Reg. No ..... Name **18P3605**

MSc DEGREE END SEMESTER EXAMINATION - OCTOBER 2018

SEMESTER 3 : PHYSICS

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

(For Regular - 2017 Admission & Supplementary - 2016 Admission)

Time : Three Hours Max. Marks: 75

Section A
Answer any 5 (1 marks each)

1. If A_S is the observable in the Schrodinger picture, H and H_0 the total and the unperturbed Hamiltonian respectively then the observable in the Heisenberg picture A_H is
   (a) $e^{-iH_0t/\hbar}A_Se^{iH_0t/\hbar}$ (b) $e^{iH_0t/\hbar}A_Se^{-iH_0t/\hbar}$
   (c) $e^{iHt/\hbar}A_Se^{-iHt/\hbar}$ (d) $e^{-iHt/\hbar}A_Se^{iHt/\hbar}$
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. An asymptitic wavefunction(ψ) is
   (a) $\psi_{inc} + \psi_{sc}$ (b) $\psi_{inc} + \psi_{sc}$ at $r \to \infty$
   (c) $\psi_{inc} + \psi_{sc}$ at $r \to 0$ (d) outgoing wave at $r \to \infty$
4. In relativistic quantum mechanics the γ_4^2 is
   (a) $\begin{pmatrix} I & 0 \\ 0 & -I \end{pmatrix}$ (b) $\begin{pmatrix} I & 0 \\ 0 & I \end{pmatrix}$
   (c) $\begin{pmatrix} -I & 0 \\ 0 & I \end{pmatrix}$ (d) $\begin{pmatrix} -I & 0 \\ 0 & -I \end{pmatrix}$
5. The generalized momentum p_i conjugate to the generalized coordinate q_i is
   (a) $\frac{\partial L}{\partial \dot{q}}$ (b) $\frac{\partial L}{\partial q}$
   (c) $\frac{\partial L^2}{\partial q}$ (d) $\frac{\partial L^2}{\partial \dot{q}}$

(1 x 5 = 5)

Section B
Answer any 7 (2 marks each)

6. Describe the operation of time evolution operator.
7. Sate Fermis golden rule.
8. Explain electric dipole approximation in time dependent perturnation theory.
9. Explain hard sphere scattering.
10. Define differential scattering cross section and total scattering cross section.
11. Explain Ramsauer - Townsend effect.
12. Write down the Dirac matrices.

13. Find the matrix $\sigma \cdot \boldsymbol{p}$ where $p = p_1\hat{i} + p_2\hat{j} + p_3\hat{k}$
14. Write down the Lagrangian equations of motion and the Hamiltons canonical equations of motion.
15. State Noether's theorem.

(2 x 7 = 14)

Section C
Answer any 4 (5 marks each)

16. Explain the interaction picture in quantum mechanics and obtain the equation of motion in that picture.
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. Obtain the expression for the differential scattering crossection for scattering of the electron by Coulomb potential.
19. Obtain Klein-Gordon equation.
20. Determine the current density and the charge density on the basis of Klein Gordon equation.
21. Derive the Hamiltonian form of the classical field equation in terms of Hamiltonian density.

(5 x 4 = 20)

Section D
Answer any 3 (12 marks each)

22.1. Discuss time dependent Perturbation theory and deduce Fermi's Golden Rule.
OR
2. Explain the interaction of an atom with electromagnetic field using time dependent perturbation theory.

23.1. Obtain Rutherford scattering formula by applying first Born approximation.
OR
2. Explain resonances in scattering theory. with a neat diagram explain how metastable bound states are formed.

24.1. Obtain the solution of the dirac equation for the particle at rest.
OR
2. Explain the second quantization of the schrodinger field and apply this formalism to a system of bosons.

(12 x 3 = 36)