D3APH2201 **(2 Pages)** **Name.....**
Reg.No.....

THIRD SEMESTER M.Sc. DEGREE EXAMINATION, NOVEMBER 2023
(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. Explain the principle of WKB approximation?
2. What is the effect of spin orbit interaction for an electron in the n= 2 state of the hydrogen atom.
3. State and explain Fermi's Golden rule.
4. What are Dirac spinors?
5. Explain first order Stark effect in ground state of hydrogen atom.
6. Explain the role of dipole moment operator.
7. Define differential scattering cross section and total scattering cross-section.
8. The orbital momentum of a Dirac particle is not a constant of motion. Comment.

(8 × 1 = 8 weightage)

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

9. Discuss time independent perturbation theory for a system with degenerate levels and apply it to explain the effect of electric field on the n= 2 state of hydrogen.
10. What are the features of Klein– Gordon equation? Discuss how Klein –Gordon equation leads to positive and negative probability density values**.**
11. Using time dependent perturbation theory, get an expression for the transition probability when a system is subjected to a harmonic perturbation.
12. Using partial wave analysis, find the scattering amplitude and scattering cross section in the case of a central potential.

(2 × 5 = 10 weightage)

(P.T.O.)

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

13. Using trial wave function $\Psi(x) = Ae^{-\alpha x^2}$, where α is the variational parameter, obtain an upper bound for ground state energy of linear harmonic oscillator.

14. Evaluate the first order correction to the energy of the n^{th} state of the anharmonic oscillator having the potential energy

$$V = \frac{1}{2}m\omega^2x^2 + bx^4 \qquad \text{where } bx^4 \ll \frac{1}{2}m\omega^2x^2$$

15. Show that a plane wave can be expanded as a linear combination of infinite number of spherical waves.

16. Express Dirac's equation in the covariant form.

17. Find the energy eigen values of a linear harmonic oscillator by WKB method.

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

19. Explain the principle of detailed balance using time dependent perturbation theory.

(4 × 3 = 12 weightage)