APRIL/MAY 2018

MPH23 — QUANTUM MECHANICS – II

Time : Three hours Maximum : 75 marks

SECTION A — ($5 \times 6 = 30$ marks)

Answer ALL questions.

All questions carry equal marks.

1. (a) Derive the relation between the scattering angles and the scattering cross-sections in the laboratory system and the center-of-mass system.

Or

(b) Explain how the scattered wave function is used to determine the scattering cross-section and hence find derive its relation to the scattering amplitude.

2. (a) Write a note on Sudden approximation.

Or

(b) Explain the density matrix of non-interacting systems.

3. (a) Derive the continuity equation for the Klein-Gordon equation, and discuss the problem of probability interpretation in this context.

Or

(b) Show that the Dirac equation describes particles of spin 1/2.

4. (a) Find the trace of the $\gamma^{\mu} (\mu = 0,1,2,3)$ without using the explicit matrix form of the γ^{μ}. Also find the trace of $(\gamma^{\mu}\gamma^{\nu})$.

Or

(b) Derive the covariant form of Dirac equation.

5. (a) Explain creation, annihilation and number operators.

Or

(b) Develop the theory of second quantization of the Schrödinger equation.

SECTION B — (3 × 15 = 45 marks)

Answer any THREE questions.

All questions carry equal marks.

6. Use the Phase shift analysis to give a detailed derivation of the scattering amplitude, scattering cross-section and total cross-section. Hence obtain the optical theorem.

7. Outline the perturbation theory for the time evolution of a system. Obtain Fermi's Golden rule for a constant perturbation switched on at $t = 0$.

8. Set-up the free particle Dirac equation and solve it to get the free particle solutions.

9. Obtain the necessary and sufficient conditions for the invariance of the Dirac equation under Lorentz transformation.

10. Obtain an expression for second quantization of Klein-Gordon equation.

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