D3APH2101 **(2 Pages)** **Name.....**
Reg.No.....

THIRD SEMESTER M.Sc. DEGREE EXAMINATION, NOVEMBER 2022
(Regular/Improvement/Supplementary)

PHYSICS
FPHY3C09 - QUANTUM MECHANICS-II

Time: 3 Hours **Maximum Weightage: 30**

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

1. Discuss the principle of Variational method.
2. Discuss quadratic stark effect.
3. Give the significance of connection formulae in WKB approximation? State any one formula.
4. Explain why the intensity of stimulated emission is much less than that of stimulated absorption between two atomic energy levels.
5. Give the features of Klein Gordan equation.
6. What are the validity conditions of WKB approximations?
7. List the properties of Dirac Matrices.
8. What is Optical theorem in scattering? Explain.

(8 × 1 = 8 weightage)

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

9. Apply time independent perturbation theory to find the energy states and wave functions to explain Zeeman effect in Hydrogen atom.
10. Using partial wave analysis, obtain the expression for differential scattering cross section in the case of spherically symmetric potential.
11. Discuss how the time dependent perturbation theory is applied to find the scattering cross section in the first order Born approximation.
12. Obtain ground state energy of a Helium atom using variational method.

(2 × 5 = 10 weightage)

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

13. Establish the expansion of a plane wave in terms of an infinite number of spherical waves.
14. Show that the orbital angular momentum is not a constant of motion for a Dirac particle moving in a central potential.
15. Find the energy eigen values of harmonic oscillator using WKB method.
16. Show that the Dirac particles have spin ½.

(P.T.O.)

17. Consider a quantum system with just three linearly independent states. Suppose the Hamiltonian of the system is given by, $H = V_0 \begin{pmatrix} 1-\varepsilon & 0 & 0 \\ 0 & 1 & \varepsilon \\ 0 & \varepsilon & 2 \end{pmatrix}$, where V_0 is a constant and ε is some small number such that $\varepsilon << 1$.

    a) Calculate the eigenvalues and eigenvectors of the unperturbed Hamiltonian, corresponding to $\varepsilon = 0$.

    b) Use degenerate perturbation theory to find the first-order correction to the two initially degenerate eigenvalues.

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

19. An atomic system in an unperturbed state m is suddenly subjected to a constant perturbation V(r) which exists during short time t. Find the probability for transition from state m to state k and show that it varies simple harmonically with angular frequency = $(E_K - E_m)/2\hbar$.

(4 × 3 = 12 weightage)