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Exam. Code : 0473

M.Sc. Physics 2nd Semester

1059

QUANTUM MECHANICS—II

Paper–PHY-6012

Time Allowed : Three Hours] **[Maximum Marks : 60**

Note :— Attempt **five** questions in all taking **one** question each from Unit-I to Unit-IV and the compulsory question from Unit-V.

UNIT—I

1. (a) Define Scattering cross-section. Obtain the expression for scattering amplitude in terms of phase shift.

   (b) What is Green's function in scattering theory ? 9,3

2. (a) What is Born approximation ? What are its limitations ?

   (b) Obtain exact expression for phase shift for low energy scattering from hard sphere potential $V(r) = \begin{cases} \infty & \text{for } r < a \\ 0 & \text{for } r > a \end{cases}$

   Also find the total scattering cross-section. 6,6

UNIT—II

3. (a) Obtain the expression for current density and probability density for K.G. equation.

   (b) Describe the behaviour of Dirac particle in an electromagnetic field. 6,6

4. (a) Explain Zitterbewegung.

   (b) Derive an expression for spin-orbit interaction energy for Dirac particle. 6,6

UNIT—III

5. (a) Describe the features of second quantization using Schrodinger field as an example.

   (b) Write down the free scalar field theory Lagrangian and obtain equations of motion. 6,6

6. (a) Write down the free classical electromagnetic field Lagrangian and obtain the equations of motion.

   (b) Write down the free classical Dirac field Lagrangian and obtain the equations of motion. 6,6

UNIT—IV

7. (a) Establish the quantization rules for complex scalar field.

   (b) What are Feynman diagrams ? Draw the Feynman diagram(s) for scattering of photon by an electron and write corresponding amplitudes. 6,6

8. (a) For real scalar field, express momentum operator in terms of number operator.

   (b) Discuss the Gupta-Bleular formalism for quantizing electromagnetic field. 6,6

UNIT—V

9. Attempt all parts :—

   (a) Explain optical theorem.

   (b) State properties of Dirac Gamma matrix.

   (c) Define helicity operator, show that its eigenvalues are ± 1.

   (d) What is Lamb shift ?

   (e) What are Feynman rules ?

   (f) What is normal ordered product and time ordered product of operators ? 6×2