

(i) Printed Pages : 3

Roll No.

(ii) Questions : 9

Sub. Code :

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Exam. Code :

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M.Sc. Physics 3rd Semester
(2125)

QUANTUM MECHANICS-II
Paper—PHY-8035

Time Allowed : Three Hours]

[Maximum Marks : 60

Note :— Answer FIVE questions in all, selecting ONE question each from Units I–IV and the compulsory question from Unit-V.

UNIT—I

1. (a) Define scattering cross-section. Derive the expression for scattering amplitude in terms of phase shift. 6
- (b) What is Born approximation? What are its limitations? 6
2. (a) 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

- (b) What are identical particles? From scattering of identical particles, how can one infer the spin of particles? 6

UNIT—II

3. (a) Develop the Klein-Gordon equation for a spin zero particle and construct the continuity equation. Define probability and current densities. 6
- (b) Explain how the magnetic moments of the electron are obtained in Dirac's relativistic theory. 6
4. (a) Prove that total angular momentum operator commutes with Dirac Hamiltonian in a central field. 6
- (b) Discuss the significance of negative energy solutions in relativistic quantum mechanics. 6

UNIT—III

5. (a) Write down the Lagrangian for free Dirac field. Obtain the equations of motion for ψ and $\bar{\psi}$. 6
- (b) Write down Lagrangian for complex scalar field. Obtain the Euler-Lagrange equations of motion. 6
6. (a) Describe the features of second quantization using Schrödinger field as an example. 6
- (b) For real scalar field, obtain Hamiltonian in terms of number operator. 6

UNIT—IV

7. (a) Explain what are Feynman diagrams? Draw the Feynman diagrams for scattering of photon by an electron and write corresponding amplitudes. 6
- (b) Discuss relativistic quantum field theory. 6

8. (a) Quantize free electromagnetic field. 6
(b) Establish quantization rules for Dirac field. 6

UNIT—V

(Compulsory)

9. (a) What is Green function in scattering theory?
(b) Give physical interpretation of negative energy states of Dirac particle.
(c) Define helicity operator and show that its eigenvalues are ± 1 .
(d) What is Lamb shift?
(e) Write a note on S-matrix.
(f) What is Zitterbewegung? 2×6=12