



ONLINE TEST SERIES

SYLLABUS (CSIR-UGC-NET-Physical Sciences)

UNIT TEST

(I) Mathematical Methods of Physics

- **Unit Test 01 [Mathematical Physics-1]:** Dimensional analysis. Vector algebra and vector calculus. Linear algebra, matrices, Cayley-Hamilton Theorem. Eigenvalues and eigenvectors. Linear ordinary differential equations of first & second order, Special functions (Hermite, Bessel, Laguerre and Legendre functions)
- **Unit Test 01 [Mathematical Physics-2]:** Fourier series, Fourier and Laplace transforms. Elements of complex analysis, analytic functions; Taylor & Laurent series; poles, residues and evaluation of integrals. Elementary probability theory, random variables, binomial, Poisson and normal distributions. Central limit theorem.
- **Unit Test 01 [Mathematical Physics-3]:** Green's function. Partial differential equations (Laplace, wave and heat equations in two and three dimensions). Elements of computational techniques: root of functions, interpolation, extrapolation, integration by trapezoid and Simpson's rule, Solution of first order differential equation using RungeKutta method. Finite difference methods. Tensors. Introductory group theory: $SU(2)$, $O(3)$.
- **Unit Test 01 [Mathematical Physics-4]:** Full syllabus of Mathematical Physics.

(II) Classical Mechanics

- **Unit Test 02 [Classical Mechanics-1]:** Newton's laws. Central force motions. Two body Collisions - scattering in laboratory and Centre of mass frames. Rigid body dynamics moment of inertia tensor. Non-inertial frames and pseudoforces.
- **Unit Test 02 [Classical Mechanics-2]:** Variational principle, Generalized coordinates. Lagrangian and Hamiltonian formalism and equations of motion. Conservation laws and cyclic coordinates. Dynamical systems, Phase space dynamics, stability analysis. Poisson brackets and canonical transformations.



- **Unit Test 02 [Classical Mechanics-3]:** Periodic motion: small oscillations, normal modes. Special theory of relativity Lorentz transformations, relativistic kinematics and mass–energy equivalence, Symmetry, invariance and Noether's theorem. Hamilton-Jacobi theory.
- **Unit Test 02 [Classical Mechanics-4]:** Full syllabus of Classical Mechanics.

(III) Electromagnetic Theory

- **Unit Test 03 [EMT-1]:** Electrostatics: Gauss's law and its applications, Electrostatic potential, Laplace and Poisson equations, boundary value problems, electric dipole, dielectric, conductor, image methods.
- **Unit Test 03 [EMT-2]:** Magnetostatics: Biot-Savart law, Ampere's theorem, Magnetic Vector potential, magnetic dipole moment, Boundary value problems, Electromagnetic induction.
- **Unit Test 03 [EMT-3]:** 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 electromagnetic fields. Dispersion relations in plasma. Lorentz invariance of Maxwell's equation. Transmission lines and wave guides. Radiation- from moving charges and dipoles and retarded potentials.
- **Unit Test 03 [EMT-4]:** Full syllabus of EMT.

(IV) Quantum Mechanics

- **Unit Test 04 [Quantum Mechanics-1]:** 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.
- **Unit Test 04 [Quantum Mechanics-2]:** Motion in a central potential: orbital angular momentum, angular momentum algebra, spin, addition of angular momenta; Hydrogen atom. Stern-Gerlach experiment. Identical particles, Pauli exclusion principle, spin-statistics connection. Relativistic quantum mechanics: Klein-Gordon and Dirac equations. Semi-classical theory of radiation.



- **Unit Test 04 [Quantum Mechanics-3]:** Time independent perturbation theory and applications. Variational method. Time dependent perturbation theory and Fermi's golden rule, selection rules. Spin-orbit coupling, fine structure. WKB approximation. Elementary theory of scattering: phase shifts, partial waves, Born approximation.
- **Unit Test 04 [Quantum Mechanics-4]:** Full syllabus of Quantum mechanics.

(V) Thermodynamic and Statistical Physics

- **Unit Test 05 [Thermodynamics-1]:** Laws of thermodynamics and their consequences. Thermodynamic potentials, Maxwell relations, First- and second-order phase transitions.
- **Unit Test 05 [Statistical -2]:** chemical potential, phase equilibria. Phase space, micro- and macro-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. Diamagnetism, paramagnetism, and ferromagnetism. Ising model. Bose-Einstein condensation. Diffusion equation. Random walk and Brownian motion. Introduction to non-equilibrium processes.
- **Unit Test 05 [Therm+Statistical-3]:** Full Syllabus of Thermodynamics & Statistical Physics.

(VI) Electronics

- **Unit Test 06 [Analog Electronics-1]:** 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. Linear and nonlinear curve fitting, chi-square test. Transducers (temperature, pressure/vacuum, magnetic fields, vibration, optical, and particle detectors). Measurement and control. Signal conditioning and recovery. Impedance matching, amplification (Op-amp based, instrumentation amp, feedback), filtering and noise reduction, shielding and grounding. Fourier transforms, lock-in detector, box-car integrator, modulation techniques.
- **Unit Test 06 [Digital Electronics-2]:** Digital techniques and applications (logic gates, registers, counters, comparators and similar circuits, half-adder, full-adder, Multiplexer, De-Multiplexer, encoder, decoder etc.) A/D and D/A converters.
- **Unit Test 06 [Electronics-3]:** Full syllabus of Electronics



(VII) Atomic & Molecular Physics

- **Unit Test 07 [Atomic & Molecular-1]:** 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
- **Unit Test 07 [Atomic & Molecular-2]:** 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 coherence length.
- **Unit Test 07 [Atomic & Molecular-3]:** Full Syllabus of Atomic & molecular Physics

(VIII) Condensed Matter Physics (Solid State Physics)

- **Unit Test 08 [Solid State Physics-1]:** 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.
- **Unit Test 08 [Solid State Physics-2]:** 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 and dislocations. Ordered phases of matter: translational and orientational order, kinds of liquid crystalline order. Quasi crystals.
- **Unit Test 08 [Solid State Physics-3]:** Full Syllabus of Solid State Physics

(IX) Nuclear and Particle Physics

- **Unit Test 09 [Nuclear Physics-1]:** Basic nuclear properties: size, shape and charge distribution, spin and parity. Binding energy, semiempirical 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. Rotational spectra. Elementary ideas of alpha, beta and gamma decays and their selection rules. Fission and fusion. Nuclear reactions, reaction mechanism, compound nuclei and direct reactions.



- **Unit Test 09 [Particle Physics-2]:** 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. Application of symmetry arguments to particle reactions. Parity non-conservation in weak interaction. Relativistic kinematics.
- **Unit Test 09 [Particle Physics-3]:** Full Syllabus of Nuclear & Particle Physics.

MINOR TEST

1. Minor Test 01 | G.A. + QM + EMT + Solid State
2. Minor Test 02 | G.A. + C.M. + Electronics + Atomic
3. Minor Test 03 | G.A. + M.P. + Thermo & Stats. + Nu
4. Minor Test 04 | G.A. + EMT + QM + Solid State
5. Minor Test 05 | G.A. + CM + Electronics + Atomic
6. Minor Test 06 | G.A. + Nuclear + M.P. + Thermo
7. Minor Test 07 | G. A. + QM + EMT
8. Minor Test 08 | G. A. + QM + EMT + N.P.
9. Minor Test 09 | G. A. + ELECTRONICS + C.M.
10. Minor Test 10 | G. A. + M.P. + Thermo-Stats

FULL LENGTH TEST

1. Full Length Test 01 | Physical Sciences
2. Full Length Test 02 | Physical Sciences
3. Full Length Test 03 | Physical Sciences
4. Full Length Test 04 | Physical Sciences
5. Full Length Test 05 | Physical Sciences
6. Full Length Test 06 | Physical Sciences
7. Full Length Test 07 | Physical Sciences
8. Full Length Test 08 | Physical Sciences
9. Full Length Test 09 | Physical Sciences
10. Full Length Test 10 | Physical Sciences
11. Full Length Test 11 | Physical Sciences

