Screening test syllabus for the post of Assistant Professor

Subject: Physics

Unit I
Dimensional analysis. Vector algebra and vector calculus. Linear algebra, matrices, Cayley-Hamilton Theorem.Eigenvalues and eigenvectors.Linear ordinary differential equations of first & second order, Partial differential equations (Laplace, wave and heat equations in two and three dimensions).Fourier series, Fourier and Laplace transforms. Elements of complex analysis, analytic functions; Taylor & Laurent series; poles, residues and evaluation of integrals.Binomial, Poisson and normal distributions.Central limittheorem.

Unit II
Newton's laws.Central force motions.Rigid body dynamics- moment of inertia tensor. Non-inertial frames and pseudoforces.Variational principle.Generalized coordinates.Lagrangian and Hamiltonian formalism and equations of motion.Conservation laws and cyclic coordinates.Poisson brackets and canonical transformations.Symmetry, invariance and Noether's theorem.Hamilton-Jacobi theory.
Periodic motion: small oscillations, normal modes. Special theory of relativity- Lorentz transformations, relativistic kinematics and mass–energyequivalence.

Unit III
Electrostatics: Gauss's law and its applications, Laplace and Poisson equations, boundary value problems. Magnetostatics: Biot-Savart law, Ampere's theorem. Electromagnetic induction.Maxwell's equations in free space and linear isotropic media; boundary conditions on the fields at interfaces.Scalar and vector potentials, gauge invariance. Electromagnetic waves in free space. Dielectrics and conductors.Reflection and refraction, polarization, Fresnel's law, interference, coherence, and diffraction.Dynamics of charged particles in static and uniform electromagneticfields.Lorentz invariance of Maxwell's equation.Radiation-from moving charges and dipoles and retarded potentials.

Unit IV
Wave-particle duality.Schrödinger equation (time-dependent and time-independent).Eigenvalue problems (particle in a box, harmonic oscillator, etc.).Tunneling through a barrier.Wave-function in coordinate and momentum representations.Commutators and Heisenberg uncertainty principle.Dirac notation for state vectors. Motion in a central potential: orbital angular momentum, angular momentum algebra, spin, addition of angular momenta; Hydrogen atom. Stern-Gerlach experiment.Time- independent perturbation theory and applications.Variational method.Time dependent perturbation theory and Fermi's golden rule, selection rules. Identical particles, Pauli exclusion principle, spin-statistics connection.

Unit V
Laws of thermodynamics and their consequences. Thermodynamic potentials, Maxwell relations, chemicalpotential,phaseequilibria.Phasespace,micro-andmacro-states.Micro-canonical,canonical

and grand-canonical ensembles and partition functions. Free energy and its connection with thermodynamic quantities.Classical and quantum statistics.Ideal Bose and Fermi gases.Principle of detailed balance.Blackbody radiation and Planck's distribution law.

Unit VI
Semiconductor devices (diodes, junctions, transistors, field effect devices, homo- and hetero-junction devices), device structure, device characteristics, frequency dependence and applications.Opto-electronic devices (solar cells, photo-detectors, LEDs).Operational amplifiers and their applications.Digital techniques and applications (registers, counters, comparators and similar circuits).A/D and D/A converters.Microprocessor and microcontroller basics.

Data interpretation and analysis.Precision and accuracy.Error analysis, propagation of errors. Least squares fitting.

Unit VII
Quantum states of an electron in an atom.Electron spin.Spectrum of helium and alkali atom.Relativistic corrections for energy levels of hydrogen atom, hyperfine structure and isotopic shift, width of spectrum lines, LS & JJ couplings.Zeeman, Paschen-Bach & Stark effects.Electron spin resonance. Nuclear magnetic resonance, chemical shift.Frank-Condon principle.Born-Oppenheimer approximation.Electronic, rotational, vibrational and Raman spectra of diatomic molecules, selection rules. Lasers: spontaneous and stimulated emission, Einstein A& B coefficients. Optical pumping, population inversion, rate equation.Modes of resonators and coherencelength.

Unit VIII
Bravais lattices.Reciprocal lattice.Diffraction and the structure factor.Bonding of solids. Elastic properties, phonons, lattice specific heat. Free electron theory and electronic specific heat. Response and relaxation phenomena.Drude model of electrical and thermal conductivity.Hall effect and thermoelectric power. Electron motion in a periodic potential, band theory of solids: metals, insulators and semiconductors. Superconductivity: type-I and type-II superconductors. Josephson junctions.Superfluidity.Defects.

Unit IX
Basic nuclear properties: size, shape and charge distribution, spin and parity. Binding energy, semi-empirical mass formula, liquid drop model.Nature of the nuclear force, form of nucleon-nucleon potential, charge-independence and charge-symmetry of nuclear forces.Deuteron problem.Evidence of shell structure, single-particle shell model, its validity and limitations.Elementary ideas of alpha, beta and gamma decays and their selection rules.Fission and fusion.Nuclear reactions, reaction mechanism, compound nuclei and directreactions.

Unit X
Classification of fundamental forces.Elementary particles and their quantum numbers (charge, spin, parity, isospin, strangeness, etc.).Gellmann-Nishijima formula.Quark model, baryons and mesons.C, P, and T invariance.CP violation.Application of symmetry arguments to particle reactions.Parity non-conservation in weak interaction.Relativistic kinematics.