K22P 142

Reg. No. : .....

Name : .....

III Semester M.Sc. Degree (CBSS – Reg./Sup./Imp.) Examination, October 202
(2019 Admission Onwards)
PHYSICS
PHY3C10 : Quantum Mechanics – II

Time : 3 Hours Max. Marks : 6

SECTION – A

Answer **both** questions (Either **a** or **b**). **(2×12=24**

1. a) Using time dependent perturbation theory, derive expression for transition probability under harmonic perturbation and obtain the condition of detailed balancing.

OR

b) Discuss the first order Born approximation in scattering theory. Obtain the condition for the validity of Born approximation. Estimate the differential cross section for a Coulomb potential given by $V(r) = \frac{Z_1 Z_2 e^2}{r}$.

2. a) Modify the free particle Dirac equation so as to obtain the Dirac equation in presence of an external electromagnetic field. Discuss the non-relativistic limit of this equation and show that it gives the correct magnetic moment of the electron.

OR

b) Discuss the fermion quantisation of the Schrödinger field .

SECTION – B

Answer **any four** questions (**1** mark for Part **a**, **3** marks for Part **b** and **5** marks for Part **c**). **(4×9=36**

3. a) Give the Dyson series for the time evolution operator in interaction picture.
   b) Discuss the selection rules for the electric dipole transition.
   c) Using the expression for transition rate of absorption, show that a free photon can not absorb radiation.

P.T.O

4. a) Give the basic idea of partial wave analysis of scattering.
   b) Discuss optical theorem.
   c) Show that the quantum differential cross section for the scattering of two bosons at a scattering angle $\theta = \pi/2$ is twice the classical value when calculated in the centre of mass frame.

5. a) Explain what do we mean by saying that two particles are identical.
   b) Show that a system of two identical particles is represented by either a symmetric wave function or by an anti-symmetric wave function and that symmetry is a constant of motion.
   c) Show that in helium atom, the singlet state is always higher in energy than the triplet state.

6. a) Write down the expressions for charge density and current density in Klein-Gordon theory.
   b) Deduce the expressions for positive and negative charge densities and interpret them in terms of particle energies.
   c) Obtain the Hamiltonian form of the Klein-Gordon equation.

7. a) Express the Hamiltonian density of a field in terms of its Lagrangian density.
   b) Obtain the Hamiltonian density of a field whose Lagrangian density is given by
$$\mathcal{L} = \frac{1}{2}\left\{\frac{1}{c^2}\left(\frac{\partial\varphi}{\partial t}\right)^2 - (\nabla\varphi)^2 - m^2\varphi^2\right\}.$$
   c) Obtain the field equation corresponding to the above Lagrangian.

8. a) According to the famous EPR paper, what are the conditions of completeness and physical reality ?
   b) Write a brief note on the EPR paradox.
   c) Derive Bell's inequalities using a system of two spin half particles.
