Roll No. ..... Total Pages : 3

CMDE/M-24 **4698**

QUANTUM MECHANICS–II

Paper–PHY–201

Time Allowed : 3 Hours] [Maximum Marks : 60

Note : Attempt **five** questions in all, selecting **one** question from each Unit. Question No. **1** is compulsory. All questions carry equal marks.

Compulsory Question

1. Attempt the following questions : 4×3=12

   (a) Show that in the usual stationary state perturbation theory, if the Hamiltonian can be written $H = H_0 + H'$ with $H_0\phi_0 = E_0 + \phi_0$, then the correction ΔE_0 is $\Delta E_0 \approx \langle \phi_0 | H' | \phi_0 \rangle$.

   (b) Give the importance of connection formulate in WKB theory.

   (c) Differentiate between L-S and j-j couplings.

   (d) Calculate the Born approximation to the differential cross section for scattering a particle of mass *m* off the δ – function potential $V(r) = g\delta^3(r)$.

UNIT–I

2. (a) Discuss the first order stationary perturbation theory for a non degenerate case. 6

   (b) A particle of mas m moves (non relativistically) in the three-dimensional potential :

   $V = \frac{1}{2}k(x^2 + y^2 + z^2 + \lambda xy)$. Consider λ as a small parameter and calculate the ground state energy through second order perturbation theory. 6

3. Explain in detail the Rayleigh-Ritz Variational method and hence calculate the ground state Energy of Helium atom using it. 12

UNIT–II

4. (a) Derive the WKB approximate solutions of one-dimensional Schrodinger equation and show that they are not valid near the turning points. 6

   (b) Explain the quantum mechanical tunneling through a potential barrier within the framework of WKB method. 6

5. Obtain an expression of the transition probability for a two level system within the framework fo the first order time dependent perturbation theory. Also describe the problem when transition occurs to a group of final states forming a continuum. 12

UNIT–III

6. (a) Discuss the central field approximation for calculating the electronic structure of a many electron atom. 6

   (b) Explain the Thomas-Fermi statistical model to determine potential for a multi electron system. 6

7. (a) Explain Hartree's self-consistent fields and connection with the Variational method. 6

   (b) Determine the rotational and vibrational energy levels of a diatomic molecule using Morse potential. 6

UNIT–IV

8. (a) Show that the s-wave scattering is spherically symmetric in the center of mass system. 6

   (b) Calculate the scattering cross section for a Low energy particle from a potential given by : 6

   $V = -V_0$ for $r < a, V = 0$ for $r > a$.

9. (a) Derive Breit-Wigner single level formula for scattering. Show that the scattering cross section is maximum at resonance energy. 6

   (b) Explain first Born approximation. Apply it to study the scattering of an electron by a screened Coulomb potential. 6