

## 17. SYLLABUS FOR COMPETITIVE EXAMINATION FOR THE POST OF TEACHING ASSOCIATE IN PHYSICS

### **I: Electromagnetic Theory-**

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 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; Dispersion relations in plasma; Lorentz invariance of Maxwell's equations; Dynamics of charged particles in static and uniform electromagnetic fields; Radiation from moving charges, dipoles and retarded potentials.

### **II: Electronics-**

Physics of P-N junction, Diode as a circuit element, clipping and clamping, Rectification, Zener regulated power supply Transistor as a circuit element, CC, CB and CE configuration, Transistor as a switch, Feedback in amplifiers, Oscillators, FET, MOSFET and their applications, Operational amplifiers and its applications, inverting and non-inverting amplifiers, adder, integrator differentiator, wave form generator, multivibrators, comparator, Schmidt trigger. Boolean Algebra, Digital integrated circuits: Logic gates, NAND and NOR gates as building blocks, X-OR gate, Half and Full adder circuits, Karnaugh map, Flip – Flops, counters and registers.

### **III: Circuit Analysis-**

Energy sources, Active and Passive elements, Kirchhoff's laws and their applications. Four terminal networks, Z, Y and h parameters, Thevenin's and Norton's Theorem, Maximum Power Transfer Theorem, Superposition Theorem, Reciprocity Theorem, Miller Theorem, T and PI Network, Mean and rms values in AC circuits. LR, CR and LCR circuits- series and parallel resonance. Quality factor. Principal of transformer.

### **IV: Atomic & Molecular Physics-**

Quantum states of an electron in an atom; Electron spin; Stern-Gerlach experiment; Spectrum of Hydrogen, helium and alkali atoms; Relativistic corrections for energy levels of hydrogen; Hyperfine structure and isotopic shift; width of spectral lines; LS & JJ coupling; Zeeman, Paschen Back & Stark effect; X-ray spectroscopy; Electron spin resonance, Nuclear magnetic resonance, chemical shift; Rotational, vibrational, electronic, and Raman spectra of diatomic molecules; Frank-Condon principle and selection rules; Spontaneous and stimulated emission, Einstein A & B coefficients; Lasers, optical pumping, population inversion, rate equation.

### **V: Condensed Matter Physics-**

Crystal structure, Miller Indices, 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; Einstein and Debye model, Response and relaxation phenomena;

Drude model of electrical and thermal conductivity; Boltzman transport equation, Sommerfield theory of electrical conductivity, Mathiessen's rule, Hall effect and thermoelectric power; Origin of Atomic Magnetism, Diamagnetism, paramagnetism, and ferromagnetism; Curie, Langevin and Quantum theories of magnetism, Electron motion in a periodic potential, band theory of metals, Kronig-Penny model, Effective mass, concept of holes, insulators and semiconductors; Superconductivity, type- I and type - II superconductors, BCS theory, DC and AC Josephson Effects, Semiconductor: laws of mass action, Impurity conductivity, Recombination mechanism, Photo conductivity and Photo luminescence.

## **VI. Mathematical Methods of Physics-**

Dimensional analysis; Vector algebra and vector calculus; Linear algebra, matrices, Cayley Hamilton theorem, eigen value problems; Linear differential equations; Special functions (Hermite, Bessel, Laguerre and Legendre); Fourier series, Fourier and Laplace transforms; Elements of complex analysis; Elementary ideas about tensors; Introductory group theory; Elements of computational techniques: roots of functions, interpolation, extrapolation, integration by trapezoid and Simpson's rule, solution of first order differential equations using Runge-Kutta method; Finite difference methods; Elementary probability theory, random variables, binomial, Poisson and normal distributions.

## **VII. Classical Mechanics-**

Newton's laws; Phase space dynamics, stability analysis; Central-force motion; Kepler's laws, Gravitational field and potentials; Two-body collisions, scattering in laboratory and centre-of-mass frames; Rigid body dynamics, Angular momentum, moment of inertia tensor, non-inertial frames and pseudoforces; Variational principle, Lagrangian and Hamiltonian formalisms and equations of motion; Poisson brackets and canonical transformations; Symmetry, invariance and conservation laws, cyclic coordinates; Periodic motion, small oscillations and normal modes; Damped harmonic oscillations, Driven harmonic oscillations; Waves in media, Superposition of waves; Special theory of relativity, Lorentz transformations, relativistic kinematics and mass-energy equivalence. Kinematics of moving fluids: Bernouli's theorem, Viscosity, Surface tension.

## **VIII. Quantum Mechanics-**

Wave-particle duality; Wave functions in coordinate and momentum representations; Commutators and Heisenberg's uncertainty principle; Matrix representation; Dirac's bra and ket notation; Schroedinger equation (time-dependent and time-independent); Eigen value problems such as particle-in-a-box, harmonic oscillator, etc.; Tunneling through a barrier; Motion in a central potential; Orbital angular momentum, Angular momentum algebra, spin; Addition of angular momenta; Hydrogen atom, spin-orbit coupling, fine structure; Time-independent perturbation theory and applications; Variational method; WKB approximation; Time dependent perturbation theory and Fermi's Golden Rule; Selection rules; Semi-classical theory of radiation; Elementary theory of scattering, phase shifts, partial waves, Born approximation; Identical particles, Pauli's exclusion principle, spin-statistics connection; Relativistic quantum mechanics: Klein Gordon and Dirac equations.

## **IX. Thermodynamic and Statistical Physics-**

Laws of thermodynamics and their consequences; Thermodynamic potentials, Production of low temperature and its applications; Maxwell relations; Chemical potential, phase equilibria; Phase space, micro- and macro states; Micro canonical, canonical and grand-canonical ensembles and partition functions; Free Energy and connection with thermodynamic quantities; First and second-order phase transitions; Classical and quantum statistics, ideal Fermi and Bose gases; Principle of detailed balance; Blackbody radiation and Planck's distribution law; Bose-Einstein condensation; Random walk and Brownian motion; Introduction to non-equilibrium processes; Diffusion equation.

## **X. Nuclear and Particle Physics-**

Basic nuclear properties: size, shape, charge distribution, spin and parity; Binding energy, semi-empirical mass formula; Liquid drop model; Fission and fusion; Nature of the nuclear force, form of nucleon-nucleon potential; Charge-independence and charge-symmetry of nuclear forces; Isospin; Deuteron problem; Evidence of shell structure, single- particle shell model, its validity and limitations; Rotational spectra; Elementary ideas of alpha, beta and gamma decays and their selection rules; Nuclear reactions, reaction mechanisms, compound nuclei and direct reactions; Classification of fundamental forces; Elementary particles (quarks, baryons, mesons, leptons); Spin and parity assignments, isospin, strangeness; Gell-Mann-Nishijima formula; C, P, and T invariance and applications of symmetry arguments to particle reactions, parity non-conservation in weak interaction; Particle accelerators and detectors.

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