THIRD SEMESTER M.Sc. DEGREE EXAMINATION, NOVEMBER 2020

PHYSICS

FPHY3C09: QUANTUM MECHANICS- II

Time: Three Hours   **Maximum Weightage: 30**

Part A: Short answer questions. Answer *all* **questions. Each carries** *one* **weightage**.

1. Briefly discuss the results of linear Stark effect in hydrogen atom.
2. What are connection formulae in WKB approximation? State any one formula.
3. Explain Bohr-Sommerfield quantization theory.
4. Explain the principle of the Variational method of approximation.
5. Discuss Optical theorem in Scattering.
6. Briefly explain stimulated emission using time dependent perturbation theory.
7. State and explain Fermi's Golden rule.
8. Write the Weyl equation for the neutrino.

(8 × 1 = 8 Weightage)

Part B: Essay Questions. Answer any *two* **questions. Each carries** *five* **weightage.**

9. Discuss the Schrodinger perturbation theory for a system with non-degenerate levels and apply it to explain first Stark effect in Hydrogen.

10. Discuss time dependent perturbation theory. Derive an expression for the transition probability when a system is subjected to a harmonic perturbation.

11. Discuss WKB method for a one-dimensional bound system. Apply it to the case of a particle in an infinite potential well and show that this approximation method yields the exact results in this case.

12. What is the basic idea in partial wave analysis of scattering problem? Show that a plane wave with propagation vector k can be expanded as a sum of infinite number of partial waves.

(5 x 2 = 10 weightage)

(P.T.O.)

Part C: Problems. Answer any *four* questions. Each carries *three* weightage.

13. Show that the Dirac's particles have spin ½.
14. Starting from the Klein – Gordon equation,derive the equation of continuity.

15. Show that Dirac matrices α_x, α_y, α_z and β are unimodular and they are anti- commute with each other by choosing a pair.

16. A linear harmonic oscillator is perturbed by the potential kx^4. Find the first order correction to the energy of the nth state.
17. Find the transmission coefficient using WKB method.

18. Find the ground state energy of a one-dimensional Harmonic oscillator using the trial wave function $\psi(x) = N\, xe^{-bx^2}$ (N is a normalization constant.)

19. A particle of mass m and energy E is incident from the left on the potential

$$V(x) = \begin{cases} 0 & (x < -a) \\ -V_0 & (-a \leq x \leq 0) \\ \infty & (x > 0) \end{cases}$$

a) If the incoming wave is Ae^{-ikx} where ($k = \sqrt{2mE}/\hbar$ find the reflected wave.
b) Find the phase shift for a very deep well ($E \ll V_0$).

(4 × 3 = 12 Weightage)