

Syllabus of B.Sc.I (NEP) 2025-2026 Physics

Semester-I

Paper-I: Mechanics-I

1. Vector Analysis: Background of Vector Calculus, Concept of gradient, divergence and curl of line, surface and volume integral.

2. Mechanics: Frame of Reference, Galilean transformation, Galilean invariance, Inertial and Non-inertial frames, Pseudo forces, Rotating reference frame, Centrifugal force, Coriolis Force. Inertial and Gravitational mass, Principle of Equivalence. 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.

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.

Semester –I

Paper-II: Thermodynamics

- 1. Temperature and Zeroth Law of Thermodynamics:** Thermodynamic systems, Macroscopic and Microscopic Variables, Thermodynamical Equilibrium, Thermodynamical state, Zeroth law of thermodynamics and concept of Temperature.
- 2. Heat and First Law of Thermodynamics:** Heat and Work and their path-dependence, Thermal processes, First law of thermodynamics and internal energy, Joule's law, Applications of first law.
- 3. Carnot Cycle and Thermodynamic Temperature Scale:** 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.
- 4. Entropy and Second Law of Thermodynamics:** Entropy, Calculation of entropy in various processes, Entropy and unavailable energy, Physical significance of entropy, Second Law of thermodynamics.
- 5. Thermodynamic Relations:** Conditions for natural changes, Thermodynamic potentials and Maxwell's equation, Applications of Maxwell's equations
- 6. Open Systems:** Joule-Thomson effect, Inversion Temperature, Change of phase, First and second order phase transitions, and Ehrenfest's equations.

Semester-I

Paper-III: Electrical Circuit

1. Analysis of Electrical Networks: Circuit parameters, R, L, and C, Kirchoff's Law for a loop and junction, Solutions by determinant and matrix method: application to T, π and bridge circuits, Norton and Thevenin's Theorem, Maximum power transfer Theorem.

2. Transient Analysis of D.C. Circuit: Difference between steady state and transient, Growth and decay of current in an inductive circuit, Charging and discharging of a capacitor through a resistor and through inductor and resistor in series.

3. Moving Coil Galvanometer: Ballistic Galvanometer, Cs and Qs, Measurement of capacity and of high resistance by leakage method.

4. Alternating Currents: AC analysis (vector treatment only): complex impedance and phasor notations, Impedance and Admittance operators, vector diagram for voltage and current in LR, CR and LCR in series and parallel, Power consumed in the circuit, Series and parallel resonance, Q of a coil, Transformer – its equivalent circuit.

5. AC Bridges: Balance and sensitivity conditions for AC bridge, Measurement of L by Maxwell's bridge, Measurement of C by Schering's bridge.

Semester-II

Paper-I: Mechanics-II

1. 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.

2. Fluid Mechanics: Ideal fluids, Equation of continuity, Streamline flow, Rotational and irrotational flows, Euler's equation of motion, Bernoulli's Theorem, Viscous fluids, Poiseuille's equation, Viscosity by rotating cylinder method.

3. Special Theory of Relativity: 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 Aberration.

Semester –II

Paper-II: Thermal Physics

- 1. Kinetic Theory of Gases:** Maxwell-Boltzmann Law of distribution of molecular velocities, Evaluation of r.m.s. Velocity and average and most probable speeds, Mean free path, Transport phenomenon.
- 2. Conduction of Heat:** Fourier equation for one-dimensional flow of heat and its steady-state solution, Periodic flow of heat (only sinusoidal heat current).
- 3. Radiation-I:** 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.
- 4. Radiation-II:** 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.

Semester-II

Paper-III: Basic Semi-conductor Electronics

- 1. Conduction in Solids:** conductor, insulator and semi-conductor, insulator and semi-conductor, Electrons and holes as charge carriers, Intrinsic and extrinsic semi-conductors, Conductivity and mobility, Conduction by diffusion and drift.
- 2. P.N. Junction:** Built-in-voltage and charge depletion region, Statement of diode equation and diode characteristics, Forward and reverse resistance, Zener diode: its characteristics. Filtering by RC and LC circuit. Regulation: voltage regulation using Zener diode.
- 3. BJT:** NPN and PNP transistor action, characteristics in CB and CE configurations. Hybrid, alpha and beta parameters, their inter-relationships. Load line, Small signal hybrid equivalent circuit, CE amplifier, Middle frequency response, Practical amplifier circuit
- 4. Feedback Oscillators:** Principles of feedback, Barkhausen criteria for sustained oscillations. Qualitative discussion of collector tuned oscillator, Circuits of Hartley and Colpitts oscillator.
- 5. Modulation:** Need for modulation, three types of modulation. Frequency spectrum and power in a.m. wave, A typical a.m. circuit. Linear diode detector.
- 6. C.R.O.:** working of cathode ray tube, block diagram of CRO, typical applications of CRO.

B.Sc. (Physics)–III Semester:

Paper-I Optics-I

Cardinal Points of coaxial optical systems. Simple problems on combination of thin lenses, Eyepieces, Aplanatic 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 phenomena).

Conditions for observing interference, Degree of coherence and visibility of fringes, Production of interference fringes and determination of wavelength, Michelson interferometer and its uses, Colour of thin films, Newton's Rings. Theory of Multiple Reflections, FP Etalon.

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

Paper II Waves and Oscillation

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

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.

Ultrasonic-Generation and detection. Measurement of velocity in Liquids, Applications.

Paper III Atomic and Nuclear Physics-I

Bohr-Sommerfeld Model (Historical developments), Bohr model and the spectra of hydrogenic atoms, Critical resonance and the Ionisation potentials. Frank-Hertz experiment. Characteristic and continuous X-rays, Moseley's law, Bragg's law.

Space Quantization, Vector atom model and Quantum Numbers, Magnetic moment of the electrons and magneton, Larmor Precession, Electron Spin, Stern-Gerlach experiment, Qualitative concept of various quantum number of an electron, Pauli's exclusion principle and electronic configuration of atoms.

Particle nature of radiation, Photoelectric effect and Compton effect. Wave nature of particles.

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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

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B.Sc. (Physics) – IV Semester:

Paper-I Optics-II

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.

Unpolarised, polarised and partially polarised lights. Polarisation by reflection, Double refraction by uni-axial crystals, Polaroids, Huygen's theory of double refraction. Half and quarter waveplates. Production of elliptically polarised light.

Babinet compensator, Analysis of elliptically polarised light by using a Nicol and a quarter wave plate, and by using Babinet compensator. Optical activity. Fresnel's theory of optical rotation, Specific rotation, Biquartz and Laurent's half-shade polarimeters.

Paper II Electromagnetism

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

Ampere's Law, Biot Savart's Law, Law of Force in Magnetic Field on Currents and charged particles. Magnetic Field 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 and for Straight Infinite Wire. Divergence and Curl of $\mathbf{B}$. Distant Field due to a Loop of Current. Magnetic Moment. Magnetic Materials and Magnetization. Magnetization Current Field $\mathbf{H}$, Curl of $\mathbf{H}$ and Calculation of $\mathbf{H}$.

Polarization. Polarization Charges. Field $\mathbf{D}$. 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.

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

Displacement Current, Curl $\mathbf{H}$. Faraday's Law (Integral and Differential forms). Self and Mutual Inductances. Energy of Coupled Circuits and current distribution. $M \leq \sqrt{L_1 L_2}$ Energy as an Integral over the Magnetic Field. Energy of Solenoid.

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Maxwell Equations, Plane polarized Plane Wave solution. Characteristics of these Electromagnetic waves.

Paper III Atomic and Nuclear Physics-II

Diamagnetism, Larmor's theory and diamagnetic susceptibility. Paramagnetism, Langevin's theory and Curie-Weiss Law, Qualitative discussion of Ferromagnetism and antiferromagnetism.

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.

Classification of Elementary Particles, Leptons, mesons and baryons and their quantum numbers, Conservation Laws

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