Reg. No ..... Name **23P308**

M. Sc. DEGREE END SEMESTER EXAMINATION : NOVEMBER 2023

SEMESTER 3 : PHYSICS

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

(For Regular 2022 Admission and Supplementary 2021 Admission)

Duration : Three Hours Max. Weights: 30

PART A

Answer any 8 questions **Weight: 1**

1.	In scattering theory, if σ_{qm} and σ_{cl} denotes the quantum mechanical and classical scattering crossection then for the case of hard shpere scattering how are they related?	(A)
2.	If A_S is the observable in the Schrodinger picture, H and H_0 the total and the unperturbed Hamiltonian respectively then write the observable in the Heisenberg picture A_H interms of the observable in the Schrodinger picture.	(U)
3.	What is dipole approximation?	(R)
4.	Distinguish between stimulated emission and spontaneous emission.	(R)
5.	State the meaning of the 'Covariance of Dirac Equation'.	(U)
6.	Write and explain the interaction term in Helium atom Hamiltonian.	(E)
7.	What is meant by large and small components in relativistic quantum mechanics?	(U)
8.	What do you mean by asymptotic wavefuction in scattering theory?	(U)
9.	Briefly discuss how WKB method can be used to analyze alpha decay problems.	(E)
10.	Write Ritz variational principle.	(R)

(1 x 8 = 8)

PART B

Answer any 6 questions **Weights: 2**

11.	Using time dependent perturbation theory solve a two state problem interacting with a sinusoidal potential.	(A)
12.	Discuss S wave scattering in the case of a hard sphere and arrive at the S-wave total cross section.	(A)
13.	A simple harmonic oscillator of mass m_0 and angular frequency ω is perturbed by an additional potential bx^3. Evaluate the second order correction to the ground state energy of the oscillator.	(A)
14.	For a Dirac particle moving in a central potential show that the orbital angular momentum is not a constant of motion.	(A)
15.	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)
16.	How did Dirac interpret the negetive energy states of free Dirac particle?	(A)
17.	In the case of Yukawa potential arrive at the differential scattering cross section.	(A)

18. 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)

(2 x 6 = 12)

PART C

Answer any 2 questions **Weights: 5**

19. Explain Electric dipole approxiamtion. (A)

20. Show that orbital angular momentum 'L' will not be conserved for a free Dirac particle. Show further that the toral angular momentum 'LtS' will be conserved Where, S = $\frac{1}{2}\hbar \begin{bmatrix} \sigma & 0 \\ 0 & \sigma \end{bmatrix}$ is the spin vectors. (Cr)

21. Derive the Dirac equation. (U)

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

(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;