Test Code : PHB : (Short Answer Type) 2021

Junior Research Fellowship in Physics and Applied Mathematics

The candidates for Junior Research Fellowship in Physics and Applied Mathematics will have to write Two Papers − Test PHA (objective type) in the forenoon session and Test PHB (short answer type) in the afternoon session.

The PHB test booklet will consist of three parts. The candidates are required to answer Part I (compulsory) and any one between Parts II & III.

The syllabus for the test is as follows.

PART-I

Mathematical and Logical Reasoning

Syllabus

B.Sc. Pass Mathematics Syllabus of Indian Universities

PART-II

Physics

Syllabus

1. **Classical Mechanics**

   Mechanics of a particle and system of particles, Scattering in a central field, Lagrange's equations and their applications, Hamilton's equations, Canonical transformations, Special theory of relativity, Small oscillations, Vibrations and acoustics.

2. **Electromagnetic Theory**

   Electrostatics, Magnetostatics, Maxwell's equations, Gauge transformations, Poynting's theorem, Wave equation and plane waves, Radiating system and scattering.

3. **Statistical Physics and Condensed Matter Physics**

   Statistical basis of thermodynamics, Ensembles – microcanonical, canonical and grand canonical, Quantum statistics, Phase transitions, Statistical fluctuations, Free electron theory, Band theory of electrons, Semiconductor physics, Transport phenomena, Magnetism, Superconductivity.

4. **Quantum Mechanics and Quantum Field Theory**

   Schrödinger wave equation, General formalism of wave mechanics, Exactly solvable eigenvalue problems for various potentials, Approximation methods, Scattering theory, Time dependent perturbation theory, Symmetries and conservation laws, Relativistic quantum mechanics, Quantum field theory – scalar and spinor fields, Quantum electrodynamics.

5. **Elementary Particles**

   Elementary particles, Weak and strong interactions, Selection rules, CPT theorem, Symmetry principles in particle physics.

Mathematics

Syllabus

1. **Linear Algebra**

   Vector space; Linear transformation; Matrices; Properties of eigenvalues and eigen-vectors; Diagonalizability of matrices, Jordan canonical form, Hermitian and unitary matrices; Linear operators, Hermitian and unitary operators, Minimal polynomial; Spectral decomposition; Rank; System of linear equations.

2. **Abstract Algebra**

   Sets; Relations and mappings; Groups; Rings; Fields.

3. **Real analysis**

   Functions of single and several variables; Proper and improper integrals; Lebesgue measure, Lebesgue integration and their properties; Absolute continuity; Fourier series; Integral transform; Metric space, normed linear space, Lp spaces, Banach space, Hilbert space.

4. **Differential Equations**

   Existence and uniqueness of solutions of initial value problems for first order or-dinary differential equations; Linear homogeneous differential equation, ordinary and singular points, series solution, Frobenius method; Linear nonhomogeneous dif-ferential equation, solution by variation of parameters, Strum-Liouvilles problem; Special functions: Legendre, Bessel and Hypergeometric; System of ordinary differ-ential equations; Nonlinear dynamical systems: equilibrium points and their stabil-ity analysis, Lyapunov function, bifurcation diagram; Partial differential equation up to second order, equations of parabolic, hyperbolic and elliptic types.

5. **Continuum Mechanics**

   Kinematics of fluid, equation of continuity, irrotational motion, velocity potential; Dynamics of ideal fluid, Eulerian and Lagrangian equations of motion, stream func-tion, sources, sinks and doublets, vortex, surface waves, boundary layer.

6. **Functions of Complex Variables**

   Analytic function; Taylor and Laurent series; Singularities and their classification, Branch-point; Contour integration, Cauchys residue theorem; Analytic continuation; Entire function; Uniform convergence; Properties of uniformly convergent series, power series.

7. **Classical Mechanics**

   Mechanics of a particle and system of particles, DAlemberts principle; velocity de-pendent potential and dissipation function; Lagranges equations and their applica-tions; Hamiltons principle, symmetry properties and conservation laws, Canonical transformation; Hamiltons equation; Special theory of relativity, Galilean Transfor-mations, Lorentz transformations, Simultaneity, time dilation and Lorentz contrac-tion.

8. **Probability and Stochastic Processes**

   General definition of expectation and conditional expectation; Different modes of convergence and limit theorems; Stochastic processes; Martingales; Markov chains; Stochastic process in continuous time, Poisson process; Brownian motion.