M.Sc. Semester–II (CBCS Scheme) Examination
PHYSICS
2-PHY-2 Quantum Mechanics–II

Time : Three Hours] [Maximum Marks : 80

N.B. :— All questions are compulsory and carry equal marks.

EITHER

1. (a) Discuss and compute the Stark effect for the ground state of hydrogen atom. 8

   (b) For a non-degenerate case, mentioning the first order correction to energy and wave function, derive the second order correction to wave function and energy using time independent perturbation theory. 8

OR

   (p) Show that in the usual stationary state perturbation theory, if the Hamiltonian can be written

   $H = H_0 + H'$ with $H_0\phi_0 = E\phi_0$ then correction is $\Delta E_0 \approx < \phi_0 | H' | \phi_0 >$ 8

   (q) Explain first order and second order Zeeman effect using perturbation theory. 8

EITHER

2. (a) Obtain the expression for transition probability per unit time in the first order when constant perturbation acts on the system for short interval. 8

   (b) Derive and explain Fermi Golden Rule for the transition rate from a given initial state to a final state of continuum. 8

OR

   (p) Explain briefly in context with the time dependent perturbation theory induced emission and absorption of electromagnetic radiation in atomic system. 8

   (q) Explain the application of selection rules for explaining atomic spectra by suitable examples. 8

EITHER

3. (a) Explain the significance of the phase shift in the scattering cross-section of a spherically symmetric potential. 4

   (b) Define total cross section and differential scattering cross section and obtain the relation between scattering cross-sections in L-system and C-system. 6

   (c) Solve Hard sphere scattering problem using partial wave analysis method. 6

OR

   (p) Discuss the validity condition for Born approximation. 4

   (q) Calculate scattering cross-section for a particle from a square well potential of finite potential using Born Approximation. 6

   (r) What is partial wave analysis ? Explain mathematical formalism of partial wave analysis method. 6

EITHER

4. (a) Explain the algebra of creation and annihilation operators for Fermions. 7

(b) Explain how symmetric (ψ_S) or antisymmetric (ψ_A) wave functions can be constructed from general unsymmetrical wave function ψ. 5

(c) Construct spin functions for three electron system. 4

OR

(p) Show that antisymmetric wave function for two fermions would vanish if both occupy the same position with identical spin. 5

(q) Show that symmetry character does not change with time. 5

(r) What is general representation of one and two particle operators in creation and annihilation operator algebra ? 6

EITHER

5. (a) Show that spinning motion of electron is natural outcome of the Dirac's equation. 6

(b) Obtain covariant form of Klein-Gordon equation. 4

(c) Explain the semiclassical theory of radiation. 6

OR

(p) Develop K. G. equation for spin zero particle. 6

(q) Discuss the properties of Dirac's matrices. 4

(r) State Dirac's relativistic wave equation. Obtain the equation of continuity corresponding to it. 6