K20P 1119

Reg. No. : .....

Name : .....

III Semester M.Sc. Degree (CBSS – Reg./Suppl./Imp.) Examination, October 2020
(2014 Admission Onwards)
PHYSICS
PHY3C10 : Quantum Mechanics – II

Time : 3 Hours Max. Marks : 60

SECTION – A

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

1. a) What is transition probability ? Obtain an expression for first order transition probability and apply it to the case of constant perturbation.

   OR

   b) Describe the method of partial waves for elastic scattering.

2. a) Obtain the normalised solutions of the free particle Dirac equation.

   OR

   b) Discuss the boson 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 Fermi's golden rule in time-dependent perturbation theory.
   b) Explain electric dipole approximation.
   c) Calculate the transition rate for the absorption of a photon of energy $\hbar w_k$ by an atom using electric dipole approximation.

4. a) Give the relation between scattering amplitude and differential cross section.
   b) Discuss the validity of Born approximation.
   c) Show that the quantum differential cross section for the scattering of two electrons at a scattering angle $\theta = \pi/2$ is half the classical value when calculated in the centre of mass frame.

P.T.O.

5. a) State Pauli exclusion principle.
   b) Write down the Slater determinant for a system of N fermions.
   c) Find all possible forms of the wave functions of a system of two identical, non-interacting spin 1/2 particles.

6. a) Write down the Weyl equations for the neutrino.
   b) Discuss charge conjugation and bring out the difference between positive and negative charge parities.
   c) Give a physically meaningful interpretation for the continuity equation obtained from the Klein-Gordon equation.

7. a) Explain what is meant by the Lagrangian density of a field.
   b) Obtain the classical field equation in terms of the Lagrangian density.
   c) Obtain the field equation corresponding to the Lagrangian density.

$$\mathcal{L} = \frac{1}{2}\left\{\frac{1}{c^2}\left(\frac{\partial\varphi}{\partial t}\right)^2 - (\nabla\varphi)^2\right\} + \cos\varphi .$$

8. a) Explain how measurements play a central role in quantum mechanics.
   b) Discuss Bohr's complementarity principle.
   c) Describe the EPR paradox and discuss Bohr's explanation for it.
