Reg. No ..... Name **24P308**

M. Sc. DEGREE END SEMESTER EXAMINATION - OCTOBER 2024

SEMESTER 3 : PHYSICS

COURSE : **21P3PHYT09 : QUANTUM MECHANICS - II**

(For Regular 2023 Admission and Supplementary 2022/2021 Admissions)

Duration : Three Hours Max. Weights: 30

PART A

Answer any 8 questions **Weight: 1**

1. How does the state ket and the base ket evolve with time in Heisenberg picture? (R)
2. If the state ket in the schrodinger picture is given by $|\alpha, t_0; t\rangle_s$ then write down the state ket in the Heisenberg picture. (R)
3. V_0 and E denotes the potential and the energy of the incident particles, write the criterion for the application of Born approximation. (A)
4. Define differential scattering cross section and total scattering cross section. (U)
5. What are the physical interpretation of Klein - Gorden wave equation? (U)
6. What is hard sphere scattering? (R)
7. Write Ritz variational principle. (R)
8. State the criterion for the validity of WKB approximation. (U)
9. If $\Sigma_3/2$ is the infinitesimal generator of rotation about the z axis acting on the space time independent part of the Dirac wavefunction then write down Σ_3 (U)
10. In the presence of $V(t)$ a time dependant potential, write the experssion for the probability of finding the system in the state $|n\rangle$ if the system was initialy in the state $|i\rangle$. (U)

(1 x 8 = 8)

PART B

Answer any 6 questions **Weights: 2**

11. A particle of mass m_0 and charge e oscillates along the x-axis in a one dimentional harmonic potential with an angular frequency ω. If an electric field E is applied along the x-axis, evaluate the first and second order corrections to the energy of the n^{th} state. (E)
12. How did Dirac interpret the negetive energy states of free Dirac particle? (A)
13. Deduce Klein Gordon wave equation for a free particle. (A)
14. In the Case of constant perturbation show that the condition to induce a transition is $\Delta E \bullet t \geq \hbar$. Here t is the duration of perturbation and ΔE is the change in energy caused by transition. (A)
15. In scattering theory derive the Breit -Wigner formula for the scattering crosssection. (A)
16. Write the Dyson series and explain its significance. (R)
17. Discuss S wave scattering in the case of a hard sphere and arrive at the S-wave total cross section. (A)

18. Evaluate the first and second order correction to the energy of the $n = 1$ state of an oscillator of mass m and angular frequency ω subjected to a potential $V(x) = \frac{1}{2}m\omega^2x^2 + bx$ where $bx \leq \frac{1}{2}m\omega^2x^2$. (A)

(2 x 6 = 12)

PART C

Answer any 2 questions **Weights: 5**

19. In time dependent perturbation theory consider the case of harmonic perturbation and arrive at the symmetry between absorption and emission. (An)

20. Discuss the time independent perturbation theory for the non degenerate case and obtain an expression for the first order energy correction. (U)

21. Explain resonances in scattering theory. with a neat diagram explain how metastable bound states are formed. (An)

22. Derive the Klein Gordon equation and show that the probability density is not positive definite. (E)

(5 x 2 = 10)

OBE: Questions to Course Outcome Mapping

CO	Course Outcome Description	CL	Questions	Total Wt.

Cognitive Level (CL): Cr - CREATE; E - EVALUATE; An - ANALYZE; A - APPLY; U - UNDERSTAND; R - REMEMBER;