NEHRU GRAM BHARATI VISHWAVIDYALAYA

KOTWA-JAMUNIPUR, DUBAWAL, ALLAHABAD
(U.P.)

Syllabi
of
B.Sc. Part-I, II, III

(A Three Years Degree Course)

DEPARTMENT OF PHYSICS

(w.e.f. Session-2017-18)

B.Sc. (Part-I)-Physics

Sr. No.	Paper	Paper Title	Total Units	Total Lectures/ Periods	Lectures/ Periods Per Week	Maximum Marks
1	I	**Mechanics**	5	60	2	33
2	II	**Thermal Physics**	5	60	2	33
3	III	**Electrical Circuits & Basic Semiconductor Electronics**	5	60	2	34
Physics Theory (Total 180 Hrs/Periods) Total Marks = 100						
4	**Practical**			120	4	50
Total Marks (Theory + Practical) = 150						

B.Sc. (Part-II)-Physics

Sr. No.	Paper	Paper Title	Total Units	Total Lectures/ Periods	Lectures/ Periods Per Week	Maximum Marks
1	I	**Optics**	5	60	2	33
2	II	**Oscillation, Waves and Electromagnetism**	5	60	2	33
3	III	**Atomic and Nuclear Physics**	5	60	2	34
Physics Theory (Total 180 Hrs/Periods) Total Marks = 100						
4	**Practical**			120	4	50
Total Marks (Theory + Practical) = 150						

B.Sc. (Part-III)-Physics

Sr. No.	Paper	Paper Title	Total Units	Total Lectures/ Periods	Lectures/ Periods Per Week	Maximum Marks
1	I	**Quantum Mechanics**	5	60	2	37
2	II	**Statistical Mechanics and Solid State Physics**	5	60	2	37
3	III	**Basic Digital Electronics and Photonic Devices**	5	60	2	38
4	IV	**Electromagnetic Theory, Laser, Holography and Optical Instruments**	5	60	2	38
Physics Theory (Total 240 Hrs/Periods) Total Marks = 150						
5	**Practical**			180	6	75
Total Marks (Theory + Practical) = 225						

Paper Setting pattern for Annual Examination

1. **Question paper consists of eleven questions in all. All questions are divided into Three Sections-A, B &C.**
2. **Section A is compulsory of objective/ Short Answer/Fill in the blanks types of Questions from all five Units. Total Marks: 8/9 Marks for B.Sc. (Part-I & II); 7/8 Marks for B.Sc. (Part-III).**
3. **Section B has Six questions from units I, II, & III (Two Questions from each Units). Each question may be divided into more than one part. Attempt any three from this section. Total Marks: 15 (5 marks each question) for B.Sc. (Part-I & II); Total Marks: 18 (6 marks each question) for B.Sc. (Part-III).**
4. **Section C has Four questions from units IV & V (Two Questions from each Units). Each question may be divided into more than one part. Attempt any two from this section. Total Marks: 10 (5 marks each question) for B.Sc. (Part-I & II); Total Marks: 12 (6 marks each question) for B.Sc. (Part-III).**

B.Sc. Part-I

Paper-I: Mechanics

Unit-1. Mathematical Background & Special Theory of Relativity

Background of Vector Calculus, Concept of line, surface and volume integral, Physical significance of Gradient, Divergence and Curl.

Frame of Reference, Inertial and Non-inertial frames, Galilean transformation, Galilean invariance, Pseudo forces, Rotating reference frame, Centrifugal force, Coriolis Force. Inertial and Gravitational mass, Principle of Equivalence. Inference of Michelson-Morley Experiments. Postulates of special relativity, Lorentz transformations, Length contraction, Time dilation, Simultaneity in relativity theory, Addition of velocities, Relativistic dynamics, Variation of mass with velocity, mass-energy relation. Relativistic Doppler shift.

Unit-2. Mechanics of Rigid Bodies

System of particles, Centre of Mass, Linear momentum, Centre of mass frame, Rotational motion in two and three dimensions, Angular momentum, Moment of inertia tensor, Central forces, Conservative forces, Potential energy, Gravitational potential and field due to a uniform spherical shell and solid sphere, Conservation Laws.

Unit-3. Motion Under A Central Force

Two-particle central force problem reduced mass, lab and Center of mass co-ordinate systems, Motion in an inverse square field, Kepler's laws.

Unit-4. Mechanics of Non-Rigid Bodies

Strain and stress in an isotropic homogeneous medium, Elastic moduli and relations between them, Torsion of cylinders, Bending of beams, Internal energy of a strained body.

Unit-5. Fluid Mechanics:

Ideal fluids, Equation of continuity, Streamline flow, Rotational and irrotational flows, Euler's equations of motion, Bernoulli's theorem, Viscous fluids Poiseuillie's equation, Viscosity by rotating cylinder method.

Reference Books:

1. *Berkeley Physics Course 2/e, Vol 1: Mechanics by C. Kittel, W. D. Knight, M. A. Ruderman, C. A. Helmholz, B. J. Moyer (McGraw-Hill).*
2. *The Feynman Lectures on Physics, Volume 1 by R. P. Feynman, R. B. Leighton and M. Sands (Narosa Publishing House)*
3. *Introduction to Special Relativity 1/e by R. Resnick (Wiley India Pvt Ltd)*
4. *Mechanics by J. C. Uppadhyaya (Ram Prasad & Sons)*
5. *Mechanics by D. S. Mathur (S. Chand & Company Ltd)*

Paper-II: Thermal Physics

Unit-1. Basic Concept and First Law of Thermodynamics

Thermodynamic systems, Macroscopic and Microscopic variables, Thermodynamical State, Thermal Equilibrium, Zeroth Law of Thermodynamics and Concept of Temperature.

Heat and Work and their path-dependence, Thermal processes, First law of thermodynamics and internal energy, Joule's law, Applications of first law.

Unit-2. Second Law of Thermodynamics & Entropy

Carnot cycle, Carnot Engine and Refrigerator, Reversible and irreversible processes, Carnot's Theorem. Thermodynamical scale of temperature, Clausius-Clapeyron's equation, Specific heat of saturated vapour, Clausius theorem, Clausius inequality, Entropy, Calculation of entropy in various processes, Entropy and unavailable energy, Physical significance of entropy, Second Law of thermodynamics.

Unit-3. Thermodynamic Relations

Conditions for natural changes, Thermodynamic potentials and Maxwell's equation, Applications of Maxwell's equations, Joule-Thomson effect, Inversion Temperature. Third Law of Thermodynamics. Change of Phase, First and second order phase transitions, Ehrenfest's equations.

Unit-4. Kinetic Theory of Gases & Conduction of Heat

Kinetic Theory of Gases: Maxwell Boltzman law of distribution of molecular velocities, Equation of r.m.s. velocity and average and most probable speeds, Mean free path, Transport phenomena.

Conduction of Heat: Fourier equation for one-dimensional flow of heat and its steady-state solution, Periodic flow of heat (only sinusoidal heat current).

Unit-5. Radiation

Radiation as electromagnetic waves, Emissive and Absorptive powers, Radiation in a hollow enclosure, Black-body radiation, Kirchoff's Law, Intensity and energy density, Pressure and energy density, Stefan Boltzmann law, Solar constant and temperature of sun, Temperature of Non-black bodies, Distribution of energy in the spectrum of black body radiation, Adiabatic expansion of black-body radiation, Wein's distribution law, Wein's displacement law, Wein's formula, Rayleigh-Jean's law, Planck's law.

Reference Books:

1. *Thermal Physics 2/e by C. Kittel, H. Kroemer (W.h. Freeman & Company).*
2. *Fundamentals of Statistical and Thermal Physics by F. Reif (Waveland Pr Inc)*
3. *Heat and Thermodynamics (SIE) by M. W. Zemansky, Phillips, Dittman R. H. (Tata Mcgraw Hill Education Private Limited).*
4. *Thermal Physics by B. K. Agarwal (Lokbharati Prakashan).*
5. *Thermal Physics by Garg, Ghose & Bansal (Tata Mcgraw Hill Education Private Limited).*
6. *Treatise on Heat by M. N. Saha, B. N. Srivastava (Unknown Publisher)*

7. *Heat, Thermodynamics and Statistical Physics 12/e by Brij Lal, N. Subrahmanyam, P. S. Hemne (S. Chand Publisher).*

Paper-III: Electrical Circuits & Basic Semiconductor Electronics

Unit-I: Electrical Circuits-I

Circuit parameters, R, L & C. Kirchoffs Law for a loop and junction, Solutions by determinant and matrix methods. Applications to T, Π and bridge circuits, Norton and Thevenin's theorems, Maximum power transfer theorem.

Unit-II: Electrical Circuits-II

Difference between steady state & transients; Growth & decay of current in an inductive circuit, Charging and discharging of a capacitor through a resistor, C_S and through an inductor and resistor in series. Ballistic Galvanometer, and Q_S, Measurement of a capacity and of a high resistance by leakage method.

Unit-III: Electrical Circuits-III (A.C. Analysis & A.C. Bridges)

A.C. Analysis (Vector treatment only): Complex impedance and phasor notations. Impedance & Admittance & Admittance operators, vector diagrams for Voltage and Current in RL, CR and LCR in series & parallel, Power consumed in the circuit, Series and parallel resonance, Q of a coil, Transformer-its equivalent circuit and turn ratio. *A.C. Bridges:* Balance and sensitivity conditions for A.C. bridge, Measurement of L by Maxwell's Bridge, Measurement of C by Schering's bridge.

Unit-IV: Basic Semiconductor Electronics-I

Conduction in Solid: Conductor, Insulator and Semiconductor, electrons and holes as charge carriers, Intrinsic and extrinsic semiconductors Conductivity and mobility, Conduction by diffusion and drift.

P.N. Junctions: Built-in-voltage and charge depletion region, Statement of diode equation and diode characteristics, Forward and reverse resistances, Zener diode: its characteristics, Half wave, Full wave and Bridge rectifiers, Ripple factor, filtering by RC, π and LC circuit. Regulation: voltage regulation using Zener diode, Photo-diode, Solar cell.

Unit-V: Basic Semiconductor Electronics-II

BJT: NPN and PNP transistor action, Characteristics in CB, CE and CC configurations. Hybrid, alpha and beta parameters, their inter-relationship, Load line, small signal hybrid equivalent circuit, CE amplifier, Mid frequency response, Practical amplifier circuit Barkhausen criteria for sustained oscillations, Qualitative discussion of collector tuned oscillator, Circuits of Hartley and Colpitts oscillator, sweep oscillator.

Modulation: Need for modulation, three types of modulation, Amplitude modulation, Frequency spectrum and power in A. M. wave typical A.M. circuit, Linear diode detector.

CRO: Working of cathode ray tube, black diagram of CRO, typical applications of CRO.

Reference Books:

1. *Electronic Devices And Circuits (SIE) (Schaum's Outline Series) by J. J. Cathey (Tata Mcgraw Hill Education Private Limited).*
2. *Millman's Electronic Devices and Circuits by J. Millman (Tata Mgraw Hill)*
3. *Electronic Devices and Circuits Theory 10/e by R. L. Boylestad, L. Nashelsky (Pearson).*
4. *Eletrical Circuits and Introductory Electronics by Vinod Prakash (Lokbharati Prakashan).*
5. *Basic Electronics and Linear Circuits by N. Bhargava, D. Kulshreshtha, S. Gupta (Tata Mcgraw Hill Education Private Limited).*
6. *Introductory Circuit Analysis 12/e by R. L. Boylestad (Pearson)*
7. *Electronic Devices and Circuits 5/e by D. A. Bell (Oxford University Press).*
8. *Electricity & Magnetism 3/e by K. K. Tiwari (S. Chand Publisher).*

B.Sc. Part –I: Practical Physics

List of Experiments

Group: A- (Mechanics, General Properties of Matter)

1. **Fly wheel**: To determine the moment of Inertia (I) of a fly-wheel about the axis of rotation.
2. **Compound Pendulum**: To determine the value of 'g' with the compound pendulum and the radius of gyration (k) of the pendulum about an axis passing through the centre of gravity and perpendicular to its length.
3. **Rectangular Lamina**: To determine:

(i) The value of 'g' with a rectangular lamina.

(ii) The Moment of Inertia (I) and Radius of Gyration (k) of a rectangular lamina about an axis passing through the centre of gravity and perpendicular to the plane of the lamina.

4. **Spiral Spring**: To determine the force per unit extension (K) and effective mass (m_e) of a spiral-spring (static and dynamic method).
5. **Maxwell's Needle**: To determine the rigidity modulus of the material in the form of a wire by Maxwell's needle.
6. **Surface Tension**: To determine the surface tension (T) of water by Jaeger's method.
7. **Searle's Apparatus**: To determine Y, η and σ of the material of a given wire by Searle's apparatus.
8. **Y by bending**: To determine the Young's modulus (Y) of the material of the beam.
9. **Viscosity**: To determine the viscosity (η) of a liquid by Poiseuille's method.
10. **Torsion Table**: To determine the modulus of rigidity of the material of the given wire and moment of inertia of an irregular body with the help of a torsion table.
11. **Statical Method**: To determine the modulus of rigidity (η) of the given material in the form of a wire by statical method.

Group: B- (Thermal, Electricity & Electronics)

12. **PN- Junction Diode**: To draw the characteristic curves of a PN junction diode.
13. **Zener Diode:** To study the breakdown characteristic of a Zener diode.
14. **P. O. Box:** (i) To measure resistances of by a Ammeter P. O. Box.
    (ii) To measure resistances of voltmeter by a P. O. Box.
    (iii) To determine internal resistance of a cell by Mance's constant deflection method.
    (iv) To measure the galvanometer resistance by Thomson's constant deflection method.
15. **Energy Meter:** To calibrate an electrical energy meter with the help of a Joule's calorimeter.
16. **Stefan-Boltzmann law:** To verify the Stefan-Boltzmann law for radiation.
17. **K of Rubber**: To determine the thermal conductivity (K) of a rubber given in the form of a tube.
18. **K of Copper**: To determine the thermal conductivity (K) of the given material in the form of a rod by Searle's apparatus.

19. **K of Asbestos**: To determine the thermal conductivity (K) of asbestos by Lees disc method.
20. **Transistor-CE**: To draw the input, output and transfer (voltage and current) characteristics for a PNP transistor in the common emitter (CE) configuration and to evaluate the current gain (β).
21. **Transistor-CB:** To draw the input, output and transfer (voltage and current) characteristics for a PNP transistor in the common base (CB) configuration and to determine the current gain (α).
22. **Current Sensitivity:** To determine the current sensitivity and resistance of a moving coil galvanometer.

Reference Books:

1. Practical Physics by S. K. Kor, R. P. Khare & S. K. Jain (United Book Depot, Allahabad)
2. Practical Physics by Arora (S. Chand Publisher)

Practical Examination: Max Marks 50, Exam. Duration 4½ hrs. (Two experiments: 25, Viva voce: 10, Record: 15)

**In the practical examination every student is supposed to perform two experiments, one from each of these two groups.*

B.Sc. Part-II

Paper-I: Optics

Unit-I: Geometrical Optics & Elementary Idea of EM Wave

Cardinal points of coaxial optical systems. Simple problem on combination of thin lenses, eyepieces, Aplantic points. Nature of light, elementary ideas of electromagnetic wave and photon theories of light. Complex representation of waves and its application (to be used in the theory of various phenomenon).

Unit-II: Interference

Conditions for observing interference, Degree of coherence and visibility of fringes. Production of interference fringes and determination of wavelength, Michelson interferometer and its uses, Color of thin films, Newton's Rings. Theory of multiple reflections, F. P. Etalon.

Unit-III: Laser

Temporal and Spatial Coherence. Michelson Stellar interferometer. Stimulated emission, Basic ideas about laser emission, Ruby and He-Ne lasers as examples.

Unit-IV: Diffraction

Fresnel's theory of diffraction, Half-Period elements. Diffraction from circular obstacle and aperture (Elementary theory), Zone plate, Cornu's Spiral, Fresnel diffraction by straight edge and single slit. Fraunhofer's diffraction by single slit and double slit, Theory of plane grating, Width of principal maxima, Rayleigh's criterion of resolution, Resolving power of prism, grating and FP etalon. Limit of resolution for telescope. Concave grating (elementary theory) and its mountings.

Unit-V: Polarization

Unpolarised, polarized and partially polarized lights. Polarisation by reflection, Double refraction by uni-axial crystals, Polaroids, Huygen's theory of double refraction. Half and quarter wave plates. Production of elliptically polarized light. Babinet compensator, Analysis of elliptically polarized light using a Nicol and a quarter wave plate, and by using Baninet compensator. Optical activity. Fresnel's theory of optical rotation, Specific rotation. Biquatz and Laurent's half shade polarimeters.

Reference Books:

1. *Fundamentals of Optics 4/e by F. A. Jenkins and F. E. White (McGraw-Hill International Editions).*
2. *Geometrical & Physical Optics by R. S. Longhurst (Prentic Hall Press).*
3. *Optics 4/e by A. Ghatak (Tata Mgraw Hill).*
4. *Geometrical and Physical Optics by B. K. Mathur and T. P. Pandya (New Gopal Printing Press).*
5. *Optics (Schaum's Outline Series) by E. Hhecht (Tata Mcgraw Hill Education Private Limited).*
6. *A Textbook of Optics 4/e by M. N Avadhanulu, N Subrahmanyam, Brij Lal (S. Chand & Company Ltd)*

Paper-II: Oscillation, Waves and Electromagnetism

Unit-I: Oscillations & Ultrasonics

Simple Harmonic Motion, Damped Motion, Steady Forced Oscillations. Resonance. Fourier Series Decomposition. Simple cases of square, Saw-tooth and Rectified Sinusoidal Waves.

Ultrasonics: Generation and detection. Measurement of velocity in Liquids, Applications.

Unit-II: One-dimensional Wave-motion in non-dispersive media

Wave Equation, Progressive Wave solution, Particle Velocity and Wave Velocity. Equations for Wave in fluids and on Strings. Specific Acoustic Impedance of fluids and Characteristic Impedance of strings. Energy density. Intensity of Energy Transfer. Reflection and transmission of plane waves at a discontinuity, Standing Wave Solutions. Modes of Natural Oscillations. Energy Considerations.

Unit-III: Electrostatics in Free Space & Dielectrics

Electrostatics in Free Space: Coulomb Law, Electric Field. Simple case of charge distributions. Gauss Flux Law (Integral and Differential forms). Electric Dipole in Electrostatic Field. Irrotational Nature of Electric Potential. Simple Cases of Charge Distributions.

Electrostatics in Dielectrics: Polarization, Polarization Charges. Displacement Vector D. Gauss Flux Law (Integral and Differential forms) and simple Applications. Energy of Charge Distribution. Energy as an integral over the Field. Simple Problems (Parallel Plate Condenser, Uniformly charged spherical surface and volume).

Electric Current: Current Density Vector. Equation of Continuity, Ohm and Joule's Laws (Integral and differential forms).

Unit-IV: Magnetostatics

Ampere's Law, Biot-Savart's Law, Law of force in Magnetic Field on Currents and charged particles. Magnetic Filed due to a straight infinite wire. Magnetic Field due to circular loop and solenoid at axial points. Vector potential and its evaluation for uniform Magnetic Field due to a Loop of Current. Magnetic Moment. Magnetic Materials and Magnetization. Magnetization Current density J, Magnetic Field **H**, Curl of **H** and Calculation of **H**.

Unit-V: Time Varying Fields & Electromagnetic Waves in Free-Space

Time Varying Fields: Displacement Current, Curl **H** Faraday's Law (Integral and Differentia forms). Self and Mutual Inductances. Energy of Coupled Circuits and current distribution. $M \leq L_1 L_2$. Energy as an integral over the Magnetic Field. Energy of Solenoid.

Electromagnetic Waves in Free-Space: Maxwell Equations, Plane polarized Plane Wave solution. Characteristics of these Electromagnetic waves.

Reference Books:

1. *Physics of Vibration and Waves 6/e by H. J. Pain (Wiley India Pvt Ltd).*
2. *The Feynman Lectures on Physics, Volume 2 by R. P. Feynman, R. B. Leighton and M. Sands (Narosa Publishing House).*
3. *Physics of Oscillations and Waves by R. B. Singh (United Book Depot, Allahabad).*
4. *A Text Book Oscillations,Waves & Acoustics by M. M. Ghosh, D. Bhattacharya (S. Chand Publisher).*

5. *Introduction to Electrodynamics 3/e by D. J. Griffiths (Phi Learning).*
6. *Berkeley Physics Course, Vol 2: Electricity and Magnetism by E. M. Purcell (McGraw-Hill).*
7. *Electromagnetics by B. B. Laud (New Age International Pvt. Ltd. New Delhi).*

Paper-III: Atomic and Nuclear Physics

Unit-I: Atomic Physics

Bohr-Summerfield Model (Historical developments), Bohr model and the spectra of hydrogenic atoms, critical resonance and the ionization potential. Frank-Hertz experiment. Characteristic and continuous X-rays. Moseley's law, Bragg's Law.

Space Quantization, Magnetic moment of the electrons and magneton, Larmor Precession, Electron Spin, Stern-Gerlach experiment, Quantative concept of various quantum numbers of an electron, Pauli's exclusion principle and electronic configurations of atoms.

Unit-II: Megnetic Properties of Materials

Diamagnetism, Larmor's theory and diamagnetic susceptibility. Paramagentism, Langvin's theory and Curie Weiss Law. Qualitative discussion of Ferromagnetism and anti-ferromagnetism.

Unit-III: Quantum Concepts

Particle nature of radiation, Photoelectric effect and Compton effect. Wave nature of particles. De-Broglie Waves, Davisson-Germer experiment, Wave Packets, Phase velocity and group velocity, Heisenberg's Uncertainty Principle and applications, One dimensional Schrodinger's Wave Equation and concept of probabilities, amplitude, application to one-dimensional potential step and barrier, Quantum Mechanical Tunneling.

Unit-IV: Nuclear physics

Natural radioactivity, Laws of radioactive disintegration, radioactive series, Detection of radiation, GM Counter and Bubble Chamber, Scintillation Counter. Kinematics of nuclear reactions, artificial nuclear transmutation, discovery of neutron, radioactive tracers, transuranic elements. Cyclotron. Constitution of nucleus, Binding energy, liquid drop model and the semiempirical mass formula, Elementary theory of α-decay, β-decay and discovery of neutrino Magic numbers and the shell model, exchange forces in nuclei and Yukawa theory (qualitative), Fission and fusion, Nuclear reactors (qualitative), Thermonuclear energy.

Unit-V: Elementary Particles

Classification of Elementary Particles, Leptons, Mesons and Baryons and their quantum numbers, Conservation Laws.

Reference Books:

1. *Concept of Modern Physics 6/e (SIE) by A. Beiser, S. Mahajan, S. Rai Choudhury (Tata Mcgraw Hill Education Private Limited).*
2. *Atomic and Nuclear Physics - An Introduction by T. A. Littlefield (Littlefield Press).*
3. *Introduction to Elementary Particles 2/e by D. Griffiths (Wiley-vch Verlag Gmbh).*
4. *Modern Physics by R. Murugeshan, Kiruthiga Sivaprasath (S. Chand Publisher).*
5. *Nuclear Physics by D. C. Tayal (Variety Book Depot).*

B.Sc. Part –II: Practical Physics

List of Experiments

Group: A- (Electricity)

1. **Self Inductance (by BG):** To determine the self –inductance of a given coil by Rayleigh's method using post-office box.
2. **Mutual Inductance (by BG):** To determine the mutual inductance of a given pair of coils using a ballistic galvanometer.
3. **Capacity of condenser (by BG):** To determine the capacity of condenser using a ballistic galvanometer.
4. **High Resistance by leakage method (by BG):** To determine the high resistance by the method of leakage of condenser.
5. **Search Coil (by BG):** To determine field of an electromagnet with a search coil.
6. **Earth Inductor (by BG):** To determine the value of horizontal (H) and vertical (V) components of the earth's magnetic field and the angle of dip (δ) by an earth inductor.
7. **Maxwell's Bridge**: To measure mutual inductance of a pair of coils with a Maxwell's bridge.
8. **Schering Bridge**: With the help of Schering bridge:
    a) To measure the capacity and power factor of the given condenser.
    b) To verify the laws of series and parallel arrangement of capacities.
9. **A.C. Frequency:** To determine the frequency (f) of AC mains by sonometer.
10. **Ionization Potential**:
    (i) To draw the firing voltage Vs grid voltage curve for the thyratron.
    (ii) To observe the breakdown of Child-Langmuir's law, using thyratron as a diode.
    (iii) To observe the rise of plate current with positive grid bias greater than the ionization potential (applying negative plate voltage).

Group: B- (OPTICS)

11. **Nodal Slides:** To locate the cardinal points of an optical systems with the help of a nodal slide and hence to determine the focal length of the system.
12. **Sextant:** With the help of a sextant to determine the following
    (i) Variation of Zero-Error of the sextant with distance.
    (ii) Height of the tower.
    (iii)Horizontal distance between two objects or points
13. **Dispersive Power of the Prism:** To determine the refractive index (μ) of the material of the prism for a given wave lengths and dispersive power (ω) of the materials of the prism with a spectrometer.
14. **Newton's Rings:** To determine the wavelength (λ) of sodium light by Newton's ring method.
15. **Fresnel's Bi-prism:** To determine the wavelength of sodium light with Fresnel's Bi-prism.
16. **Single Slit Diffraction:** To determine the width of a narrow slit (α) by observing the diffraction bands.
17. **Plane Transmission Grating:** To determine the wavelength (λ) of different spectral lines emitted by light source with a plane transmission grating.
18. **Brewster's Law:** To measure the angle of polarization for glass and to measure the refractive index using Brewster's law.
19. **Polarimeter:** To determine the specific rotation (α) of an optically active substance (cane sugar solution) with the help of a polarimeter.

Reference Books:

1. Practical Physics by S. K. Kor, R. P. Khare & S. K. Jain (United Book Depot, Allahabad)

2. Practical Physics by Arora (S. Chand Publisher)

Practical Examination: *Max Marks 50, Exam. Duration 4½ hrs. (Two experiments: 25, Viva voce: 10, Record: 15) *In the practical examination every student is supposed to perform two experiments, one from each of these two groups.*

B.Sc. Part-III

Paper-I: Quantum Mechanics

Unit-I: Quantum Theory & Schrödinger's Wave Mechanics

Need of Quantum Mechanics, Schrödinger Equation and interpretation of wave function.

Observables and Operators, Hermitian, operator, Parity operator, commutation relations. Eigen values and eigen functions orthonormality and completeness. Dirac Delta function.

Measurement in quantum mechanics, Non-Commutability, uncertainly, Expectation values, Ehrenfest's Theorem.

Unit-II: Time-Dependent Schrödinger equation & Harmonic Oscillator Problem

Separation of variables in Time-Dependent Schrödinger equation. Density of states, One-dimensional Potential Barrier problems. Tunneling through squire well potential.

One-dimensional Harmonic Oscillator, Hermite Polynomials, Zero-point energy, Correspondence with Classical theory.

Unit-III: Angular Momentum & H-Atom Problem

Angular Momentum, Commutation Relations. Eigen Values and Eigen functions of L^2, L_z and ladder (L_+ L_-) operators.

Spherically symmetric potentials, Complete solutions of the Hydrogen-Atom Problem, Hydrogen Spectrum.

Unit-IV: Time-Independent Perturbation Theory

Time-independent, non-degenerate, first-order Perturbation Theory, Spin Orbit coupling. Ground and excited states of helium atom and exchange degeneracy. Qualitative and elementary idea about Lamb shift.

Unit-V: Spin & Identical Particles

Elementary concept of spin, Pauli Matrices and spin wave functions. Total angular momentum.

Identical Particles, Symmetric and Anti-symmetric wave function, Pauli's Exclusion Principle.

Reference Books:

1. *Introduction to Quantum Mechanics 2/e by D. J. Griffiths (Pearson).*
2. *Quantum Mechanics: Concepts and Applications 2/e by N. Zettili (John Wiley & Sons).*
3. *Quantum Mechanics by J. L. Powell, B. Crasemann (Narosa Publishing House).*
4. *Quantum Mechanics 3/e by L. Schiff (Tata Mcgraw Hill Education Private Limited).*
5. *Introduction to Quantum Mechanics by A. Ghatak (Macmillan Publishers India).*
6. *Quantum Mechanics by H. Prakash and B. K. Agarwal (Phi Learning).*
7. *Modern Quantum Mechanics, 2/e by J.J. Sakurai (Pearson Education India).*

Paper-II: Statistical Mechanics and Solid State Physics

Unit-I: Statistical Mechanics-I

Elementary concepts of Lagrangian and Hamiltonian, Hamilton equations of Motion, Microscopic and Macroscopic systems, Phase space representation, Division of phase space into cells, Liouville theorem and its consequences, Statistical ensembles, Equilibrium and fluctuations, Distribution probability, Equilibrium between two macroscopic systems in thermal diffusive and mechanical contacts,

Unit-II: Statistical Mechanics-II

Postulates of quantum statistical mechanics, Entropy and probability, Entropy of a perfect gas using the concept of micro canonical ensemble, Gibbs Paradox, Partition functions, Thermodynamical functions, Calculations of entropy of perfect monoatomic gas using canonical and grand canonical ensemble. Principle of Equipartition of the energy, Maxwell's velocity distribution, Distribution function for two types of quantum statistics (Bose–Einstein and Fermi-Dirac): Simple applications (Black – body radiations, and Electronic specific heat).

Unit-III: Solid State Physics

Crystalline, amorphous and glassy state of solids, Lattices translation vector, Crystal lattices, Primitive lattice cell, Miller indices, interplaner spacing, Bravais lattices, Crystal structures of s.c., b.c.c., f.c.c., diamond and h.c.p.

Reciprocal Lattice: s.c., b.c.c. and f.c.c. lattices, Brillouin Diffraction conditions in reciprocal lattice, Bragg's law.

Unit-IV: Interatomic forces and classification of solids

Inert gas solids, Vander Waals-London interaction, Repulsive interaction and equilibrium lattice constant, Compressibility and Bulk modulus, Lattice energy of ionic crystals. Madelung constant, Cohesive energy, Generalized Hooke's law, Elastic constant of cubic crystals, Vibrations of monatomic linear chain, Dispersion relation, density of modes, Group Velocity, Vibrational Spectrum of lattice with two atoms per primitive cell, acoustic and optical modes. Lattice specific heat, Einstein and Debye models.

Unit-V: Free electron theory & Band theory of solids

Free electron theory: Free electron gas in one dimension, Energy levels and density of states, Fermi Energy, Electrical conductivity, Pauli paramagnetism, Hall effect.

Band theory of solids: Energy Bands; Kronig-Penny model in one dimension, Energy gap, Number of state in a branch, Distinction between metal, Semi-conductor and insulator. Intrinsic semiconductors. Variation of Fermi level wit temperature, Effective mass.

Reference Books:

1. *Berkeley Physics Course, Vol 5: Statistical Physics by F. Rief (McGraw-Hill).*
2. *Elementary Statistical Physics by C. Kittel (Dover).*
3. *Fundamentals of Statistical Mechanics by B. B. Laud (New Age International Publishers Ltd.-New Delhi).*
4. *Statistical Physics by Hermann (Springer India).*
5. *Statistical Mechanics 2/e by B. K. Agarwal (New Age International (p) Limited).*

6. *Introduction to Solid State Physics 7/e by C. Kittel (Wiley India Pvt Ltd).*
7. *Solid State Physics by A. J. Dekker (Macmillan India Limited).*
8. *Solid State Physics 6/e by S. O. Pillai (New Age International (p) Limited)*

Paper-III: Basic Digital Electronics and Photonic Devices

Unit-I: Diode & BJT

Review of characteristics of a semiconductor diode: cut in voltage, explanation of storage and transition capacitances.

BJT as a switch, Analytic expression using Ebers-Moll model, saturation properties for normal, inverse and emitter follower mode and their comparisons. Switching speed of diode, storage and transition time, switching speed of a BJT. Metal-semiconductor junction, Schottky diode and transistor.

Unit-II: FET

Field effect transistor, principle of operation, a practical FET structure, MOSFET, enhancement and depletion modes, their representations. The MOS switch.

Unit-III: RTL, DTL & TTL

The diode-transistor gate, fan out, I/O characteristics. The transistor-transistor logic, caparison between TTL and DTL. The active pull-up, I/O characteristics. The Resistance-transistor logic, RTL-OR gates, pull-up resistors, fanout. I/O characteristics, noise margin, rise time, RTL, Ex.-OR gate.

Unit-IV: Basic Logic Gates & Combinational logic circuits

AND, OR, NOR, NOT, NAND and Ex-OR operation. Truth tables, their representations, Venn diagrams. Binary Notation, Boolean algebra, Karnaugh mapping.

Combinational logic circuits: Half-Adder, Full-Adder, Parallel and Series addition. Half and full subtractor. BCD adder.

Unit-V: IC & Photonic Devices

Integrated Circuits: Various techniques of fabrication, LSI and MSI, metal semi-conductor contact.

Photonic Devices: Photoelectric effect in semiconductors, photoresisters and photoconductor, visible light emitting diodes and displays, Photodiode, Phototransistor, PN-Junction, solar cell and its characteristics.

Reference Books:

1. *Digital Integrated Electronics by H. Taub and D. Schilling (McGraw-Hill International Editions).*
2. *Millman's Integrated Electronics: Analog & Digital Circuits & Systems 2/e by J. Millman, C. Halkias, C. D. Parikh (Tata Mcgraw Hill Education Private Limited).*
3. *Digital Logic And Computer Design by M. M. Mano (Prentice-Hall of India Pvt. Ltd.).*
4. *Electronic Devices and Circuits: An Introduction by A. Mottershead (PHI Learning)*
5. *Millman's Electronic Devices and Circuits by J. Millman (Tata Mgraw Hill)*
6. *Electronic Fundamentals and Applications: Integrated and Discrete Systems 5/e by J. D. Ryder (Phi Learning).*
7. *Electronic Devices and Circuits Theory 10/e by R. L. Boylestad, L. Nashelsky (Pearson).*
8. *Physics of Semiconductor Devices 2/e by S. M. Sze (Wiley).*
9. *Physics of Photonic Devices 2/e by S. L. Chuang (John Wiley & Sons).*
10. *Modern Digital Electronics 4/e by R. P. Jain (Tata Mcgraw Hill Education Private Limited).*

11. *Basic Electronics and Linear Circuits by N. Bhargava, D. Kulshreshtha, S. Gupta (Tata Mcgraw Hill Education Private Limited).*

Paper-IV: Electromagnetic Theory, Laser, Holography and Optical Instruments

Unit-I: Electromagnetic Theory-I

Electrostatic potential due to a charge distribution, Multipoles and their interaction with electrostatic field, Solution of Lapalce equation by separation of variables in Cartesian Spherical and Polar Coordinates.

Poynting's Theorem, Conservation of energy and momentum for a system of charged particles and electromagnetic fields, Maxwell's stress tensor.

Plane wave solution of Maxwell's equations in source free space and simple dielectrics.

Unit-II: Electromagnetic Theory-II

Polarization of electromagnetic waves. Plane wave propagation in metal and plasma. Elementary theory of dispersion. Boundary condition at a discontinuity, Fresnel's formula. Total internal reflection, Metallic reflection and skin depth.

Unit-III: Laser

Stimulated and spontaneous emission. Einstein's coefficients, relative contribution of stimulated and spontaneous emission, population inversion, Laser emission, characteristic of Laser light (including temporal), Amplification in an inverted medium, threshold condition for lasing.

Unit-IV: Holography

Basic principles, Recording a Hologram, Viewing a hologram, Thick hologram, Multiple holograms, white light reflection holograms.

Unit-V: Optical Instruments

Introduction of multiple beam interferomety, Fabry-Perot interferometer and etalon (resolving power and determination of wavelengths), Resolving power of Lummer-Gehreck plate, Grating and prisms, spectrograph for visible, IR and UV regions.

Reference Books:

1. *Electromagnetic Wave and Radiating Systems 2/e by E. C Jordan, K. G Balmain (PHI Learning).*
2. *Introduction to Electrodynamics 3/e by D. J. Griffiths (Phi Learning).*
3. *Berkeley Physics Course, Vol 2: Electricity and Magnetism by E. M. Purcell (McGraw-Hill).*
4. *Electromagnetics by B. B. Laud (New Age International (p) Ltd N Delhi).*
5. *Fundamentals of Optics 4/e by F. A. Jenkins and F. E. White (McGraw-Hill International Editions).*
6. *Geometrical & Physical Optics by R. S. Longhurst (Ol).*
7. *Optics 4/e by A. Ghatak ((Tata Mgraw Hill).*
8. *Geometrical and Physical Optics by B. K. Mathur and T. P. Pandya (New Gopal Printing Press).*
9. *Optics (schaum's Outline Series) by E. Hhecht (Tata Mcgraw Hill Education Private Limited).*
10. *Introduction to Optics by F. L. Pedrotti, L. M. Pedrotti, L. S. Pedrotti (Pearson).*
11. *Lasers: Theory and Applications by K. Thyagarajan and A. K. Ghatak (Macmillan Publishers India Ltd.).*

12. *Lasers and Non-Linear Optics 3/e by B. B. Laud (New Age International).*
13. *Holography: A Practical Approach by Gerhard K. Ackermann, Jurgen Eichler (Wiley-vch Verlag Gmbh).*

B.Sc. Part –III: Practical Physics

List of Experiments

Group: A- (Optics)

1. **Spectrometer:** Refractive index of water and of prism material by (a) Total internal reflection (b) grazing incidence methods.

2. **Michelson Interferometer:** Determination of wavelength and separation of wavelength of sodium light by Michelson Interferometer.

3. **Ultrasonic:** Determination of velocity of ultrasonic in kerosene oil by diffraction method.

4. **Babinet Compensator:** To determine (1) phase difference in two orthogonal plane polarized components, (2) Orientation and ratio of axis of elliptically polarized light by (a)α, β method (b) direct method.

5. **Carnues fringe:** To determine the Young's modulus of a rectangular glass-plate by Carnues fringe method.

6. **Thickness of mica sheet:** To determine the thickness of mica sheet using Fresnel's Bi-Prism.
7. **Plane Reflection Grating:** To determine wavelength of laser light using plane reflection grating (inch scale & cm scale).
8. **Refractive Index Gradient:** Gradient of refractive index in a mixture of two liquids, to find,
   (a) Difference Between refractive indeces of two liquids
   (b) variation of refractive index and refractive index gradient with height.
   (c) maximum (dN/dy) and
   (d) width of transition region at half maximum.
9. **Fraunhoffer Diffraction:** Fraunhoffer Diffraction at double slit.
   (a) Plotting the intensity variation in diffraction pattern.
   (b) To determine the wavelength of He-Ne/Diode laser.
   (c) Finding the ratio of maximum intensity and observation of missing order.

Group: B- (Electronics)

10. **Photo transistor and photo diode:** (1) Calibration of OPAM (2) To draw characteristic of photo diode/transistor for at least three different distances (3) Verification of inverse squre law.

11. **e/m:** To determine e/m of electron and also check from graph and calculation (plot B vs l/i , I vs l, B vs i).

12. **CE Amplifier :** To (1) trace the circuit and write the value of resistances by colour code, (2) Note D.C. Voltages and currents, (3) Study input-output characteristics at 1 KHz, (4) Study frequency response & obtain mid frequency gain and cut off frequencies.

13. **FET:** To (1) trace the circuit for amplifier with value of resistance by colour code and note D.C. voltages and currents, (2) find the voltage amplification 'A' given 0.2V A.C. voltage of 1khz, (3) Find Q point, (4) Draw characteristic curves at different gate voltages taking care that curves near Q point is also plotted, (5) Draw A.C. & D.C. load lines (6) Find 'A' from A.C. load line also (7) Calculate saturation current for different V_{gs}, Plot a graph & obtain out of voltages, (8) Calculate g (m), R(on) & R_d (9) verify $I(ds) = I(dss)\left(1-\frac{Vgs}{V_p}\right)^2$
14. **RTL gate :** to verify (1) Truth table for NOR- NOT gates, (2) switching action of transistor & draw $V_L - V_0$, $I_B - I_c$, σ Vs V, R_{switch} Vs V_{CE} curves, (3) To find out the fanout using driver driven condition in (a) single input RTL gate (b) double input RTL gate.
15. **DTL:** (1) To verify truth table for DTL gates, (2) To draw input-output characteristic & voltages at different points for DTL gates, (3) To find fan out.
16. **TTL:** (1) To verify truth table for TTL gates, (2) To draw input-output characteristic & voltages at different points for TTL gates, (3) To find fan out.
17. **Hysteresis:** To draw hysteresis loop for the material of given anchor ring and to find: **(i) Hysteresis loss (ii) Retentivity (iii) Coercivity (iv) B_{max} (v) H_{max}**
18. **Bias Stabilization:** (i) To Calculate the band gap by plotting I_B Vs (I_B+I_C) for collector biasing case at two temperatures: (1) at room temperature (2) at 55 ^{0}C
    (ii) To calculate stability factor for fixed biasing, collector biasing, emitter biasing and potential divider biasing.
    (iii) To study the variation of I_B, I_C, V_{CC} and V_{BE} with temperature for different biasing.
    (iv) Plot temperature Vs V_{CE} , V_{BE}, I_B, I_C (at room temperature).

Reference Book:

1. Advanced Practical Physics by H. B. Lal, U. S. Pandey & R. B. Singh (United Book Depot, Allahabad).

Practical Examination: Max. Marks 75, Exam. Duration 6 Hrs.
[Two experiments: 30, Viva voce: 15, Record: 20, Project :10]

**In the practical examination every student is supposed to perform two experiments, one from each of these two groups.*