

PHYSICS (PH)

EXAM SCHEME

The JAM Examination is will be carried out as **ONLINE** Computer Based Test (CBT) where the candidates will be shown the questions in a random sequence on a computer screen. The duration of the examination will be 3 hours. The medium for all the test papers will be English only. There will be a total of 60 questions carrying 100 marks. The entire paper will be divided into three sections, A, B and C. All sections are compulsory. Questions in each section will be of different types as given below:

- **Section–A** contains a total of 30 Multiple Choice Questions (MCQ) involving 10 questions of one mark each and 20 questions of two marks each. Each MCQ type question has four choices out of which only one choice is the correct answer. Candidates can mark the answer by clicking the choice.
- **Section–B** contains a total of 10 Multiple Select Questions (MSQ) carrying two marks each. Each MSQ type question is similar to MCQ but with a difference that there may be one or more than one choice(s) that are correct out of the four given choices. The candidate gets full credit only if he/she selects all the correct answers only and no wrong answers. Candidates can mark the answer(s) by clicking the choice(s).
- **Section–C** contains a total of 20 Numerical Answer Type (NAT) questions involving 10 questions of one mark each and 10 questions of two marks each. For these NAT type questions, the answer is a signed real number, which needs to be entered using the virtual numeric keypad on the monitor. No choices will be shown for these types of questions.
- In all sections, questions not attempted will result in zero mark. In Section-A (MCQ), wrong answer will result in **negative** marks. For each wrong answer of 1 mark questions, 1/3 mark will be deducted and similarly for each wrong answer of 2 marks questions, 2/3 mark will be deducted. In Section-B (MSQ), there are **no negative** and **no partial** marking provisions. There is **no negative** marking in Section-C (NAT) as well.
- There is provision of using **online virtual calculator** and hence, the candidates should not bring any calculator with them.

- Mobile phones or any other electronic devices are **strictly prohibited** inside examination hall. Charts, graph sheets, and tables are also **NOT** allowed inside the examination hall.
- A scribble pad will be provided for rough work and this has to be returned back at the end of the examination.
- The candidates are required to select the answer for MCQ and MSQ type questions using the mouse. The answer for NAT questions can be entered using a virtual numeric keypad (the keyboard of the computer will be disabled). At the end of the 3 hours, the computer will automatically end the examination.



SYLLABUS

Mathematical Methods:

Calculus of single and multiple variables, partial derivatives, Jacobian, imperfect and perfect differentials, Taylor expansion, Fourier series. Vector algebra, Vector Calculus, Multiple integrals, Divergence theorem, Green's theorem, Stokes' theorem. First order equations and linear second order differential equations with constant coefficients. Matrices and determinants, Algebra of complex numbers.

Mechanics and General Properties of Matter:

Newton's laws of motion and applications, Velocity and acceleration in Cartesian, polar and cylindrical coordinate systems, uniformly rotating frame, centrifugal and Coriolis forces, Motion under a central force, Kepler's laws, Gravitational Law and field, Conservative and non-conservative forces. System of particles, Center of mass, equation of motion of the CM, conservation of linear and angular momentum, conservation of energy, variable mass systems. Elastic and inelastic collisions. Rigid body motion, fixed axis rotations, rotation and translation, moments of Inertia and products of Inertia, parallel and perpendicular axes theorem. Principal moments and axes. Kinematics of moving fluids, equation of continuity, Euler's equation, Bernoulli's theorem.

Oscillations, Waves and Optics:

Differential equation for simple harmonic oscillator and its general solution. Superposition of two or more simple harmonic oscillators. Lissajous figures. Damped and forced oscillators, resonance. Wave equation, traveling and standing waves in one-dimension. Energy density and energy transmission in waves. Group velocity and phase velocity. Sound waves in media. Doppler Effect. Fermat's Principle. General theory of image formation. Thick lens, thin lens and lens combinations. Interference of light, optical path retardation. Fraunhofer diffraction. Rayleigh criterion and resolving power. Diffraction gratings. Polarization: linear, circular and elliptical polarization. Double refraction and optical rotation.

Electricity and Magnetism:

Coulomb's law, Gauss's law. Electric field and potential. Electrostatic boundary conditions, Solution of Laplace's equation for simple cases. Conductors, capacitors, dielectrics, dielectric polarization, volume and surface charges, electrostatic energy. Biot-Savart law, Ampere's law, Faraday's law of electromagnetic induction, Self and mutual inductance. Alternating currents. Simple DC and AC circuits with R, L and C components. Displacement current, Maxwell's equations and plane electromagnetic waves, Poynting's theorem, reflection and refraction at a dielectric interface, transmission and reflection coefficients (normal incidence only). Lorentz Force and motion of charged particles in electric and magnetic fields.

Kinetic theory, Thermodynamics:

Elements of Kinetic theory of gases. Velocity distribution and Equipartition of energy. Specific heat of Mono-, di- and tri-atomic gases. Ideal gas, van-der-Waals gas and equation of state. Mean free path. Laws of thermodynamics. Zeroth law and concept of thermal equilibrium. First law and its consequences. Isothermal and adiabatic processes. Reversible, irreversible and quasi-static processes. Second law and entropy. Carnot cycle. Maxwell's thermodynamic relations and simple applications. Thermodynamic potentials and their applications. Phase transitions and Clausius-Clapeyron equation. Ideas of ensembles, Maxwell-Boltzmann, Fermi-Dirac and Bose-Einstein distributions.

Modern Physics:

Inertial frames and Galilean invariance. Postulates of special relativity. Lorentz transformations. Length contraction, time dilation. Relativistic velocity addition theorem, mass energy equivalence. Blackbody radiation, photoelectric effect, Compton effect, Bohr's atomic model, X-rays. Wave-particle duality, Uncertainty principle, the superposition principle, calculation of expectation values, Schrödinger equation and its solution for one, two and three dimensional boxes. Solution of Schrödinger equation for the one dimensional harmonic oscillator. Reflection and transmission at a step potential, Pauli exclusion principle. Structure of atomic nucleus, mass and binding energy. Radioactivity and its applications. Laws of radioactive decay.

Solid State Physics, Devices and Electronics:

Crystal structure, Bravais lattices and basis. Miller indices. X-ray diffraction and Bragg's law; Intrinsic and extrinsic semiconductors, variation of resistivity with temperature. Fermi level. p-n junction diode, I-V characteristics, Zener diode and its applications, BJT: characteristics in CB, CE, CC modes. Single stage amplifier, two stage R-C coupled amplifiers. Simple Oscillators: Barkhausen condition, sinusoidal oscillators. OPAMP and applications: Inverting and non-inverting amplifier. Boolean algebra: Binary number systems; conversion from one system to another system; binary addition and subtraction. Logic Gates AND, OR, NOT, NAND, NOR exclusive OR; Truth tables; combination of gates; de Morgan's theorem.

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