NOVEMBER/DECEMBER 2019

MPH23 — QUANTUM MECHANICS II

Time : Three hours Maximum : 75 marks

SECTION A — (5 × 6 = 30 marks)

Answer ALL questions.

All questions carry equal marks

1. (a) Obtain the condition for the validity of Born approximation, with necessary theory.

Or

(b) Obtain an expression for scattering amplitude.

2. (a) Define density matrix. Obtain an expression for the expectation value of any operator F. List the basic properties of the density matrix.

Or

(b) (i) In the dipole approximation obtain the selection rules for radiative transitions in an *atom*.

(ii) Determine whether the transition $1S \rightarrow 2P$ is allowed or not under dipole selection rules.

3. (a) Obtain Klein—Gordon relativistic equation for a free particle.

Or

(b) Show that the Dirac equation describes a particle with spin, and that the spin value is h/2.

4. (a) Show that gamma matrices transform as the components of a four vector.

Or

(b) Discuss the Lorentz covariance of the Dirac equation.

5. (a) Define the number operator N_k for a system of bosons and show that commutator $[N_k, N_l] = 0$.

Or

(b) Explain creation and annihilation operator.

SECTION B — ($3 \times 15 = 45$ marks)

Answer any THREE questions.

All questions carry equal marks.

6. Discuss the partial wave analysis and arrive at the Optical theorem.

7. In the dipole approximation discuss the semi-classical treatment of interaction of an atom with electromagnetic field.

8. Determine magnetic moment of electron use the Dirac's equation.

9. Starting from two component equation, find the energy eigenvalues of hydrogen atom.

10. Obtain the classical field equation in terms of Lagrangian density.