Reg. No ..... Name **17P3605**

MSc DEGREE END SEMESTER EXAMINATION- OCTOBER-NOVEMBER 2017

SEMESTER 3 : PHYSICS

COURSE : **16P3PHYT09 ; QUANTUM MECHANICS - II**

(For Regular - 2016 admission)

Time : Three Hours Max. Marks: 75

Section A

Answer any 5 (1 marks each)

1. In the case of a two state system which is initially in the ground state, interacting with the sinusoidal oscillating potential $V(t)$ on resonance with the system, With $c_g(t)$ and $c_e(t)$ denoting the coefficients for the ground state and the excited state respectively, the probability of finding the system in the excited state
   (a) is $c_e(t)$ (b) $|c_e(t)|$
   (c) $1-|c_g(t)|^2$ (d) $c_e(t)^2$
2. If the state ket in the schrodinger picture is given by $|\alpha, t_0; t\rangle_s$ then the state ket in the interaction picture is
   (a) $|\alpha, t_0; t\rangle_s$ (b) $|\alpha, t_0; t\rangle_s e^{-iH_0t/\hbar}$
   (c) $|\alpha, t_0; t\rangle_s e^{iH_0t/\hbar}$ (d) $|\alpha, t_0; t\rangle_s e^{iHt/\hbar}$
3. Born Approximation is a
   (a) all energy approximation (b) low energy approxiamtion
   (c) medium energy approxiamtion (d) high-energy approxiamtion
4. σ is the Pauli matrix then H^{spin} which is the interaction hamiltonian for the electron spin with the applied magnetic field B is
   (a) (eħ/2mc) $\vec{\sigma}\cdot\vec{B}$ (b) (eħ/2mc) $\vec{\sigma}\times\vec{B}$
   (c) (- eħ/2mc) $\vec{\sigma}\cdot\vec{B}$ (d) (- eħ/2mc) $\vec{\sigma}\times\vec{B}$
5. For a system of Bosons the valid relation is
   (a) $[a_k, a_l^\dagger] = \delta_{kl}$ (b) $\{a_k, a_l^\dagger\} = \delta_{kl}$
   (c) $[a_k, a_l^\dagger] = 0$ (d) $\{a_k, a_l^\dagger\} = 0$

5 x 1 (5)

Section B

Answer any 7 (2 marks each)

6. If V_S and V_I are the potential in the Schrodinger picture and the Interaction picture respectively, how are they related?

7. Distinguish between stimulated emission and spontaneous emission.
8. Sate Fermis golden rule.
9. Discuss the criterion for the validity of Born apprximation.
10. How are differential scattering cross section related to the scattering amplitude?
11. Explain Ramsauer - Townsend effect.
12. Find the matrix $\sigma \cdot \boldsymbol{p}$ where $p = p_1\hat{i} + p_2\hat{j} + p_3\hat{k}$
13. State the meaning of the 'Covariance of Dirac Equation'.
14. Write the quantization conditions for the Bosons and Fermions.
15. What is the motivation of the quantization of the field

7 x 2 (14)

Section C
Answer any 4 (5 marks each)

16. Derive the differential cross section for photoelectric effect.
17. In the case of Harmonic perturbation, show that the transition rate for a transition from the ground state $|g\rangle$ to the excited state $|e\rangle$ is same as that from $|e\rangle$ to $|g\rangle$.
18. In the Born approxiamtion, derive the scattering amplitude for scattering from a square well potential, $V(r) = -V_0$ for $0 < r < r_0$ and $V(r) = 0$ for $r > 0$.
19. Deduce Klein Gordon wave equation for a free particle.
20. Show that Klein Gordon equation leads to negetive probability density.
21. Distinguish between second quantization of Bosons and Fermions.

4 x 5 (20)

Section D
Answer any 3 (12 marks each)

22. Distinguish between the three pictures in quantum mechanics. Show that the transition probability in Schrodinger picture and the interaction picture are the same. Also deduce the equation of motion in the interaction picture.
23. Discuss time dependent Perturbation theory and deduce Fermi's Golden Rule.
24. Obtain Rutherford scattering formula by applying first Born approximation.
25. Obtain the expression for the differential scattering crosssection when the energy of the incident particle is small compared to the energy of the scattering potential.
26. Show the covariance of the Dirac equation.
27. Discuss the quantization of the non relativistic field.

3 x 12 (36)