current.

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WAVE AND OSCILLATIONS – I

Scheme of examination: *MM: 24*

1. *In all five questions are to be answered. There shall be two questions from each unit. A student has to answer one question from each unit. Fifth question will be compulsory and will cover the entire syllabus.*

UNIT-I

Simple harmonic and anharmonic Oscillators: Oscillations in an arbitrary potential well, Simple harmonic motion, examples-mass on a spring, LC Circuit, torsional oscillator, mass and two spring system. Energy of the oscillators. Anharmonic oscillator, simple pendulum as an example.

UNIT-II

Damped harmonic oscillators: Damped harmonic oscillators, mathematical formulation of damped harmonic oscillators Energy of damped harmonic oscillator, Power dissipation, relaxation time, Quality factor of damped harmonic oscillators. Examples – Electromechanical system-Ballistic galvanometer. Damped oscillation in LCR Circuit.

UNIT-III

Driven harmonic oscillators: Driven harmonic oscillators. Mathematical formulation of driven harmonic oscillator. Frequency response on amplitude and phase, Quality factor of driven harmonic oscillators, Resonance, Sharpness of resonance, Power absorption by forced oscillator. Series and parallel LCR Circuit.

UNIT-IV

Coupled Oscillators: Equation of motion of two coupled S. H. Oscillators, Normal modes, motion in mixed modes, Transient behavior, Effect of coupling in mechanical systems. Electrically coupled circuits, frequency response, reflected impedance. Effect of coupling and resistive load.

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MECHANICS - II

Scheme of examination: *MM: 23*

1. *In all five questions are to be answered. There shall be two questions from each unit. A student has to answer one question from each unit. Fifth question will be compulsory and will cover the entire syllabus.*

UNIT-I

Conservation Laws: Conservative forces, Potential energy, potential energy in gravitational and electrostatic field. Rectilinear motion under conservative forces. Discussion of potential energy curves and motion of a particle. Centre of Mass. Two particle system. Motion of centre of mass and reduced mass. Application of reduced mass: Reduced mass of hydrogen atom, Reduced mass of deuteron, Reduced mass of earth and satellite.

UNIT II

Conservation of linear and angular momentum: Conservation of linear momentum Collision of two particles in one and two dimensions (elastic and inelastic). Slowing down of neutrons in a moderator. Motion of a system with varying mass (Rocket). Angular momentum conservation and charged particle scattering by a nucleus as an example.

UNIT III

Motion under Central Forces : Motion under central forces. Gravitational interaction, intertia and gravitational mass, general solution under gravitational interaction. Rutherford scattering, Discussion of trajectories, Cases of elliptical and circular orbits, Kepler's Laws.

UNIT IV

Elastic properties of Matter : Elasticity, Young's Modulus, Bulk modulus, Modulus of rigidity, Poisson's ratio and their relations. Bending of a beam. Torsion of a cylinder, experimental determination of elastic constants.

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ELECTROMAGNETISM - II

Scheme of examination: *MM: 23*

1. *In all five questions are to be answered. There shall be two questions from each unit. A student has to answer one question from each unit. Fifth question will be compulsory and will cover the entire syllabus.*

UNIT-I

The Magnetic Field : The definition of magnetic field, properties of the magnetic field. Ampere's circuital law with application. Ampere's Law in differential from. Vector potential. Poissions equation for vector potential. Field of any current carrying wire and deduction of Biot-Savart Law.

UNIT II

Magnetic Fields in Matter: Electric current due to an orbiting electron, the field of current loop, Bohr magneton. Orbital gyromagnetic ratio. Electron spin and magnetic moment. Magnetic susceptibility, magnetic field caused by magnetized matter. magnetization current. Free current and the field H.

UNIT III

Electromagnetic Induction: Faraday's law of Electromagnetic Induction in integral and differential form. Lenz’s law Self and mutual induction. Transformer, measurement of self inductance by Rayleigh’s method. Energy stored in magnetic field.

UNIT IV

Transient Currents and Maxwell’s Equations: Transient behaviour of an R-C circuit, determination of high resistance by leakage method. Transient

behaviour of an R-L circuit, the displacement current. Maxwell's equations in differential and integral forms.

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WAVES AND OSCILLATIONS - II

Scheme of examination: *MM: 24*

1. *In all five questions are to be answered. There shall be two questions from each unit. A student has to answer one question from each unit. Fifth question will be compulsory and will cover the entire syllabus.*

UNIT I

Lattice Vibrations: Concept of group and phase velocities, Equation of motion for one dimensional monoatomic and diatomic lattices, acoustic and optical modes, dispersion relations.

UNIT II

Electrical transmission line: transmission line, transmission line equation, propagation constant, characteristic impedance, standing waves and standing wave ratio, effect of terminal load.

UNIT III

Elastic waves in a solid rod, Pressure waves in a gas column. Transverse waves in a string, waves in three dimensions, spherical waves, Fourier series and determination of Fourier constants, Fourier analysis of a square, saw tooth and triangular wave forms.

UNIT IV

Electromagnetic Waves: Plane electromagnetic waves. EM waves in an isotopic medium. Properties of EM waves, Energy density of EM waves. Momentum density of EM wave. Radiation pressure. Radiation resistance of free space, EM waves in dispersive media. Spectrum of electromagnetic radiations. -----X-----

STATISTICAL AND THERMODYNAMICAL PHYSICS – I

Scheme of examination: *MM: 23*

1. *In all five questions are to be answered. There shall be two questions from each unit. A student has to answer one question from each unit. Fifth question will be compulsory and will cover the entire syllabus.*

UNIT-I

First law of Thermodynamics: Microstates of the system Thermal interaction, Thermal insulation, Adiabatic interaction and Enthalpy, Concept of temperature and Zeroth law of Thermodynamics, idea of temperature scales, thermodynamical parameter β, distribution of energy, first law of thermodynamics.

UNIT-II

Second law of Thermodynamics and Heat Engines: Second law of thermodynamics (Different statements and their equivalence). System in contact with a heat reservoir (Canonical distribution). Partition function. Reversible and irreversible processes,. Heat engines, Carnot cycle, Carnot's ideal Engine and Refrigerator. Thermodynamical scale as an absolute scale.

UNIT-III

General Thermodynamics Interactions: Dependence of number of states on External parameters, General relations in equilibrium, equilibrium conditions. Infinitesimal quasitstatic process, entropy of an ideal gas, equilibrium of an isolated system, equilibrium of system in contact with a reservoir (Gibb's free energy).

UNIT-IV

Thermodynamic Relation: Equilibrium between phases, Clausius Clapeyron equation. Triple point, vapour pressure in equilibrium with a liquid or solid, equilibrium condition for a system of fixed volume in contact with heat reservoir (Helmoholtz free energy). Deduction of Maxwell's relation and their applications.

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OPTICS – I

Scheme of examination: *MM: 23*

1. *In all five questions are to be answered. There shall be two questions from each unit. A student has to answer one question from each unit. Fifth question will be compulsory and will cover the entire syllabus.*

UNIT-I

Elements of Geometrical Optics: Fermat's principle, laws of reflection and refraction from Fermat's principle, Refraction at a spherical surface, Linear and lateral magnifications, Refraction through a thick lens. Focal lengths of thick and thin lenses. Combination of two lenses. Cardinal points.

UNIT-II

Interference: Superposition of waves from two point sources, necessity of coherence, Concept of spatial and temporal coherence. Effective size of a point source. Shape of interference fringes. Intensity distribution in space. Interference by division of amplitude, Interference in thin films. Colours of thin films in transmitted and reflected light.

UNIT-III

Application of Interference: Newton's Rings. Michelson's interferometer, Fringes of different shapes with Michelson's interferometer, Determination of wave length with Michelson's interferometer. Determination of refractive index by Newton's ring and Michelson interferometer.

UNIT-IV

Laser and Holography: Spontaneous and stimulated emission, Einstein's coefficient, Energy density of radiation as a result of stimulated emission

and absorption, Population inversion, Methods of optical pumping, energy level schemes and working of He-Ne, Ruby and CO_2 laser. Basic concept of Holography, construction of hologram and reconstruction of the images.

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ELECTRONICS – I

Scheme of examination: *MM: 24*

1. *In all five questions are to be answered. There shall be two questions from each unit. A student has to answer one question from each unit. Fifth question will be compulsory and will cover the entire syllabus.*

UNIT-I

Circuit Analysis: Network's – some important definition, loop and nodal equations based on DC and AC circuit.

Kirchhof's Laws. Four terminal network Ampere-Volt conventions, open, close and Hybrid parameter of any four terminal network.

Network Theorems: Superposition. Thevenin, Norton and Reciprocity, Compensation, Maximum power transfer.

UNIT-II

Semiconductor and Semiconductor diodes: Energy band in solids. Intrinsic and extrinsic semiconductors, charge densities in N and P materials. Conduction by drift and diffusion of charge. P-N junction diode equation, capacitance effect. P-N junction and Zener Diode and their I-V characteristics.

UNIT-III

Rectifiers and Power supplies: Diode as a rectifier, Half-wave full wave and Bridge rectifiers, calculation of ripple factor, efficiency and regulation.

Filters: Series Inductor, Shunt Capacitor, L-Section and π-section filters,

Voltage regulation: Voltage regulation and voltage stabilization by Zener diode. Voltage multiplier.

UNIT-IV

Transistor and Transistor Amplifiers: Notation and volt ampere characteristics for bipolar junction transistors. Concept of load line and operating point, Hybrid parameter, CB, CE, CC configurations. Analysis of transistor amplifiers using hybrid parameters and its gain, frequency response. Stability factors, various types of bias circuits for thermal bias stability, Fixed bias, collector to base feed back bias and four resistor bias.

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STATISTICAL AND THERMODYNAMICAL PHYSICS - II

Scheme of examination: *MM: 23*

1. *In all five questions are to be answered. There shall be two questions from each unit. A student has to answer one question from each unit. Fifth question will be compulsory and will cover the entire syllabus.*

UNIT-I

Production of low temperatures and applications: Joule Thompson expansion and J-T coefficients for ideal as well as Vander Wall's gas, porous plug experiment. Temperature inversion, regenerative cooling and cooling by Adiabatic expansion and demagnetization, liquid Helium, He-I and He-II, Super fluidity, refrigeration through Helium dilution quest for absolute zero, Nernst heat theorm.

UNIT II

The Distribution of Molecular Velocities : The distribution of molecular velocities, most probable, average and RMS velocities, the energy distribution function, effusion of molecular beam, experimental verification of Maxwell velocity distribution, The principle of equipartition of energy. Mean free path, distribution of free paths.

Transport phenomenon; coefficients of viscosity. Thermal conductivity. Diffusion and their interrelation.

UNIT III

Classical Statistics: Validity of classical approximation, phase space, Micro and Macro State, Thermodynamical probability, Relation between

entropy and thermodynamical probability, The monoatomic ideal gas, the barometric equation, specific heat capacity of diatomic gas, specific heat capacity of solids.

UNIT IV

Quantum Statistics: Black body radiation and failure of classical statistics.

Postulates of quantum statistics, in distinguishability, wave function, exchange degeneracy, a priori-probability. Bose Einstein's Statistics and its distribution function. Planck's distribution function and radiation formula, Fermi-Dirac statistics and its distribution function, Contact potential. Thermionic emission, specific heat anomaly of metals, nuclear spin statistics (para and ortho hydrogen).

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OPTICS - II

Scheme of examination: *MM: 23*

1. *In all five questions are to be answered. There shall be two questions from each unit. A student has to answer one question from each unit. Fifth question will be compulsory and will cover the entire syllabus.*

UNIT-I

Diffraction: Fresnel's class of diffraction: Fresnel's assumptions, Half period zones, Zone Plate, phase reversal zone plate diffraction by a circular aperture, straight edge, a thin wire and rectangular slit. Cornu's spiral to study Fresnel's differection.

UNIT II

Fraunhofer class of diffraction: Fraunhoffer diffraction by single slit and a circular aperture, Fraunhoffer diffraction by N parallel slits with two slits as an application, Missing order, Plane diffraction grating, Dispersion by a grating, Rayleight's criterion of resolution, Resolving power of grating.

UNIT III

Polarization: Plane electromagnetic waves E and B of linearly, circularly and elliptically polarized electromagnetic waves. Reflection and refraction of plane EM Waves at a plane dielectric surface, Boundary conditions, Derivation of Fresnel's relation. Polarisation by reflection. Propogation of EM wave in an anisotropic media.

UNIT IV

Double refraction and optical activity: Huygen's Theory of Double Refraction using Fresnel Ellipsoidal Surfaces (no mathematical derivation), Production and Analysis of Plane Polarized, Circularly and elliptically

polarized light, Quarter and half wave plates. Specific Rotation. Bi-quartz and half shade polarimeters.

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ELECTRONICS - II

Scheme of examination: *MM: 24*

1. *In all five questions are to be answered. There shall be two questions from each unit. A student has to answer one question from each unit. Fifth question will be compulsory and will cover the entire syllabus.*

UNIT-I

Amplifier with Feed Back: Concept of feed back, Positive and negative feed back. Voltage and current feed back circuits. Advantage of negative feed back. Stabilization of gain, effect of negative feed back on output and input resistance, reduction of nonlinear distortion, effect on gain - frequency response.

UNIT II

Oscillators :Criterion for self excited and self sustained oscillations, circuit requirement for build up of oscillations, Basic transistor oscillator circuit and its analysis Colpitt's and Hartely oscillators, R.C. Oscillators, Crystal oscillators and its advantages.

UNIT III

Field Effect transistor: Junction Field effect transistors (JFET) Metal Oxide Semiconductor Field Effect Transistor (MOSFET), circuit symbols, biasing, volt-ampere characteristics, Source follower operation of JEFT, FET as variable voltage resister.

UNIT IV

Digital Circuits: Binary number system, Binary arithmetic. Logic fundamental AND, OR, NOT, NOR, NAND, XOR. Boolean algebra,

Simplification of Boolean expressions. De Morgan's theorems. Positive and negative logic. Logic gate realization using DTL and TTL.

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MATHEMATICAL PHYSICS - I

Scheme of examination: *MM: 23*

1. *In all five questions are to be answered. There shall be two questions from each unit. A student has to answer one question from each unit. Fifth question will be compulsory and will cover the entire syllabus.*

UNIT-I

Orthogonal curvilinear coordinate system:

Orthogonal curvilinear coordinate system, scale factors, expression for gradient, divergence, curl and their application to cartesian, circular cylindrical and spherical polar coordinate.

UNIT-II

Tensors:

Coordinate transformation and Jacobian, transformation of covariant, contra variant and mixed tensor, Addition, subtraction, multiplication and contraction of tensors, Metric tensor and its use in transformation of tensors. Dirac delta function and its properties.

UNIT-III

Four Vectors

Four vector formulation, energy momentum four vector, relativistic equation of motion, invariance of rest mass and orthogonality of four force and four velocity, Lorentz force as an example of four force, transformation of four frequency vector, longitudinal and transverse Doppler's effect.

UNIT-IV

Relativistic Dynamics:

Transformation between laboratory and center of mass system. four momentum conservation. kinematics of decay products of unstable particles and reaction thresholds: Pair production, inelastic collision of two particles, Compton effect. Lorentz transformation and rotation in space-time, time like and space like vectors, world line, macro-causality.

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ELEMENTARY QUANTUM MECHANICS AND SPECTROSCOPY - I

Scheme of examination: *MM: 23*

1. *In all five questions are to be answered. There shall be two questions from each unit. A student has to answer one question from each unit. Fifth question will be compulsory and will cover the entire syllabus.*

UNIT-I

Development of quantum Mechanics:

Historical development and experimental evidence for quantum theory. black body radiation. Planck's radiation law, photoelectric Effect, Compton effect. De-Broglie relation, Davisson- Germer Experiment; Uncertainty principle, its application such as (i) Non-existence of electrons in nucleus, (ii) Ground State energy of H - atom. (iii) Ground state energy of harmonic oscillator, (iv) Natural width of spectral lines.

UNIT-II

Schrodinger equation:

Its need and justification. time dependent and time independent forms. physical significance of the wave function and its interpretation. Probability, current density, Wave packet, group and phase velocities, principles of superposition, diffraction at a single slit.

UNIT-III

Operators in quantum mechanics:

definition of an operator, Algebra of operator linear and commutator operators, Eigen values and Eigen functions, Operators for momentum, K.E, Hamiltonian, total energy and angular momentum, fundamental postulates of quantum mechanics, Hermitian operator, orthogonality,

Degeneracy and commutation relations, Ehrenfest's theorm, Bohr's principle of complimentarily, principle of superposition.

UNIT-IV

Applications of Quantum theory to atomic spectra:

Quantum features of spectra of one electron atoms; Frank Hertz experiment and discreet energy states, Schrodinger's equation for a spherically symmetric potential. Schrodinger's equation for one electron atom in spherical coordinates, Separation of variables.

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NUCLEAR AND PARTICLE PHYSICS

Scheme of examination: *MM: 24*

1. *In all five questions are to be answered. There shall be two questions from each unit. A student has to answer one question from each unit. Fifth question will be compulsory and will cover the entire syllabus.*

UNIT-I

Nuclear structure and properties:

Constituents of nucleus, properties of nuclear forces, binding, energy, semi empirical mass formula, mass defect and packing fraction, saturation characteristics; Magnetic dipole moment and electric quadruple moment, angular momentum and parity; Variation of size of nucleus with mass number; Stable nucleus and conditions for stability (e.g. beta emissions for different isobars).

UNIT-II

Nuclear Fission and Fusion:

Energy released in fission, Theory of nuclear fission and liquid drop model, Barrier penetration – Theory of spontaneous fission, Nuclear chain reaction, condition of controlled chain reaction, Principle of nuclear reactors, classification of reactors. Energy released in fusion, fusion reactions in stars. carbon and pp cycle.

UNIT-III

Accelerators and Detectors:

Need for accelerators, Ion sources, Drift tube, linear accelerator, cyclotron, synchrocyclotron, Betatron, electron synchrotron, proton synchrotron.

Ionization chamber, Proportional Counter, Geiger Muller Counter, Scintillation counter.

UNIT-IV

Elementary Particle:

Properties of particles. Classification into leptons, mesons and baryons, Matter and antimatter, Conservation laws: (Qualitative discussion) of isospins, strangeness, charge conjugation and parity, Fundamental quark structure of particles.

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MATHEMATICAL PHYSICS - II

Scheme of examination: *MM: 23*

1. *In all five questions are to be answered. There shall be two questions from each unit. A student has to answer one question from each unit. Fifth question will be compulsory and will cover the entire syllabus.*

UNIT-I

Relativistic Electrodynamics:

Law of conservation of charge and equation of continuity. Lorenz transformation of charge and current densities, Lorenz transformation of four potentials, Lorenz transformation of an electric field and magnetic field. Description of Maxwell's equation in tensor form.

UNIT-II

Differential equations of second order and special functions – I:

Linear differential equation with variable coefficient and singular points, series solution method and its application to the Legendre's differential equations, Rodrique's formula, Integral properties of Legendre's polynomials, generating functions of $P_n(x)$, Recurrence relations of $P_n(x)$, Associated Legendre's polynomials graphical representations.

UNIT-III

Differential equations of second order and special functions – II:

Hermite differential equation, generating functions of Hn(x), Recurrence relations of Hn(x), Orthogonality relation for Hermite equation, Laguerre differential equation, generating functions of Laguerre polynomials, Recurrence relations of $L_n(x)$, Rodrique's formula for $L_n(x)$, Orthogonality relation for Laguerre polynomials. Associated Laguerre equations.

UNIT-IV

Boundary value problems:

Techniques of separation of variables and its application to the following boundary value problems (i) Laplace's equation in three dimensional Cartesian coordinate system – line charge between two earthed parallel plates, (ii) Helmholtz equation in circular cylindrical coordinates-Cylindrical resonant cavity, (iii) Wave equation in spherical polar coordinates-the vibration of a circular membrane, (iv) Diffusion equation in two dimensional Cartesian coordinate system-heat conduction in a thin rectangular plate, (v) Laplace's equation in spherical coordinate system-electric potential around a spherical surface.

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ELEMENTARY QUANTUM MECHANICS AND SPECTROSCOPY - II

Scheme of examination: *MM: 23*

1. *In all five questions are to be answered. There shall be two questions from each unit. A student has to answer one question from each unit. Fifth question will be compulsory and will cover the entire syllabus.*

UNIT-I

Simple solution of Schrodinger's equation:

Time independent Schrodinger equation and stationary state solution, boundary and continuity conditions, particle in one dimensional box, eigen function and eigen values, discrete energy levels, generalisation to three dimensions and degeneracy of levels.

UNIT-II

Boundary Value Problems:

Potential steps and rectangular potential barrier, calculation of reflection and transmission coefficients, qualitative discussion of application to alpha-decay; Square well potential problem, reflection and transmission coefficient, and resonant scattering; Particle in one dimensional infinite potential well and finite potential well, energy eigen values and eigen functions, transcendental equation and its solution.

UNIT-III

Simple harmonic oscillator:

Simple harmonic oscillator (one dimensional case) Schrodinger equation and its solution, eigen function, energy eigen values, zero point energy; Parity-symmetric and anti-symmetric wave functions with graphical representation; Expectation values of x, x^2, Px, P^2x and T for one

dimensional SHO in ground state. Orthogonality of Eigen functions for one dimensional SHO.

UNIT-IV

Orbital Angular Momentum and Spin:

Orbital angular momentum and quantisation, spherical harmonics, energy levels of H-atom, shapes of n=l, and n=2 wave functions, average value of radius of H-atom, comparison with Bohr model and Bohr correspondence principle, Stern-Gerlach experiment, spin and magnetic moment, spin orbit coupling and qualitative explanation of the fine structure; Atoms in a magnetic field, Zeeman splitting.

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SOLID STATE PHYSICS

Scheme of examination: *MM: 24*

1. *In all five questions are to be answered. There shall be two questions from each unit. A student has to answer one question from each unit. Fifth question will be compulsory and will cover the entire syllabus.*

UNIT-I

Crystal structure and Crystal Differection:

Various types of binding; Cohesive energy and compressibility of ionic crystals; lattice basis, lattice translation vector, Miller indices, simple crystal structures-SC, FCC, BCC and HCP, packing fraction, volume of unit cell. Bragg's Law, X – ray and neutron differection Rotating crystal method, Laue method and powder method.

UNIT-II

Electrical properties:

Equilibrium state of electron gas in a conductor in the absence of electric field, electron drift in an electric field, relaxation time and mean free path; Electrical conductivity of electron gas, Wiedemann- Franz-Lorentz law, temperature dependent electrical conductivity of metals, mobility and drift motion.

UNIT-III

Magnetic Properties:

Classification of magnetic materials, diamagnetism, paramagnetism due to free ions and conduction electrons, Curie law. Ferromagnetism, nature and origin of Wiess molecular field, Domains, Hysteresis loop, Outline of antiferromagnetism and ferrimagnetism, ferrites.

UNIT-IV

Thermal Properties and Superconductivity:

Normal modes spectrum of a lattice, spectral distribution function, concept of phonons, Debye model for the heat capacity of solids, contribution from electron gas in metals, Zero resistivity, critical temperature, critical magnetic field, Meissonier effect. Type-I and Type-II superconductors, BCS theory (Basic idea). High Tc superconductors .

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CLASSICAL MECHANICS

Scheme of examination: *MM: 70*

1. *In Semester End Examination there will be 5 questions in each paper. All questions are compulsory and of 14 mark each. Candidate has to answer all questions in the main answer book only.*
2. *Q. No. 1 shall be of short answer type, compulsory, and covering entire syllabus.*
3. *Each paper is divided in four units. There will be two questions from each unit. Student has to answer one question from each unit.*

Unit – I

Holonomic and non-holonomic constraints: D-Alembert's Principle, Generalized coordinates, lagrangian, lagrange's equation and its application, velocity dependent potential in lagrangian formulation. Generalized momentum, legendre transformation, Hamiltonian, Hamiltonian's canonical Equation.

Unit - II

Calculus of variational principle, derivation of lagrange's and Hamilton,. Canonical equation from Hamilton's variational principle. Extension of Hamiltons principle for nonconservative and nonholonomic system, Method of lagrange's multipliers, 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.

Unit - III

Canonical transformation, integral invariant of poincare: Lagrange's and Poisson brackets as canonical invariants, equation of motion in Poisson

bracket formulation . Infinitesimal contact transformation and generation of symmetry, louvilee's theorem, Hamilton-Jacobi equation and its application.

Unit - IV

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, Euler's theorem, Eigen values of the inertia tensor, Euler equations, force free motion of a rigid body.

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CLASSICAL ELECTRODYNAMICS- I

Scheme of examination: *MM: 70*

1. *In Semester End Examination there will be 5 questions in each paper. All questions are compulsory and of 14 mark each. Candidate has to answer all questions in the main answer book only.*
2. *Q. No. 1 shall be of short answer type, compulsory, and covering entire syllabus.*
3. *Each paper is divided in four units. There will be two questions from each unit. Student has to answer one question from each unit.*

Unit – I

Electrostatics: Electric field, Gauss's Law, Differential form of Gaussian 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 the Dirchlet or Neumann boundary Conditions, Formal Solutions 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 presence of a charged insulated conducting sphere, point charge near a conducting sphere at a fixed potential, conducting sphere in a uniform electric field by method of images, Green function for the sphere, General solution for the potential, conducting sphere with hemisphere at a different potential, orthogonal functions and expansion.

Unit - II

Multipoles, electrostatics of Macroscopic Media, Dielectric: Multipole expansion, multipole expansion of the energy of a charge distribution in an external field, Elementary treatment of electrostatics with ponderable media. Boundary value problems with dielectrics. Molar polarizability and electric susceptibility. Models for molecular polarizability, electrostatic energy in dielectric media.

Unit - III

Magnetostatics: Introduction and definition, Biot and Savart Law, the differential equations of magnetostatics and Ampere's law, Vector potential and magnetic induction for a current loop, Magnet field of a localized current distribution, Magnetic moment, Force and torque on and energy of a localized current distribution in an external induction, Macroscopic equations, Boundary conditions on B and H methods of solving Boundary 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 - IV

Time varying field, Maxwell's equations conservation laws: Energy in a magnetic field, vector and scalar potentials, Gauge transformations, Lorentz gauge, Coloumb gauge, Green function for the wave equation, Derivation of the equations of Macroscopic Electromagnetism, Poynting's Theorem and conservation of energy and momentum for a system of charged particles and EM fields. Conservation laws for macroscopic media. Electromagnetic field tensor, transformation of four potential and four currents, tensor dissipation of Maxwell's equations.

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QUANTUM MECHANICS

Scheme of examination: *MM: 70*

1. *In Semester End Examination there will be 5 questions in each paper. All questions are compulsory and of 14 mark each. Candidate has to answer all questions in the main answer book only.*
2. *Q. No. 1 shall be of short answer type, compulsory, and covering entire syllabus.*
3. *Each paper is divided in four units. There will be two questions from each unit. Student has to answer one question from each unit.*

Unit - I

(a) States, Amplitude and Operators: States of a quantum mechanical system, representation of quantum-mechanical states, properties of quantum mechanical amplitude, operators and change of a state, a complete set of basis states, products of linear operators, language of quantum mechanics, postulates, essential definition and commutation relations.

(b) Observables and Description of Quantum system: Process of Measurement, expectation values, time dependence of quantum mechanical amplitude, observable with no classical analogue, spin dependence of quantum mechanical amplitude on position, the wave function, super position of amplitudes, identical particles.

Unit - II

Hamiltonian matrix and the time evolution of Quantum mechanical States: Permittivity 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 system.

Unit - III

Transition between stationary state: Transitions in a two state system, time dependent 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.

The co-ordinate Representation: Compatible observables, quantum conditions and uncertainty relation, Coordinate representation of operators, position, momentum and angular momentum, time dependence of expectation values, The Ehernfest Theorem, the time evolution of wave function, the Schrödinger equation, energy quantization, periodic potential as an example.

Unit - IV

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 conservation of momentum, energy and angular momentum.
b. Angular momentum operators and their Eigen values, matrix representation of the angular momentum operators and their eigen states, coordinate representations of the orbital angular momentum operators and their eigen state (Spherical Harmonics), composition of angular momenta, Clebsch-Gordon Coefficient, tensor operators and Wigner Expart theorem, commutation relations of J_x, J_y, J_z with reduced tensor operator, matrix elements of vector operators, time reversal invariance and vanishing of static electric dipole moment of stationary state.

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ELECTRONICS

Scheme of examination: *MM: 70*

1. *In Semester End Examination there will be 5 questions in each paper. All questions are compulsory and of 14 mark each. Candidate has to answer all questions in the main answer book only.*
2. *Q. No. 1 shall be of short answer type, compulsory, and covering entire syllabus.*
3. *Each paper is divided in four units. There will be two questions from each unit. Student has to answer one question from each unit.*

Unit - I

Operational Amplifiers: Differential amplifier – circuit configuration – dual input, balanced output differential amplifier, DC analysis – AC analysis, inverting and non-inverting inputs, CMRR – constant current bias level translator. Block diagram of 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; 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 response. DC and AC 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 generator, clamping and

clipping. Voltage regulators –fixed regulators, adjustable voltage regulators, switching regulators.

Unit - III

Digital Electronics: Combinational logic: The transistor as a switching, circuits, realization of OR, AND, OR, NOR NAND gates, Exclusive OR gate, Boolean algebra – De-Morgan Theorem, Adder, subtractor, comparator, decoder/demultiplexer Data selector/Multiplexer, encoder. Sequential logic: Flip-Flops: one bit memory, the RS flip-flop, J flip flop, JK master slave flip-flops, T flip flop, D flip flop, shift registers – synchronous and asynchronous counters, cascade counters, binary counter, decade counter, Ring counters.

Unit – IV

Microprocessors: Introduction to microcomputers: Memory – input/output- interfacing device 8085, CPU – Architecture – BUS timings, Demultiplexing the address bus generating control signals – Instruction set – addressing modes – Illustrative programmes – writing Assembly language programmes looping, counting and indexing – counter and timing delays- stack and subroutine.

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MATHEMATICAL METHODS IN PHYSICS

Scheme of examination: *MM: 70*

1. *In Semester End Examination there will be 5 questions in each paper. All questions are compulsory and of 14 mark each. Candidate has to answer all questions in the main answer book only.*
2. *Q. No. 1 shall be of short answer type, compulsory, and covering entire syllabus.*
3. *Each paper is divided in four units. There will be two questions from each unit. Student has to answer one question from each unit.*

UNIT I

Coordinate transformation in N-dimesional space: Contravariant and covariant tensor, Jacobian. Relative tensor, pseudo tensors (Example: change density, angular momentum) Algebra of tensors, Metric tensor, Associated tensors, Reimann space (Example: Euclidean space and 4-D Minkowski space), Christoffel symbols, transformation of Christoffel symbols,

Covariant differentiation. Ricci's theorem, Divergence, Curl and Laplacian tensor form. Stress and Strain tensors, Hook's law in tensor form. Lorentz covariance of Maxwell equation. Klein Gordon and Dirac equation, Test of covariance of Schrodinger equation.

UNIT II

Group of transformations. (Example: symmetry transformation of square), Generators of a finite group, Normal subgroup, Direct product of groups. Isomorphism and Homomorphism. Representation theorem 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.

UNIT III

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 terms of spectral density for quasi-monochromatic EM waves, momentum representation. Application of Fourier Transform to differaction theory; diffraction pattern of one and two slits.

UNIT IV

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

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CLASSICAL ELECTRODYNAMICS

Scheme of examination: *MM: 70*

1. *In Semester End Examination there will be 5 questions in each paper. All questions are compulsory and of 14 mark each. Candidate has to answer all questions in the main answer book only.*
2. *Q. No. 1 shall be of short answer type, compulsory, and covering entire syllabus.*
3. *Each paper is divided in four units. There will be two questions from each unit. Student has to answer one question from each unit.*

UNIT I

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

UNIT II

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.

UNIT III

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 Potential 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.

UNIT IV

Radiation damping, self fields of a particle, scattering and absorption of radiation by a bound system: Introductory considerations, Radiative reaction force from conservation of energy, Abraham 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.

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ATOMIC AND MOLECULAR PHYSICS

Scheme of examination: *MM: 70*

1. *In Semester End Examination there will be 5 questions in each paper. All questions are compulsory and of 14 mark each. Candidate has to answer all questions in the main answer book only.*
2. *Q. No. 1 shall be of short answer type, compulsory, and covering entire syllabus.*
3. *Each paper is divided in four units. There will be two questions from each unit. Student has to answer one question from each unit.*

UNIT I

Hydrogen Atom: Gross structure energy spectrum, 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 qualitative description)

UNIT II

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 III

Systems with Identical Particles: Indistinguishability and exchange symmetry, many particle wave functions and Pauli's exclusion principle, spectroscopic terms for atoms.

The Helium atom, Variation method and its use in the calculation of ground state and excited state energy, Helium atom. The ground state of Hydrogen molecule, Hitler-London method for H_2 molecule, WKB method for one dimensional problem, application to bound states (Bohr-Sommerfield quantization) and the barrier penetration (alpha decay problems).

UNIT IV

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, 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.

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NUMERICAL METHODS AND COMPUTER PROGRAMMING

Scheme of examination: *MM: 70*

1. *In Semester End Examination there will be 5 questions in each paper. All questions are compulsory and of 14 mark each. Candidate has to answer all questions in the main answer book only.*
2. *Q. No. 1 shall be of short answer type, compulsory, and covering entire syllabus.*
3. *Each paper is divided in four units. There will be two questions from each unit. Student has to answer one question from each unit.*

UNIT I

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, Hermite interpolation and Spline interpolation, Solution of Linear equations, Direct and Iterative methods, Calculation of eigen values and eigen vectors for symmetric matrices.

UNIT II

Solution of Nonlinear equations: 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.

UNIT III

Integration of a function: Trapezoidal and Simpson's rules. Gaussian quadrature formula, Singular integrals, Double integration. Integration of Ordinary differential equations: Predictor - corrector methods, Runga-Kutta

method, Simultaneous and Higher order equations.Numerical Integration and Differentiation of Data, Least-Squares Approximations, Fast FourierTransform.

UNIT IV

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. Fortran 77: Variables, Expressions, jumping. Branching and looping statements, Input / Output statement, Statement for handling Input / Output Files, Subroutine, External Function, Special statements: COMMON, ENTRY, FORMAT, PAUSE, EQUIVALENCE. Programming of simple problems involving use of interpolation differentiation, Integration, matrix inversion and least square analysis.

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ADVANCED QUANTUM MECHANICS

Scheme of examination: *MM: 70*

1. *In Semester End Examination there will be 5 questions in each paper. All questions are compulsory and of 14 mark each. Candidate has to answer all questions in the main answer book only.*
2. *Q. No. 1 shall be of short answer type, compulsory, and covering entire syllabus.*
3. *Each paper is divided in four units. There will be two questions from each unit. Student has to answer one question from each unit.*

Unit - I

Scattering (non-relativistic): Differential and total scattering cross section, transformation from CM frame to Lab frame, solution of scattering problem by the method of partial wave analysis, expansion of a plane wave into a spherical wave and scattering amplitude, the optical theorem, Applications-scattering from a delta potential, square well potential and the hard sphere scattering of identical particles, energy dependence an resonance scattering, Brit-Winger formula, quasi Stationary states.

The Lippman-Schwinger equation and the Green's functions approach for scattering problem, Born approximation and its validity for scattering problem, Coulomb scattering problem under first Born approximation in elastic scattering.

Unit - II

Relativistic Formulation ad Dirac, Equation: Attempt for relativistic formulation of quantum theory, the Klein-Gordon equation, Probability density and probability current density, solution free particle KG equation

in momentum representation, interpretation of negative probability density and negative energy solutions.

Dirac equation for a free particle, properties of Dirac matrices and algebra of gamma matrices, non-relativistic correspondence of the Pauli equation (inclusive of electromagnetic interaction). Solution of the free particle Dirac equation, orthogonality and completeness relations for Dirac spinors, interpretation of negative energy solution and hole theory.

Unit - III

Symmetries of Dirac Equation: Lorentz covariance of Dirac equation, proof of covariance and derivation of Lorentz boost and rotation matrices for Dirac spinors, Projection operation involving four momentum and spin, Parity (P), charge conjugation (C), time reversal (T) and CPT operators for Dirac spinors. Billinear covariant, and their transformations, behaviors under Lorentz transformation, P, C, T and CPT, expectation values of coordinates and velocity involving only positive energy solution and the associated problems, inclusion of negative energy solution, Zitterbewegung, Klain paradox.

Unit - IV

the Quantum Theory of Radiation: Classical radiation field, Transversality condition, Fourier decomposition and radiation oscillators, Quantization of radiation oscillator, creation, annihilation and number operators, photon states, photon as a quantum mechanical excitations of the radiation field, fluctuations and the uncertainty relation, validity of the classical description, matrix element for emission and absorption, spontaneous emission in the dipole approximation, Raleigh scattering, Thomson scattering and the Raman effect, Radiation damping and Resonance fluorescence.

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NUCLEAR PHYSICS - I

Scheme of examination: *MM: 70*

1. *In Semester End Examination there will be 5 questions in each paper. All questions are compulsory and of 14 mark each. Candidate has to answer all questions in the main answer book only.*
2. *Q. No. 1 shall be of short answer type, compulsory, and covering entire syllabus.*
3. *Each paper is divided in four units. There will be two questions from each unit. Student has to answer one question from each unit.*

Unit - I

Two Nucleon system and Nuclear forces: General nature of the force between nucleons, saturation of nuclear forces, charge independence and spin dependence, General forms of two nucleon interaction, Central, non-central and velocity dependent potential, Analysis of the ground state (3S1) of deuteron using a square well potential, range-depth relationship, exited states of deuteron, discussion of the ground state of deuteron under non-central force, calculation of the electric quadrupole and magnetic dipole moments and the D-state admixture.

Unit - II

Nucleon-Nucleon Scattering and Potential: partial wave analysis of the neutron – proton scattering at low energy assuming central potential with square well shape, concept of the scattering length, coherent scattering of neutrons by protons in (ortho and para), hydrogen molecule; conclusions of these analysis regarding scattering lengths, range and depth of the potential; the effective range theory (in neutron –proton scattering) and the shape independence of the nuclear potential; A qualitative discussion of proton-

proton scattering at low energy; General feature of two – body scattering at high energy, effect of exchange force. Phenomenological Hamada-Johnston hard-core potential and Reid hard-core and soft-core potentials; Main features of the one Boson exchange potential (OBEP) no derivation.

Unit - III

Interaction of radiation and charged particle with matter (Not derivation) : Law of absorption and attenuation coefficient photoelectric effect, Compton, scattering, pair production; Klein-Nishina cross sections for polarized and unpolarized radiation angular distribution of scattering photon and electrons, energy loss of charged particles due to ionization , Bremstrahlung; energy target and projectile dependence of all three processes, range- energy curve; straggling.

Unit - IV

Experimental Techniques: Gas filled counters; Scintillation counter; Cerenkov counter; Solids state detectors; Surface barrier detectors; electronic circuits used with typical nuclear detector; Nuclear emulsions, techniques of measurement and analysis of tracks; proton synchrotron, Linear accelerators; Acceleration of heavy ions.

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STATISTICAL AND SOLID STATE PHYSICS

Scheme of examination: *MM: 70*

1. *In Semester End Examination there will be 5 questions in each paper. All questions are compulsory and of 14 mark each. Candidate has to answer all questions in the main answer book only.*
2. *Q. No. 1 shall be of short answer type, compulsory, and covering entire syllabus.*
3. *Each paper is divided in four units. There will be two questions from each unit. Student has to answer one question from each unit.*

Unit - I

Basic principles, Canonical and Grand Canonical ensembles: Concept of statistical distribution. Phase space, density of states, Liouville's theorem, systems and ensembles, entropy in statistical mechanics Connection between thermodynamic and statistical quantities micro canonical ensemble, equation of state, specific hear and entropy of a perfect gas using micro canonical ensemble.

Canonical ensemble, thermodynamic functions for canonical ensemble, calculation of mean values, energy fluctuation in a gas, grand canonical ensemble, thermodynamic functions for the grand canonical ensemble, density fluctuations.

Unit - II

Partition function and Statistics: Partition function and properties, partition function for an ideal gas and calculation of thermodynamic quantities, Gibbs paradox, validity of classical approximation, determination of translational, rotational an vibrational contributions to the

partition function of an ideal diatomic gas. Specific heat of a diatomic gas, ortho and para hydrogen.

Identical particles and symmetry requirement, difficulties with Maxwell-Bolzman statistics, quantum distribution function, Bose Einstein and Fermi-Dirac statistics and Plank's formula, Bose Einstein condensation, liquid He4 as a Boson system, quantization of harmonic oscillator and creation and annihilation of phonon operators, quantization of fermion operators.

Unit - III

Theory of metals: Fermi-Dirac distribution function, density of states, temperature dependence of Fermi energy, specific heat, use of Fermi-Dirac statistics in the calculation of thermal conductivity and electrical conduction band, Drude theory of light, absorption in metals.

Unit - IV

Band Theory: Block theorem, Kronig Penny model, and effective mass of electron, Wigner-Seitz approximation, NFE model, tight binding method and calculation of density for a band in simple cubic lattice, pseudo potential method.

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M.Sc Semester III Physics Paper IV P C 12-3184

ELECTRONICS AND COMMUNICATION - I

Scheme of examination: *MM: 70*

1. *In Semester End Examination there will be 5 questions in each paper. All questions are compulsory and of 14 mark each. Candidate has to answer all questions in the main answer book only.*
2. *Q. No. 1 shall be of short answer type, compulsory, and covering entire syllabus.*
3. *Each paper is divided in four units. There will be two questions from each unit. Student has to answer one question from each unit.*

Unit - I

Field distribution in rectangular waveguide in TE and TM modes, Phase velocity, Group velocity, Characteristic impedance, wall current, cylindrical cavity resonators and their excitation techniques, Scattering matrix for Microwave Tees and hybrid junction directional coupler, Construction and working of precision attenuator and phase shifter.

Unit - II

Microwave propagation in ferrites, Faraday rotation, Microwave devices employing Faraday rotation: Gyrator, Isolator and Circulator,
Solid state devices: Avalanche transit time devices: Read diode, negative resistance of an avalanching p-n junction diode,
Transferred electron devices: Gunn effect, two valley model, High field domains, Different modes for microwave generation,
Parametric devices: Varactor, Nonlinear reactance and Manley- Rowe power relations, Parametric Up-converter amplifier and its noise properties.

Unit - III

Power Electronics: Characteristics of power diodes, power transistor, TRIAC and DIAC. SCR: Construction and its characteristics, simple firing circuit using UJTs. Controlled rectifiers: Single and three phase half wave and full wave controlled rectifiers. Commutation Circuits: Line commutation and different commutation circuits, Inverters: Single phase tapped and bridge inverter circuits, Basic chopper circuits, 2 and 4 quadrant choppers. Principle of operation of cycloconverter.

Unit - IV

Microwave Measurements: Power, frequency, attenuation and VSWR measurements, Return loss measurement, Concept of Smith chart and its use in impedance measurement, Microwave antenna measurement, measurement of dielectric properties of a solid materials using wave guide method.

Measurement devices: Digital voltmeter- ramp type and integrating type, Measurement of time, phase, frequency using digital instruments, Q meter, Transducers as input elements to instrumentation systems: Classification, constructional and operational features, strain gauges, displacement, velocity, force, torque and pressure transducers.

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INTRODUCTORY QUANTUM FIELD THEORY

Scheme of examination: *MM: 70*

1. *In Semester End Examination there will be 5 questions in each paper. All questions are compulsory and of 14 mark each. Candidate has to answer all questions in the main answer book only.*
2. *Q. No. 1 shall be of short answer type, compulsory, and covering entire syllabus.*
3. *Each paper is divided in four units. There will be two questions from each unit. Student has to answer one question from each unit.*

Unit - I

Scalar and vector fields, Classical Lagrangian field theory, Euler-Lagrange's equation, Lagrangian density for electromagnetic field. Occupation number representation for simple harmonic oscillator, linear array of coupled oscillators, second quantization, of identical bosons, second quantization of the real Klein Gordan field and complex Klein-Gordan field, the meson propagator.

UNIT II

The occupation number representation for fermions, second quantization of the Dirac field, the fermion propagator, the em interaction and gauge invariance, covariant quantization of the free electromagnetic field, the photon propagator.

UNIT III

S-matrix, the S-matrix expansion, Wick's theorem, Diagrammatic representation in configuration space, the momentum representation, Feynman diagrams of basic processes, Feynman rules of QED.

UNIT IV

Applications of S - matrix formalism: the Coulomb scattering, Bhabha scattering, Moller scattering, Compton scattering and pair production.

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NUCLEAR PHYSICS - II

Scheme of examination: *MM: 70*

1. *In Semester End Examination there will be 5 questions in each paper. All questions are compulsory and of 14 mark each. Candidate has to answer all questions in the main answer book only.*
2. *Q. No. 1 shall be of short answer type, compulsory, and covering entire syllabus.*
3. *Each paper is divided in four units. There will be two questions from each unit. Student has to answer one question from each unit.*

UNIT - I

Nuclear shell model: Single particle and collective model in nuclei: Assumptions and justification of the shell model, average shell potential, spin orbit coupling; single particle wave functions and level sequence; magic numbers; shell model predictions for ground state parity; angular momentum, magnetic dipole and electric-quadrupole moments; and their comparison with experimental data; configuration mixing; single particle transition probability according to the shell model; selection rules; approximate estimates for the transition probability and Weisskopf units: Nuclear isomerism.

UNIT II

Collective nuclear models: Collective variable to describe the cooperative modes of nuclear motion; Parametrization of nuclear surface; A brief description of the collective model Hamiltonian (in the quadratic approximation); Vibrational modes of a spherical nucleus, Collective modes of a deformed even-even nucleus and moments of inertia; Collective spectra and electromagnetic transition in even nuclei and comparison with

experimental data; Nilsson model for the single particle states in deformed nuclei.

UNIT III

Nuclear gamma and beta decay: Electric and magnetic multipole moments and gamma decay probabilities in nuclear system (no derivations) Reduced transition probability, Selection rules; internal conversion and zero-zero transition.

General characteristics of weak interaction; nuclear beta decay and lepton capture; electron energy spectrum and Fermi- Kurie plot; Fermi theory of beta decay (parity conserved selection rules Fermi and Gamow-Teller) for allowed transitions; ft-values; General interaction Hamiltonian for beta decay with parity conserving and non conserving terms; Forbidden transitions, Experimental verification of parity violation; The V-A interaction and experimental verification

UNIT IV

Nuclear Reactions: Theories of Nuclear Reactions; Partial wave analysis of reaction Cross section; Compound nucleus formation and breakup, Resonance scattering and reaction- Breit-Wigner dispersion formula for S-waves (l= 0), continuum cross section; statistical theory of nuclear reactions, evaporation probability and cross section for specific reactions; The optical model, Stripping and pick-up reactions and their simple theoretical description (Butler theory) using plane wave Born approximation (PWBA) Shortcomings of PWBA Nuclear structure studies with deutron stripping (d,p) reactions.

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SOLID STATE PHYSICS

Scheme of examination: *MM: 70*

1. *In Semester End Examination there will be 5 questions in each paper. All questions are compulsory and of 14 mark each. Candidate has to answer all questions in the main answer book only.*
2. *Q. No. 1 shall be of short answer type, compulsory, and covering entire syllabus.*
3. *Each paper is divided in four units. There will be two questions from each unit. Student has to answer one question from each unit.*

UNIT I

Lattice dynamics and optical properties of solids: Interatomic forces and lattice dynamics and simple metals, ionic and covalent crystals, optical phonons and dielectric constants, Inelastic neutron scattering. Mossbauer effect. Debye-Waller factor, Anharmonicity, thermal expansion and thermal conductivity. Interaction of electrons and phonons with photons, Direct and indirect transitions Absorption in insulators, polarizations, one-phonon absorption, Optical properties of metals, skin effect and anomalous skin effect.

UNIT II

Semiconductors: law of mass action, doping of semiconductors, calculation of impurity conductivity, ellipsoidal energy surfaces in Si and Ge, Hall effect, recombination mechanism, optical transitions and Schockley-Read theory, excitations, photoconductivity, photo-Luminescence. Measurement of bandgap in semiconductors, the infrared absorption.

UNIT III

Magnetism: Larmor diamagnetism. Paramagnetism, Curie Langevin and Quantum theories. Susceptibility of rare earth and transition metals. Ferromagnetism: Domain theory, Weiss molecular field and exchange, spin waves: dispersion relation and its experimental determination by inelastic neutrons scattering, heat capacity. Nuclear Magnetic resonance: Conditions of resonance, Bloch equations. NMR-experiment and characteristics of an absorption line.

UNIT IV

Superconductivity: (a) Experimental results: Meissner effect, heat capacity, microwave and infrared properties, isotope effect, flux quantization, ultrasonic attenuation, density of states, nuclear spin relaxation, Giaver and AC and DC, Josephson tunneling. (b) Cooper pairs and derivation of BCS Hamiltonian, results of BCS theory (no derivation).

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M.Sc Semester IV Physics Paper IV P C 12-4184

ELECTRONICS AND COMMUNICATION

Scheme of examination: *MM: 70*

1. *In Semester End Examination there will be 5 questions in each paper. All questions are compulsory and of 14 mark each. Candidate has to answer all questions in the main answer book only.*
2. *Q. No. 1 shall be of short answer type, compulsory, and covering entire syllabus.*
3. *Each paper is divided in four units. There will be two questions from each unit. Student has to answer one question from each unit.*

UNIT I

Conventional Microwave sources: Two cavity Klystron, Reflex Klystron, their working and efficiency. Magnetron and its operating characteristics, Hull cut-off condition. Introduction to Gyratron and Travelling wave tubes, their construction and working. Introduction to antenna parameters. Electromagnetic horn antennas. Introduction to microstrip patch antennas and array antennas.

UNIT II

Optical Fiber Communication: Principles of light propagation in fibers, step and graded index fibers, mono mode & multimode fibers, transmission losses, fiber attenuation, bandwidth, power & cut-off wavelength, multiplexing in fibers.

Microwave communication: LOS microwave systems, Derivation of communication range, OTH microwave systems, Derivation of field strength of troposphere waves. Introduction to RADAR, Satellite and Mobile communications.

UNIT III

Digital communication: Principles of Digital communication, Pulse modulation systems, Sampling Theorm, Low pass and Band pass Signals. PAM. Channel BW for a PAM signal. Natural sampling. Signal recovery through holding. Quantization of signals. Quantization. Differential pulse code modulation PCM, Delta modulation, Adaptive delta modulation, Noise in pulse code and delta modulation systems. CVSD. Various digital modulation techniques.

UNIT IV

Microprocessor interfacing and application: Basic Interfacing Concepts & Peripherals, Memory mapped and Peripherals mapped I/O. Description, programming & interfacing of 8155, 8255, 8253, 8259, 8279 with 8085. Direct memory access: Basic concepts, DMA techniques. A/D and D/A converters, Serial I/O & Bus standards: Interfacing of AD558, AD7522, ADC0801, 0808 with 8085. Basic concepts in serial I/O, software controlled serial I/O, RS 232C standard, data communication buses-S-100 bus, IEE488 bus and CAMAC standard.

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