21000135

21000135

Reg. No.....

Name.....

M.Sc. DEGREE (C.S.S.) EXAMINATION, FEBRUARY 2021

Third Semester

Faculty of Science

Branch II : Physics–A–Pure Physics

PH 3C 09—QUANTUM MECHANICS–II

(2012—2018 Admissions)

Time : Three Hours Maximum Weight : 30

Part A

Answer any **six** *questions.*
Weight 1 *each.*

1. What is time dependent perturbation theory ? Why we need it ?
2. Explain Fermi's golden rule of time dependent perturbation theory.
3. Write note on photoelectric effect.
4. What is scattering amplitude ? How is it related to scattering cross-section ?
5. What is Ramsaur-Townsend effect ?
6. What are bilinear covariants ?
7. Bring the Klein-Gordon equation in covariant form.
8. Give the physical interpretation of Dirac's α matrix.
9. Briefly explain Noether's theorem.
10. Distinguish between Fermion and Boson fields.

$(6 \times 1 = 6)$

Part B

Answer any **four** *questions.*
Weight 2 *each.*

11. Obtain Einstein's A co-efficient for a one-dimensional harmonic oscillator of frequency ω in its n^{th} state.
12. Show that attractive potential leads to positive phase shifts whereas repulsive potential to negative phase shifts.

Turn over

13. In the Born approximation, calculate the scattering amplitude for scattering from a square well potential $V(r) = -V_0$ for $0 < r < r_0$ and $V(r) = 0$ for $r > r_0$.

14. Prove that the operator $c\alpha$, where α stands for Dirac matrix, can be interpreted as the velocity operator.

15. Derive expressions for probability density and probability current density in the Dirac theory.

16. For a system of fermions, define the number operator N_k and show that its eigen values are zero and one.

$(4 \times 2 = 8)$

Part C

Answer **all** *questions.*
Weight 4 *each.*

17. (a) Apply time dependent perturbation theory to dipole transition.

Or

(b) Outline the first order time dependent perturbation theory and derive the Fermi golden rule for the transition rate from a given state to a final state in the continuum.

18. (a) Discuss about Born approximation.

Or

(b) Describe the method of partial waves in calculating the scattering amplitude for the case of spherically symmetric potential and obtain an expression for the total scattering cross-section.

19. (a) Explain the free particle solution of Dirac's relativistic equation and show the existence of negative energy states.

Or

(b) Set up Klein-Gordon equation and discuss the difficulties associated with it with regard to negative probability. Show that such difficulties do not arise with Dirac equation.

20. (a) Describe the method of quantizing Schrödinger wave field and show that the field contains particles with all possible energies.

Or

(b) How is the electromagnetic field quantized ? Is it second quantization ?

$(4 \times 4 = 16)$