Physics Syllabus

Paper I is of 3 hours duration and is divided into two parts.

Part I (20 marks): This part consists of compulsory short answer questions, testing knowledge, application and skills relating to elementary/fundamental aspects of the entire syllabus.

Part II (50 marks): This part is divided into three Sections A, B and C. There are six questions in Section A (each carrying 5 marks) and you are required to answer four questions from this Section. There are four questions in Section B (each carrying 5 marks) and you are required to answer three questions from this Section. There are four questions in Section C (each carrying 5 marks) and you are required to answer three questions from this Section. Therefore, you are expected to answer ten questions in Part II.

SECTION A

1. Electrostatics

(i) Coulomb's law, S.I. unit of charge; permittivity of free space.

(ii) Concept of electric field $E = F/q_o$; Gauss' theorem and its applications.

(iii) Electric dipole; electric field at a point on the axis and perpendicular bisector of a dipole; electric dipole moment; torque on a dipole in a uniform electric field.

(iv) Electric lines of force.

(v) Electric potential and potential energy; potential due to a point charge and due to a dipole; potential energy of an electric dipole in an electric field. Van de Graff generator.

(vi) Capacitance of a conductor $C = Q/V$, farad; capacitance of a parallel-plate capacitor; $C = \varepsilon_0 A/d$. Capacitors in series and parallel combinations; effective capacitance and charge distribution. Energy stored

(vii) Dielectrics (elementary ideas only); permittivity and relative permittivity of a dielectric ($\varepsilon_r = \varepsilon/\varepsilon_o$). Effects on pd, charge and capacitance. Electric polarisation.

2. Current Electricity

(i) Mechanism of flow of current in metals, drift velocity and mobility of electrons, Ohm’s Law and its proof. Resistance and resistivity and their relation to drift velocity of electrons; description of resistivity and conductivity based on electron theory; effect of temperature on resistance, colour coding of resistance.

(ii) Potential difference as the power supplied divided by the current. Ohm's law (V-I characteristics) and its limitations; Combinations of resistors in series and parallel; Electric energy and power.

(iii) Electromotive force in a cell; internal resistance and back emf. Combination of cells in series, parallel and mixed grouping.

(iv) Kirchoff's laws and their simple applications to circuits with resistors and sources of emf; Wheatstone bridge, metre-bridge and potentiometer; use to measure potential difference and for comparison of emf and determination of internal resistance of sources of current; use of resistors (shunts and multipliers) in ammeters and voltmeters.

3. Magnetism

(i) Magnetic field B, definition from magnetic force on a moving charge; magnetic field lines; magnetic field and magnetic flux density; the earth's magnetic field and magnetic elements; Magnetic field of a magnetic dipole.

(ii) Properties of dia, para and ferromagnetic substances; susceptibility and relative permeability, hysteresis.

4. Electromagnetism

(i) Oersted's experiment; Biot-Savart law, the tesla; magnetic field near a long straight wire, at the centre of a circular loop, and at a point on the axis of a circular coil carrying current. Amperes circuital law and its application to obtain magnetic field due to a long straight wire and a solenoid.

(ii) Force on a moving charge in a magnetic field; force on a current carrying conductor kept in a magnetic field; force between two long and parallel current carrying wires; definition of ampere based on the force between two current carrying wires. Cyclotron.

(iii) A current loop as a magnetic dipole; magnetic dipole moment; torque on a current loop (magnetic dipole); moving coil galvanometer.

(iv) Electromagnetic induction, magnetic flux and induced emf; Faraday's laws and Lenz's law, motional emf; eddy currents.

(v) Mutual and self inductance: the henry. Growth and decay of current in LR and RC circuits (dc) (graphical approach), time constant. Transformer.

(vi) Simple a.c. generators. Basic differences between a.c. and d.c.

5. Alternating Current Circuits

(i) Change of voltage and current with time, phase; peak and rms values of voltage and current; their relation in sinusoidal case.

(ii) Variation of voltage and current in a.c. circuits consisting of only a resistor, only an inductor and only a capacitor (phasor representation), phase lag and phase lead.

(iii) The LCR series circuit: phasor diagram, expression for V or I; phase lag/lead; impedance of a series LCR circuit (arrived at by phasor diagram); Special cases for RL and RC circuits.

(iv) Power P associated with LCR circuit = $\frac{1}{2}V_oI_o \cos\varphi = V_{rms}I_{rms} \cos\varphi = I_{rms}^2R$; power absorbed and power dissipated; choke coil (choke and starter); electrical resonance; bandwidth of signals and Q factor; oscillations in an LC circuit ($\omega = 1/\sqrt{LC}$).

SECTION B

6. Wave Optics

(i) Complete electromagnetic spectrum from radio waves to gamma rays; transverse nature of electromagnetic waves, Huygen's principle; laws of reflection and refraction from Huygen's principle.

(ii) Conditions for interference of light, interference of monochromatic light by double slit; Young’s double slit experiment, measurement of wave length.

(iii) Single slit Fraunhofer diffraction (elementary explanation).

(iv) Plane polarised electromagnetic wave (elementary idea), methods of polarisation of light. Brewster's law; polaroids.

7. Ray Optics and Optical Instruments

(i) Reflection of light by spherical mirrors.

(ii) Refraction of light at a plane interface, Snell's law; total internal reflection and critical angle; total reflecting prisms and optical fibres.

(iii) Refraction through a prism, minimum deviation and derivation of relation between n, A and δ_{min}.

(iv) Refraction at a single spherical surface (relation between n1, n2, u, v and R); refraction through thin lenses (lens maker's formula and formula relating u, v, f, n, R1 and R2); lens formula, combined focal length of two thin lenses in contact. Combination of lenses and mirrors [Silvering of lens excluded] and magnification. Spherical aberration.

(v) Dispersion; dispersive power; pure and impure spectrum; Scattering of light. Chromatic aberration.

(vi) Simple microscope; Compound microscope and their magnifying power.

(vii) Simple astronomical telescope (refracting and reflecting), magnifying power and resolving power of a simple astronomical telescope.

(viii) Human Eye, Defects of vision and their correction.

SECTION C

8. Electrons and Photons

(i) Photo electric effect, quantization of radiation; Einstein's equation; threshold frequency; work function; stopping potential; energy and momentum of a photon. Determination of Planck’s Constant.

(ii) Wave particle duality, De Broglie equation, phenomenon of electron diffraction (qualitative only).

9. Atoms

(i) Charge and size of nuclei (α-particle scattering); atomic structure; Bohr's postulates; radii of Bohr orbits for hydrogen atom; energy of the hydrogen atom in the nth state; line spectra of hydrogen and calculation of ΔE and f for different lines.

(ii) Production of X-rays; maximum frequency for a given tube potential. Characteristic and continuous X -rays. Moseley’s law.

10. Nuclei

(i) Atomic masses; Isotopes, Isobars and Isotones; unified atomic mass unit u and its value in MeV; composition and size of nucleus; mass defect and binding energy. Energy - mass equivalence.

(ii) Radioactivity: nature and radioactive decay law, half-life, mean life and decay constant. Nuclear reactions.

11. Nuclear Energy

(i) Nuclear fission; chain reaction; principle of operation of a nuclear reactor.

(ii) Nuclear fusion; thermonuclear fusion as the source of the sun's energy.

12. Semiconductor Devices

(i) Energy bands in solids; energy band diagrams for distinction between conductors, insulators and semi-conductors - intrinsic and extrinsic; electrons and holes in semiconductors.

(ii) Junction diode; depletion region; forward and reverse biasing, V-I characteristics; half wave and a full wave rectifier; solar cell, LED and photodiode. Zener diode.

(iii) Junction transistor; npn and pnp transistors; current gain in a transistor and transistor as an amplifier in common emitter mode (only circuit diagram and qualitative treatment); transistor as a switch; oscillator.

(iv) Elementary idea of discreet and integrated circuits, analogue and digital signals. Logic gates (symbols; working with truth tables; applications and uses) - NOT, OR, AND, NOR, NAND. Combination of gates.

13. Communication Systems

Propagation of electromagnetic waves in the atmosphere, sky and space wave propagation, need for modulation, amplitude and frequency modulation, bandwidth of signals, bandwidth of transmission medium, basic elements of a communication system (block diagram only).