Shri Vishwanath P. G. College Kalan, Sultanpur

(Affiliated)

DR. RAM MANOHAR LOHIA AVADH UNIVERSITY, AYODHYA

Structure of Syllabus for the Program: B.Sc.

Subject: PHYSICS

SEMESTER-WISETITLESOFTHEPAPERSINUGPHYSICSCOURSE					
YEAR	**SEME-STER**	**COURSE CODE**	**PAPER TITLE**	**THEORY/ PRACTICAL**	**CREDIT**
CERTIFICATE **IN BASIC PHYSICS & SEMICONDUCTOR DEVICES**					
FIRST YEAR	**I**	B010101T	Mathematical Physics & Newtonian Mechanics	Theory	4
		B010102P	Mechanical Properties of Matter	Practical	2
	II	B010201T	Thermal Physics & Semiconductor Devices	Theory	4
		B010202P	Thermal Properties of Matter & Electronic Circuits	Practical	2
DIPLOMA **IN APPLIED PHYSICS WITH ELECTRONICS**					
SECOND YEAR	**III**	B010301T	Electromagnetic Theory & Modern Optics	Theory	4
		B010302P	Demonstrative Aspects of Electricity & Magnetism	Practical	2
	IV	B010401T	Perspectives of Modern Physics & Basic Electronics	Theory	4
		B010402P	Basic Electronics Instrumentation	Practical	2
DEGREE **IN BACHELOR OF SCIENCE**					
THIRD YEAR	**V**	B010501T	Classical & Statistical Mechanics	Theory	4
		B010502T	Quantum Mechanics & Spectroscopy	Theory	4
		B010503P	Demonstrative Aspects of Optics & Lasers	Practical	2
	VI	B010601T	Solid State & Nuclear Physics	Theory	4
		B010602T	Analog & Digital Principles & Applications	Theory	4
		B010603P	Analog & Digital Circuits	Practical	2

Semester I

Theoretical Paper

B010101T: Mathematical Physics & Newtonian Mechanics

PART-A (Basic Mathematical Physics)

Unit -I

Vector Algebra:
Coordinate rotation, reflection and inversion as the basis for defining scalars, vectors, pseudo- scalars and pseudo-vectors (include physical examples). Component form in 2D and 3D. Geometricalandphysicalinterpretationofaddition,subtraction,dotproduct,wedgeproduct,cross Product and triple product of vectors. Position, separation and displacement vectors.

Unit -II

Vector Calculus:
Geometrical and physical interpretation of vector differentiation, Gradient, Divergence and Curl and their significance. Vector integration, Line, Surface (flux) and Volume integrals of vector fields. Gradient theorem, Gauss-divergence theorem, Stoke-curl theorem, Greens theorem and Helmholtz theorem (statement only). Introduction to Dirac delta function.

Unit -III

Co-ordinate Systems:
2D & 3D Cartesian, Spherical and Cylindrical coordinate systems, basis vectors, transformation equations. Expressions for displacement vector, arc length, area element, volume element, gradient, divergence and curl in different coordinate systems. Components of velocity and acceleration in different coordinate systems. Examples of non-inertial coordinate system and pseudo-acceleration.

Unit -IV

Introduction to Tensors:
Principle of invariance of physical laws w.r.t. different coordinate systems as the basis for defining tensors. Coordinate transformations for general spaces of nD, contravariant, covariant & mixed tensors and their ranks, 4-vectors. Index notation and summation convention. Symmetric and skew- symmetric tensors. Invariant tensors, Kronecker delta and Epsilon (Levi Civita) tensors. Examples of tensors in physics.

PART-B (Newtonian Mechanics & Wave Motion)

Unit –V

Dynamics of a System of Particles:
Review of historical development of mechanics up to Newton. Background, statement and critical analysis of Newton's axioms of motion. Dynamics of a system of particles, centre of mass motion, and conservation laws &their deductions. Rotating frames of reference, general derivation of origin of pseudo forces (Euler, Coriolis & centrifugal) in rotating frame, and effects of Coriolis force.

Unit –VI

Dynamics of a Rigid Body:

Angular momentum, Torque, Rotational energy and the inertia tensor. Rotational inertia for simple bodies (ring, disk, rod, solid and hollow sphere, solid and hollow cylinder, rectangular lamina). The combined translational and rotational motion of a rigid body on horizontal and inclined planes. Elasticity, relations between elastic constants, bending of beam and torsion of cylinder.

Unit-VII

Motion of Planets & Satellites:

Two particle central force problem, reduced mass, relative and centre of mass motion. Newton's law of gravitation, gravitational field and gravitational potential. Kepler's laws of planetary motion and their deductions. Motions of geo-synchronous geo-stationary satellites and basic idea of Global Positioning System(GPS).

Unit-VIII

Wave Motion:

Differential equation of simple harmonic motion and its solution, use of complex notation, damped and forced oscillations, Quality factor. Composition of simple harmonic motion, Lissajous figures. Differential equation of wave motion. Plane progressive waves in fluid media, reflection of waves and phase change, pressure and energy distribution. Principle of superposition of waves, stationary waves, phase and group velocity.

Reference:

(Part-A)

1. Murray Spiegel,Seymour Lipschutz,Dennis Spellman, "Schaum's Outline Series: Vector Analysis", McGraw Hill, 2017, 2e
2. A.W.Joshi,"MatricesandTensorsinPhysics",NewAgeInternationalPrivateLimited, 1995,3e

(Part-B)

1. Charles Kittel, Walter D. Knight, Malvin A. Ruderman, Carl A. Helmholz, Burton J. Moyer, "Mechanics (In SI Units): Berkeley Physics Course Vol 1", McGraw Hill, 2017, 2e
2. RichardP.Feynman,RobertB.Leighton,MatthewSands,"TheFeynmanLecturesonPhysics-Vol.1", Pearson Education Limited, 2012
3. HughD.YoungandRogerA.Freedman,"Sears&Zemansky'sUniversityPhysicswithModernPhysics", Pearson Education Limited, 2017, 14e
4. D.S.Mathur,P.S.Hemne,"Mechanics",S.ChandPublishing,1981,3e

Practical

B010102P: Mechanical Properties of Matter

Lab Experiment List:

1. Moment of inertia of a flywheel
2. Moment of inertia of an irregular body by inertia table
3. Modulus of rigidity by statistical method (Barton's apparatus)
4. Modulus of rigidity by dynamical method (sphere/disc/Maxwell's needle)
5. Young's modulus by bending of beam.
6. Young's modulus and Poisson's ratio by Searle's method.
7. Poisson's ratio of rubber by rubber tubing.
8. Surface tension of water by capillary rise method.
9. Surface tension of water by Jaeger's method.
10. Coefficient of viscosity of water by Poiseuille's method.
11. Acceleration due to gravity by bar pendulum.
12. Frequency of AC mains by Sonometer.
13. Heigh to calculate building by Sextant.
14. Study the wave form of an electrically maintained tuning fork / alternating current source with the help of cathode ray oscilloscope.

Semester II

Theoretical Paper

B010201T: Thermal Physics & Semiconductor Devices

PART-A Thermodynamics & Kinetic Theory of Gases

Unit -I

0^{th}&1^{st}Lawof Thermodynamics:

State functions and terminologyof thermodynamics. Zeroth law and temperature. First law, internal energy, heat and work done. Work done in various thermodynamical processes. Enthalpy, relation between $C_P$and C_V.Carnot'sengine,efficiency and Carnot's theorem. Efficiency of internal Combustion engines (Ottoand diesel).

Unit -II

2^{nd}&3^{rd}Law of Thermodynamics:

Different statements of second law, Clausius inequality, entropy and its physical significance. Entropy changes in various thermo dynamical processes. Third law of thermodynamics and un attainability of absolute zero. Thermo dynamical potentials, Maxwell's relations, conditions for feasibility of a process and equilibrium of a system. Clausius-Clapeyron equation, Joule-Thompson effect.

Unit -III

Kinetic Theory of Gases:

Kinetic model and deduction of gas laws. Derivation of Maxwell's law of distribution of Velocities and its experimental verification. Degrees of freedom, law of equi-partition of energy (no derivation) and its application to specific heat of gases (mono, di and poly atomic).

Unit -IV

Theory of Radiation:

Black body radiation, spectral distribution, concept of energy density and pressure of radiation.
Derivation of Planck's law, deduction of Wien's distribution law, Rayleigh-Jeans law, Stefan- Boltzmann law and Wien's displacement law from Planck's law.

PART-B (Circuit Fundamentals & Semiconductor Devices)

Unit –V

DC & AC Circuits:

Growth and decay of currents in RL circuit. Charging and discharging of capacitor in RC, LC and RCL circuits. Network Analysis - Superposition, Reciprocity, Thevenin's and Norton's theorems. AC Bridges-measurement of inductance (Maxwell's, Owen's and Anderson's bridges) and measurement of capacitance (Schering's,Wein'sanddeSauty'sbridges).

Unit –VI

Semiconductors & Diodes:

P and N type semiconductors, qualitative idea of Fermi level. Formation of depletion layer in PN junction diode, field & potential at the depletion layer. Qualitative idea of current flow mechanism in forward & reverse biased diode. Diode fabrication. PN junction diode and its characteristics, static and dynamic

resistance. Principle, structure, characteristics and applications of Zener, Tunnel, Light Emitting, Point Contact and Photo diodes. Half and Full wave rectifiers, calculation of ripple factor, rectification efficiency And voltage regulation. Basic idea about filter circuits and voltage regulated power supply.

Unit-VII

Transistors:

Bipolar Junction PNP and NPN transistors. Study of CB, CE & CC configurations w.r.t. active, cutoff & saturation regions; characteristics; current, voltage & power gains; transistor currents & relations between them. Idea of base width modulation, base spreading resistance & transition time. DC Load Line analysis and Q-point stabilization. Voltage Divider Bias circuit for CE amplifier. Qualitative discussion of RC coupled amplifier (frequency response not included).

Unit-VIII

Electronic Instrumentation:

Multimeter: Principles of measurement of dc voltage, dc current, ac voltage, ac current and resistance. Specifications of a multimeter and their significance.

Cathode Ray Oscilloscope: Block diagram of basic CRO. Construction of CRT, electron gun, electrostatic focusing and acceleration (no mathematical treatment). Front panel controls, special features of dual trace CRO, specifications of a CRO and the in significance. Applications of CRO to study the waveform and measurement of voltage, current, frequency & phase difference.

Reference:

(Part-A)

1. M.W.Zemansky,R.Dittman,"HeatandThermodynamics",McGrawHill,1997,7e
2. F.W.Sears,G.L.Salinger,"Thermodynamics,Kinetictheory&Statisticalthermodynamics",NarosaPublishing House, 1998
3. EnricoFermi,"Thermodynamics",DoverPublications,1956
4. S.Garg,R.Bansal,C.Ghosh,"ThermalPhysics",McGrawHill,2012,2e

(Part-B)

1. R.L.Boylestad,L.Nashelsky,"ElectronicDevicesandCircuitTheory",Prentice-HallofIndiaPvt.Ltd.,2015, 11e
2. J.Millman,C.C.Halkias,SatyabrataJit,"ElectronicDevicesandCircuits",McGrawHill,2015,4e
3. B.G.Streetman,S.K.Banerjee,"SolidStateElectronicDevices",PearsonEducationIndia,2015,7e
4. J.D.Ryder,"ElectronicFundamentalsandApplications",Prentice-HallofIndiaPrivateLimited,1975,5e
5. S.L.Gupta,V.Kumar,"HandBookofElectronics",PragatiPrakashan,Meerut,2016,43e

Practical

B010202P: Thermal Properties of Matter & Electronic Circuits

Lab Experiment List:

1. Mechanical Equivalent of Heat by Callender and Barne's method.
2. Coefficient of thermal conductivity of copper by Searle's apparatus.
3. Coefficient of thermal conductivity of rubber.
4. CoefficientofthermalconductivityofabadconductorbyLeeandCharlton'sdiscmethod.
5. Value of Stefan's constant.
6. Verification of Stefan's law.
7. Variation of thermo-emf across two junctions of a thermo couple with temperature.
8. Temperature coefficient of resistance by Platinum resistance thermometer.
9. Charging and discharging in RC and RCL circuits.
10. A.C. Bridges: Various experiments based on measurement of L and C.
11. Resonance in series and parallel RCL circuit.
12. Characteristics of PN Junction, Zener, Tunnel, Light Emitting and Photo diode.
13. Characteristics of a transistor (PNP and NPN) in CE,CB and CC configurations.
14. Half wave & full wave rectifiers and Filter circuits.
15. Unregulated and Regulated power supply.
16. Various measurements with Cathode Ray Oscilloscope (CRO).

Semester III

Theoretical Paper

B010301T: Electromagnetic Theory & Modern Optics

PART-A (Electromagnetic Theory)

Unit -I

Electrostatics:

Electric charge & charge densities, electric force between two charges. General expression for Electric field in terms of volume charge density (divergence & curl of Electric field), general expression for Electric potential in terms of volume charge density and Gauss law (applications included). Study of electric dipole. Electric fields in matter, polarization, auxiliary field **D** (Electric displacement), electric susceptibility and permittivity.

Unit -II

Magneto-statics:

Electric current & current densities, magnetic force between two current elements. General expression for Magnetic field in terms of volume current density (divergence and curl of Magnetic field), General expression for Magnetic potential in terms of volume current density and Ampere's circuital law (applications included). Study of magnetic dipole (Gilbert & Ampere model). Magnetic fields in matter, magnetization, auxiliary field **H**, magnetic susceptibility and permeability.

Unit -III

Time Varying Electromagnetic Fields:

Faraday's laws of electromagnetic induction and Lenz's law. Displacement current, equation of continuity and Maxwell-Ampere's circuital law. Self and mutual induction (applications included). Derivation and physical significance of Maxwell's equations. Theory and working of moving coil ballistic galvanometer (applications included).

Unit -IV

Electromagnetic Waves:

Electromagnetic energy density and Poynting vector. Plane electromagnetic waves in linear infinite dielectrics, homogeneous & inhomogeneous plane waves and dispersive & non-dispersive media. Reflection and refraction of homogeneous plane electromagnetic waves, law of reflection, Snell's law, Fresnel's formulae (only for normal incidence & optical frequencies) and Stoke's law.

PART-B (Physical Optics & Lasers)

Unit –V

Interference:

Conditions for interference and spatial & temporal coherence. Division of Wavefront- Fresnel's Biprism and Lloyd's Mirror. Division of Amplitude-Parallel thin film, wedge shaped film and Newton's Ring experiment. Interferometer –Michelson and Fabry-Perot.

Unit –VI

Diffraction:

Distinction between interference and diffraction. Fresnel's and Fraunhofer's class of diffraction. Fresnel's Half Period Zones and Zone plate. Fraunhofer diffraction at a single slit, n slits and Diffracting

Grating. Resolving Power of Optical Instruments-Rayleigh's criterion and resolving Power of telescope, microscope & grating.

Unit-VII

Polarisation:

Polarisation by diachronic crystals, bi-refringence, Nicol prism, retardation plates and Babinet's compensator. Analysis of polarized light. Optical Rotation-Fresnel's explanation of optical Rotation and Half Shade & Biquartz polarimeters.

Unit-VIII

Lasers:

Characteristics and uses of Lasers. Quantitative analysis of Spatial and Temporal coherence. Conditions for Laser action and Einstein's coefficients. Three and four level laser systems (qualitative discussion).

Reference:

(Part-A)

1. D.J.Griffiths,"IntroductiontoElectrodynamics",Prentice-HallofIndiaPrivateLimited,2002, 3e
2. E.M. Purcell, "Electricity and Magnetism (In SI Units): Berkeley Physics Course Vol 2", McGraw Hill, 2017,2e
3. RichardP.Feynman,RobertB.Leighton,MatthewSands,"TheFeynmanLecturesonPhysics-Vol.2", Pearson Education Limited, 2012
4. D.C.Tayal,"ElectricityandMagnetism",HimalayaPublishingHousePvt.Ltd.,2019,4e

(Part-B)

1. FrancisA.Jenkins,HarveyE.White,"FundamentalsofOptics",McGrawHill,2017,4e
2. SamuelTolansky,"AnIntroductiontoInterferometry",JohnWiley&SonsInc.,1973,2e
3. A.Ghatak,"Optics",McGrawHill,2017,6e

Practical

B010302P: Demonstrative Aspects of Electricity & Magnetism

Lab Experiment List:

1. Variation of magnetic field along the axis of single coil.
2. Variation of magnetic field along the axis of Helmholtz coil.
3. Ballistic Galvanometer: Ballistic constant, current sensitivity and voltage sensitivity.
4. Ballistic Galvanometer: High resistance by Leakage method.
5. Ballistic Galvanometer: Lowre sistance by Kelvin's double bridge method.
6. Ballistic Galvanometer: Self inductance of a coil by Rayleigh's method.
7. Ballistic Galvanometer: Comparison of capacitances.
8. Carey Foster Bridge: Resistance per unit length and low resistance.
9. Deflection and Vibration Magnetometer: Magnetic moment of a magnet and horizontal component of earth's magnetic field.
10. Earth Inductor: Horizontal component of earth's magnetic field.

Semester IV

Theoretical Paper

B010401T: Perspectives of Modern Physics & Basic Electronics

PART-A (Perspectives of Modern Physics)

Unit -I

Relativity-Experimental Background:

Structure of space & time in Newtonian mechanics and inertial & non-inertial frames. Galilean transformations. Newtonian relativity. Galilean transformation and Electromagnetism. Attempts to locate the Absolute Frame: Michelson-Morley experiment and significance of the null result.

Einstein's postulates of special theory of relativity.

Unit -II

Relativity-Relativistic Kinematics:

Structure of space & time in Relativistic mechanics and derivation of Lorentz transformation equations (4-vector formulation included). Consequences of Lorentz Transformation Equations (derivations & examples included): Transformation of Simultaneity (Relativity of simultaneity); Transformation of Length (Length contraction); Transformation of Time (Time dilation); Transformation of Velocity (Relativistic velocity addition); Transformation of Acceleration; Transformation of Mass(Variation of mass with velocity). Relation between Energy &Mass (Einstein's mass & energy relation) and Energy & Momentum.

Unit -III

In adequacies of Classical Mechanics:

Particle Properties of Waves: Spectrum of Black Body radiation, Photo electric effect, Compton effect and their explanations based on Max Planck's Quantum hypothesis.

Wave Properties of Particles: Louisde Broglie's hypothesis of matter waves and their experimental Verification by Davisson-Germer's experiment and Thomson's experiment.

Unit -IV

Introduction to Quantum Mechanics:

Matter Waves: Mathematical representation, Wavelength, Concept of Wave group, Group (particle) velocity, Phase (wave) velocity and relation between Group & Phase velocities.

Wave Function: Functional form, Normalization of wave function, Orthogonal & Orthonormal Wave functions and Probabilistic interpretation of wave function based on Born Rule.

PART-B (Basic Electronics & Introduction to Fiber Optics)

Unit –V

Transistor Biasing:

Faithful amplification & need for biasing. Stability Factors and its calculation for transistor biasing circuits for CE configuration: Fixed Bias (Base Resistor Method), Emitter Bias (Fixed Bias with Emitter Resistor), Collector to Base Bias (Base Bias with Collector Feedback) &Voltage Divider Bias. Discussion of Emitter-Follower configuration.

Unit –VI

Amplifiers:

Classification of amplifiers based on Mode of operation (Class A, B, AB, C & D), Stages (single & multi stage, cascade & cascode connections), Coupling methods (RC, Transformer, Direct & LC couplings), Nature of amplification (Voltage & Power amplification) and Frequency capabilities (AF, IF, RF & VF).

Theory & working of RC coupled voltage amplifier (Uses of various resistors & capacitors, and Frequency response) and Transformer coupled power amplifier (calculation of Power, Effect of temperature, Use of heat sink & Power dissipation).

Calculation of Amplifier Efficiency (power efficiency) for Class A Series-Fed, Class A Transformer Coupled, Class B Series-Fed and Class B Transformer Coupled amplifiers.

Unit-VII

Feedback & Oscillator Circuits:

Feedback Circuits: Effects of positive and negative feedback. Voltage Series, Voltage Shunt, Current Series and Current Shunt feedback connection types and their uses for specific amplifiers. Estimation of Input Impedance, Output Impedance, Gain, Stability, Distortion, Noise and Band Width for Voltage Series negative feedback and their comparison between different negative feedback connection types.

Oscillator Circuits: Use of positive feedback for oscillator operation. Barkhausen criterion for self-sustained oscillations. Feedback factor and frequency of oscillation for RC Phase Shift oscillator and Wein Bridge oscillator. Qualitative discussion of Reactive Network feedback oscillators (Tuned Oscillator circuits): Hartley & Colpitt oscillators.

Unit-VIII

Introduction to Fiber Optics:

Basics of Fiber Optics, step index fiber, graded index fiber, light propagation through an optical fiber, acceptance angle & numerical aperture, qualitative discussion of fiber losses and applications of optical fibers.

Reference:

(Part-A)

1. A.Beiser,ShobhitMahajan,“ConceptsofModernPhysics:SpecialIndianEdition”, McGrawHill,2009,6e
2. JohnR.Taylor,ChrisD.Zafiratos,MichaelA.Dubson,“ModernPhysicsforScientistsandEngineers”,Prentice-Hall of India Private Limited, 2003, 2e
3. R.A.Serway,C.J.Moses,andC.A.Moyer,“ModernPhysics”,CengageLearningIndiaPvt.Ltd,2004,3e
4. R.Resnick,“IntroductiontoSpecialRelativity”,WileyIndiaPrivateLimited, 2007
5. R.Murugeshan,KiruthigaSivaprasath,“ModernPhysics”,S.ChandPublishing,2019,18e

(Part-B)

1. R.L.Boylestad,L.Nashelsky,“ElectronicDevicesandCircuitTheory”,Prentice-HallofIndiaPvt.Ltd.,2015, 11e
2. J.Millman,C.C.Halkias,SatyabrataJit,“ElectronicDevicesandCircuits”,McGrawHill,2015,4e
3. B.G.Streetman,S.K.Banerjee,“SolidStateElectronicDevices”,PearsonEducationIndia,2015,7e
4. J.D.Ryder,“ElectronicFundamentalsandApplications”,Prentice-HallofIndiaPrivateLimited,1975,5e

Practical

B010402P: Basic Electronics Instrumentation

Lab Experiment List:

1. Transistor Bias Stability
2. Comparative Study of CE, CB and CC amplifier
3. Clippers and Clampers
4. Study of Emitter Follower
5. Frequency response of single stage RC coupled amplifier
6. Frequency response of single stage Transformer coupled amplifier
7. Effect of negative feedback on frequency response of RC coupled amplifier
8. Study of Schmitt Trigger
9. Study of Hartley oscillator
10. Study of Wein Bridge oscillator

Semester V

Theoretical Paper -I

B010501T: Classical & Statistical Mechanics

PART-A (Introduction to Classical Mechanics)

Unit -I

Constrained Motion:

Constraints - Definition, Classification and Examples. Degrees of Freedom and Configuration space. Constrained system, Forces of constraint and Constrained motion. Generalised coordinates, Transformation equations and Generalized notations & relations. Principle of Virtual work and D' Alembert's principle.

Unit -II

Lagrangian Formalism:

Lagrangian for conservative & non-conservative systems, Lagrange's equation of motion (no derivation), Comparison of Newtonian & Lagrangian formulations, Cyclic coordinates, and Conservation laws (with proofs and properties of kinetic energy function included). Simple examples based on Lagrangian formulation.

Unit -III

Hamiltonian Formalism:

Phase space, Hamiltonian for conservative & non-conservative systems, Physical significance of Hamiltonian, Hamilton's equation of motion (no derivation), Comparison of Lagrangian & Hamiltonian formulations, Cyclic coordinates, and Construction of Hamiltonian from Lagrangian. Simple examples based on Hamiltonian formulation.

Unit -IV

Central Force:

Definition and properties (with prove) of central force. Equation of motion and differential equation of orbit. Bound & unbound orbits, stable & non-stable orbits, closed & open orbits and Bertrand's theorem. Motion under inverse square law of force and derivation of Kepler's laws. Laplace -Runge- Lenzvector (Runge-Lenzvector) and its applications.

PART-B (Introduction to Statistical Mechanics)

Unit –V

Macrostate & Microstate:

Macrostate, Microstate, Number of accessible microstates and Postulate of equal a priori. Phase space, Phase trajectory, Volume element in phase space, Quantisation of phase space and number of Accessible microstates for free particle in1D, free particle in 3D & harmonic oscillator in 1D.

Unit –VI

Concept of Ensemble:

Problem with time average, concept of ensemble, postulate of ensemble average and Liouville's theorem (proof included). Micro Canonical, Canonical & Grand Canonical ensembles. Thermodynamic Probability, Postulate of Equilibrium and Boltzmann Entropy relation.

Unit-VII

Distribution Laws:

Statistical Distribution Laws: Expressions for number of accessible microstates, probability & number of particles in i^{th} state at equilibrium for Maxwell-Boltzmann, Bose-Einstein & Fermi- Dirac statistics. Comparison of statistical distribution laws and their physical significance.

Canonical Distribution Law: Boltzmann's Canonical Distribution Law, Boltzmann's Partition Function, Proof of Equipartition Theorem (Law of Equipartition of energy) and relation between Partition function and Thermodynamic potentials.

Unit-VIII

Applications of Statistical Distribution Laws:

Application of Bose-Einstein Distribution Law: Photons in a black body cavity and derivation of Planck's Distribution Law.

Application of Fermi-Dirac Distribution Law: Free electrons in a metal, Definition of Fermi energy, Determination of Fermi energy at absolute zero, Kinetic energy of Fermi gas at absolute zero and Concept of Density of States (Density of Orbitals).

Reference:

(Part-A)

1. HerbertGoldstein,CharlesP.Poole,JohnL.Safko,"ClassicalMechanics", PearsonEducation,India,2011, 3e
2. N.C.Rana,P.S.Joag,"ClassicalMechanics",McGrawHill,2017
3. R.G.Takwale,P.S.Puranik,"IntroductiontoClassicalMechanics",McGrawHill,2017

(Part-B)

1. F.Reif,"StatisticalPhysics(InSIUnits):BerkeleyPhysicsCourseVol5",McGrawHill,2017, 1e
2. B.B.Laud,"FundamentalsofStatisticalMechanics",NewAgeInternationalPrivateLimited,2020,2e
3. B.K.Agarwal,M.Eisner,"StatisticalMechanics",NewAgeInternationalPrivateLimited,2007,2e

Theoretical Paper-II

B010502T: Quantum Mechanics & Spectroscopy

PART-A (Introduction to Quantum Mechanics)

Unit -I

Operator Formalism:

Operators: Review of matrix algebra, definition of an operator, special operators, operator algebra and operators corresponding to various physical-dynamical variables.

Commutators: Definition, commutator algebra and commutation relations among position, linear momentum & angular momentum and energy & time. Simple problems based on commutation relations.

Unit -II

Eigen & Expectation Values:

Eigen & Expectation Values: Eigen equation for an operator, eigen state (value) and eigen functions. Linear superposition of eigen functions and Non-degenerate & Degenerate eigen states.

Expectation value pertaining to an operator and its physical interpretation. Hermitian Operators: Definition, properties and applications. Prove of the hermitian nature of various physical-dynamical operators.

Unit -III

Uncertainty Principle & Schrodinger Equation:

Uncertainty Principle: Commutativity & simultaneity (theorems with proofs). Non commutativity of operators as the basis for uncertainty principle and derivation of general form of uncertainty principle through Schwarz inequality. Uncertainty principle for various conjugate pairs of physical dynamical parameters and its applications.

Schrodinger Equation: Derivation of time independent & time dependent forms, Schrodinger equation as an eigen equation, Deviation & interpretation of equation of continuity in Schrodinger representation, and Equation of motion of an operator in Schrodinger representation.

Unit -IV

Applications of Schrodinger Equation:

Application to 1D Problems: Infinite Square well potential (Particle in 1D box), Finite Square well potential, Potential step, Rectangular potential barrier and 1D Harmonic oscillator.

Application to 3D Problems: Infinite Square well potential (Particle in a 3D box) and the Hydrogen atom (radial distribution function and radial probability included). (Direct solutions of Hermite, Associated Legendre and Associated Laguerre differential equations to be substituted).

PART-B (Introduction to Spectroscopy)

Unit –V

Vector Atomic Model:

Inadequacies of Bohr and Bohr-Sommerfeld atomic models w.r.t. spectrum of Hydrogen atom (fine structure of H-alpha line). Modification due to finite mass of nucleus and Deuteron spectrum. Vector atomic model (Stern-Gerlach experiment included) and physical & geometrical interpretations of various quantum numbers for single & many valence electron systems. LS & jj couplings, spectroscopic notation for energy states, selection rules for transition of electrons and intensity rules for spectral lines. Fine structure of H-alpha line on the basis of vector atomic model.

Unit –VI

Spectra of Alkali & Alkaline Elements:

Spectra of alkali elements: Screening constants for s, p, d & f orbitals; sharp, principle, diffuse & fundamental series; doublet structure of spectra and fine structure of Sodium D line.

Spectra of alkaline elements: Singlet and triplet structure of spectra.

Unit-VII

X-Rays & X-Ray Spectra:

Nature & production, Continuous X-ray spectrum & Duane-Hunt's law, Characteristic X-ray spectrum & Mosley's law, Fine structure of Characteristic X-ray spectrum, and X-ray absorption spectrum.

Unit-VIII

Molecular Spectra:

Discrete set of energies of a molecule, electronic, vibrational and rotational energies. Quantisation of vibrational energies, transition rules and pure vibrational spectra. Quantisation of rotational energies, transition rules, pure rotational spectra and determination of inter nuclear distance. Rotational-Vibrational spectra; transition rules; fundamental band & hot band; O, P, Q, R, S branches.

Reference:

(Part-A)

1. D.J. Griffiths, "Introduction to Quantum Mechanics", Pearson Education, India, 2004, 2e
2. E. Wichmann, "Quantum Physics (In SI Units): Berkeley Physics Course Vol 4", McGraw Hill, 2017
3. Richard P. Feynman, Robert B. Leighton, Matthew Sands, "The Feynman Lectures on Physics - Vol. 3" Pearson Education Limited, 2012
4. R Murugeshan, Kiruthiga Sivaprasath, "Modern Physics", S. Chand Publishing, 2019, 18e

(Part-B)

1. H.E. White, "Introduction to Atomic Spectra", McGraw Hill, 1934
2. C.N. Banwell, E.M. McCash, "Fundamentals of Molecular Spectroscopy", McGraw Hill, 2017, 4e
3. R Murugeshan, Kiruthiga Sivaprasath, "Modern Physics", S. Chand Publishing, 2019, 18e
4. S.L. Gupta, V. Kumar, R.C. Sharma, "Elements of Spectroscopy", Pragati Prakashan, Meerut, 2015, 27e

Practical

B010503P: Demonstrative Aspects of Optics & Lasers

Lab Experiment List:

1. Fresnel Biprism: Wavelength of sodium light
2. Fresnel Biprism: Thickness of mica sheet
3. Newton's Rings: Wavelength of sodium light
4. Newton's Rings: Refractive index of liquid
5. Plane Diffraction Grating: Resolving power
6. Plane Diffraction Grating: Spectrum of mercury light
7. Spectrometer: Refractive index of the material of a prism using sodium light
8. Spectrometer: Dispersive power of the material of a prism using mercury light
9. Polarimeter: Specific rotation of sugar solution
10. Wavelength of Laser light using diffraction by single slit

Semester VI

Theoretical Paper- I

B010601T: Solid State & Nuclear Physics

PART-A (Introduction to Solid State Physics)

Unit -I

Crystal Structure:
Lattice, Basis & Crystal structure. Lattice translation vectors, Primitive & non-primitive cells. Symmetry operations, Point group & Space group. 2D & 3D Bravais lattice. Parameters of cubic lattices. Lattice planes and Miller indices. Simple crystal structures - HCP & FCC, Diamond, Cubic Zinc Sulphide, Sodium Chloride, Cesium Chloride and Glasses.

Unit -II

Crystal Diffraction:
X-ray diffraction and Bragg's law. Experimental diffraction methods - Laue, Rotating crystal and Powder methods. Derivation of scattered wave amplitude. Reciprocal lattice, Reciprocal lattice vectors and relation between Direct & Reciprocal lattice. Diffraction conditions, Ewald's method and Brillouin zones. Reciprocal lattice to SC, BCC & FCC lattices. Atomic Form factor and Crystal Structure factor.

Unit -III

Crystal Bindings:
Classification of Crystals on the Basis of Bonding - Ionic, Covalent, Metallic, van der Waals (Molecular) and Hydrogen bonded. Crystals of inert gases, Attractive interaction (van der Waals- London) & Repulsive interaction, Equilibrium lattice constant, Cohesive energy and Compressibility & Bulk modulus. Ionic crystals, Cohesive energy, Made lung energy and evaluation of Made lung constant.

Unit -IV

Lattice Vibrations:
Lattice Vibrations: Lattice vibrations for linear mono & di atomic chains, Dispersion relations and Acoustical & Optical branches (qualitative treatment). Qualitative description of Phonons in solids. Lattice heat capacity, Dulong-Petit's law and Einstein's theory of lattice heat capacity. Free Electron Theory: Fermi energy, Density of states, Heat capacity of conduction electrons, Paramagnetic susceptibility of conduction electrons and Hall effect in metals.
Band Theory: Origin of band theory, Qualitative idea of Bloch theorem, Kronig-Penney model, Effectice mass of an electron & Concept of Holes & Classification of solids on the basis of band theory.

PART-B (Introduction to Nuclear Physics)

Unit –V

Nuclear Forces & Radioactive Decays:
General Properties of Nucleus: Mass, binding energy, radii, density, angular momentum, magnetic dipole moment vector and electric quadrupole moment tensor.
Nuclear Forces: General characteristic of nuclear force and Deuteron ground state properties.
Radioactive Decays: Nuclear stability, basic ideas about beta minus decay, beta plus decay, alpha decay, gamma decay & electron capture, fundamental laws of radioactive disintegration and radioactive series.

Unit –VI

Nuclear Models & Nuclear Reactions:
Nuclear Models: Liquid drop model and Bethe-Weizsacker mass formula. Single particle shell model (the level scheme in the context of reproduction of magic numbers included).
Nuclear Reactions: Bethe's notation, types of nuclear reaction, Conservation laws, Cross-section of nuclear reaction, Theory of nuclear fission (qualitative), Nuclear reactors and Nuclear fusion.

Unit-VII

Accelerators & Detectors:

Accelerators: Theory, working and applications of Van de Graaff accelerator, Cyclotron and Synchrotron.

Detectors: Theory, working and applications of GM counter, Semiconductor detector, Scintillation counter and Wilson cloud chamber.

Unit-VIII

Elementary Particles:

Fundamental interactions & their mediating quanta. Concept of antiparticles. Classification of elementary particles based on intrinsic-spin, mass, interaction & lifetime. Families of Leptons, Mesons, Baryons & Baryon Resonances. Conservation laws for mass-energy, linear momentum, angular momentum, electric charge, baryonic charge, leptonic charge, isospin & strangeness. Concept of Quark model.

Reference:

(Part-A)

1. Charles Kittel, "Introduction to Solid State Physics", Wiley India Private Limited, 2012, 8e

2. A.J. Dekker, "Solid State Physics", Macmillan India Limited, 1993

3. R.K. Puri, V.K. Babbar, "Solid State Physics", S. Chand Publishing, 2015

(Part-B)

1. Kenneth S. Krane, "Introductory Nuclear Physics", Wiley India Private Limited, 2008

2. Bernard L. Cohen, "Concepts of Nuclear Physics", McGraw Hill, 2017

3. S.N. Ghoshal, "Nuclear Physics", S. Chand Publishing, 2019

Theoretical Paper-II

B010602T: Analog & Digital Principles & Applications

PART-A (Analog Electronic Circuits)

Unit -I

Semiconductor Junction:

Expressions for Fermi energy, Electron density in conduction band, Hole density in valence band, Drift of charge carriers (mobility & conductivity), Diffusion of charge carries and Life time of charge carries in a semiconductor. Work function in metals and semiconductors.

Expressions for Barrier potential, Barrier width and Junction capacitance (diffusion & transition) for depletion layer in a PN junction. Expressions for Current (diode equation) and Dynamic resistance for PN junction.

Unit -II

Transistor Modeling:

Transistor as Two-Port Network. Notation for dc & ac components of voltage & current. Quantitative discussion of Z, Y & h parameters and their equivalent two-generator model circuits. h-parameters for CB, CE & CC configurations. Analysis of transistor amplifier using the hybrid equivalent model and estimation of Input Impedance, Output Impedance and Gain (current, voltage & power).

Unit -III

Field Effect Transistors:

JFET: Construction (N channel & P channel); Configuration (CS, CD & CG); Operation in different regions (Ohmic or Linear, Saturated or Active or Pinch off & Break down); Important Terms (Shorted Gate Drain Current, Pinch Off Voltage & Gate Source Cut-Off Voltage); Expression for Drain Current (Shockley equation); Characteristics (Drain & Transfer); Parameters (Drain Resistance, Mutual Conductance or Transconductance & Amplification Factor); Biasing w.r.t. CS configuration (Self Bias & Voltage Divider Bias); Amplifiers (CS & CD or Source Follower); Comparison (N & P channels and BJTs & JFETs).

MOSFET: Construction and Working of DE-MOSFET (N channel & P channel) and E-MOSFET (N channel & P channel); Characteristics (Drain & Transfer) of DE-MOSFET and E-MOSFET; Comparison of JFFET and MOSFET.

Unit -IV

Other Devices:

SCR: Construction; Equivalent Circuits (Two Diodes, Two Transistors & One Diode-One Transistor); Working (Off state & On state); Characteristics; Applications (Static switch, Phase control system & Battery charger).

UJT: Construction; Equivalent Circuit; Working (Cutoff, Negative Resistance & Saturation regions); Characteristics (Peak & Valley points); Applications (Trigger circuits, Relaxation oscillators & Sawtooth generators).

PART-B (Digital Electronics)

Unit –V

Number Systems: Binary, Octal, Decimal & Hexadecimal number systems and their inter conversion.

Binary Codes: BCD, Excess-3 (XS3), Parity, Gray, ASCII & EBCDIC Codes and their advantages & disadvantages. Data representation.

Unit –VI

Binary Addition, Decimal Subtraction using 9's & 10's complement, Binary Subtraction using 1's & 2's compliment, Multiplication and Division.

Unit-VII

Logic Gates:

Truth Table, Symbolic Representation and Properties of OR, AND, NOT, NOR, NAND, EX-OR & EX-NOR Gates. Implementation of OR, AND & NOT gates (realization using diodes & transistor). De Morgan's theorems. NOR & NAND gates as Universal Gates. Application of EX-OR & EXNOR gates as pairty checker. Boolean Algebra. Karnaugh Map.

Unit-VIII

Combinational & Sequential Circuits:

Combinational Circuits: Half Adder, Full Adder, Parallel Adder, Half Substractor, Full Substractor.
Data Processing Circuits: Multiplexer, Demultiplexer, Decoders & Encoders.
Sequential Circuits: SR, JK & D Flip-Flops, Shift Register (transfer operation of Flip-Flops), and Asynchronous & Synchronous counters.

Reference:

(Part-A)

1. R.L. Boylestad, L. Nashelsky, "Electronic Devices and Circuit Theory", Prentice-Hall of India Pvt. Ltd., 2015, 11e
2. J. Millman, C.C. Halkias, Satyabrata Jit, "Electronic Devices and Circuits", McGraw Hill, 2015, 4e
3. B.G. Streetman, S.K. Banerjee, "Solid State Electronic Devices", Pearson Education India, 2015, 7e
4. J.D. Ryder, "Electronic Fundamentals and Applications", Prentice-Hall of India Private Limited, 1975, 5e
5. S.L. Gupta, V. Kumar, "Hand Book of Electronics", Pragati Prakashan, Meerut, 2016, 43e

(Part-B)

1. D. Leach, A. Malvino, Goutam Saha, "Digital Principles and Applications", McGraw Hill, 2010, 7e
2. William H. Gothmann, "Digital Electronics: An Introduction to Theory and Practice", Prentice-Hall of India
Private Limited, 1982, 2e
3. R.P. Jain, "Modern Digital Electronics", McGraw Hill, 2009, 4e

Practical

B010603P: Analog & Digital Circuits

Lab Experiment List:

1. Energy band gap of semiconductor by reverse saturation current method
2. Energy band gap of semiconductor by four probe method
3. Hybrid parameters of transistor
4. Characteristics of FET, MOSFET, SCR, UJT
5. FET Conventional Amplifier
6. FET as VVR and VCA
7. Study and Verification of AND gate using TTL IC 7408
8. Study and Verification of OR gate using TTL IC 7432
9. Study and Verification of NAND gate and use as Universal gate using TTL IC 7400
10. Study and Verification of NOR gate and use as Universal gate using TTL IC 7402
11. Study and Verification of NOT gate using TTL IC 7404
12. Study and Verification of Ex-OR gate using TTL IC 7486