F 5094 (Pages : 2) Reg. No..................................

Name..................................

M.Sc. DEGREE (C.S.S.) EXAMINATION, JANUARY 2016

Third Semester

Faculty of Science

Branch II—Physics-A-Pure Physics

PH 3C 09—QUANTUM MECHANICS—II

(2012 Admission onwards)

Time : Three Hours Maximum Weight : 30

Part A

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

1. Write down the interaction part of the Hamiltonian in the presence of external electromagnetic field.
2. Write down the properties of Dirac matrices.
3. Explain the Klien-Gordon equation.
4. Discuss the validity conditions for Born approximation.
5. Show that the scattering amplitude $f(\theta, \varphi)$ bears a relation with the scattering cross section $(d\sigma / d\Omega)$.
6. What are partial waves ?
7. Explain dipole approximation.
8. Obtain the quantization rule for Bose particles.
9. Briefly discuss Noether's theorem and its significance.
10. What are bilinear co-variants ?

(6 × 1 = 6)

Part B

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

11. In the dipole approximation, (i) obtain the selection rules for radiative transitions in an atom. (ii) Determine whether the transition 1S → 2P is allowed or not under dipole selection rules.
12. Prove Dirac matrices are trace-less and the Eigen values are ± 1. Show that a wave field φ which satisfies

$$\frac{\partial \varphi}{\partial t} = (\sigma \cdot \nabla)\,\varphi$$

satisfies Klein Gordon equation for a mass less particle.

Turn over

13. Prove that :

$$\sigma_{\text{total}} = 4\frac{\pi}{k}\,\text{Im}\, f(0)$$

where $f(0)$ is an imaginary part of the forward scattering amplitude.

14. Use Born approximation to find the scattering cross-section for a delta function potential.

15. Derive the Hamiltonian density of Dirac's field.

(4 × 2 = 8)

Part C

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

16. (a) Derive the expression for the scattering amplitude for the scattering by the Yukawa's potential.

Or

(b) Quantize the Klein-Gordon field with necessary theory.

17. (a) Discuss Sudden and adiabatic approximations in detail.

Or

(b) Derive the Klein Gordon equation for relativistic fields and explain why it does not represent a particle with spin ½ $\hbar$.

18. (a) Obtain the differential scattering cross section, using Fermi's golden rule considering the scattering potential $V(r)$ as a perturbation.

Or

(b) What is harmonic perturbation ? Calculate the transition probability per unit radiation of intensity of a harmonic perturbation

19. (a) Discuss the hard sphere scattering, and s-wave scattering for finite potential well.

Or

(b) Discuss the relativistic co-variance of Dirac equation

(4 × 4 = 16)