LOYOLA COLLEGE (AUTONOMOUS), CHENNAI – 600 034

M.Sc. DEGREE EXAMINATION – **PHYSICS**

FOURTH SEMESTER – NOVEMBER 2016

PH 4810 - QUANTUM MECHANICS - II

Date: 05-11-2016 Dept. No. Max. : 100 Marks
Time: 01:00-04:00

PART A

Answer **ALL** questions: 10 x 2 = 20 marks

1. Explain Fermi's golden rule.
2. What is Dipole moment approximation?
3. Obtain the relation between proper velocity and ordinary velocity.
4. Atomic particles in the form of a beam have their velocity of 95% of the speed of light. What is the relativistic mass as compared to its rest mass?
5. What is a hole, with reference to a free Dirac particle?
6. Prove $[S_x , S_y] = i\hbar\sigma_z$
7. Show that the symmetry character of a wave function does not change with time.
8. Find the Eigen values of the particle exchange operator.
9. Draw a Feynman diagram for absorption of photon by an electron.
10. Describe Bremsstrahlung and pair production.

PART B

Answer **ANY FOUR** questions 4x7.5= 30 marks

11. What are Einstein's coefficients? Outline the way in which absorption and emission of radiation are explained in quantum mechanics?
12. Explain Compton's scattering and find an expression for the change in wavelength of the scattered X- ray beam.
13. Explain how Klein - Gordon equation leads to positive and negative probability density values.
14. Prove that the operator cα , where α stands for Dirac matrix can be interpreted as the velocity operator.

15. The energy momentum tensor for fields is defined by $T_{\mu\gamma} = \sum_{\alpha} \pi_{\mu\alpha} \partial_{\gamma} \psi_{\alpha} - L\, \partial_{\mu\gamma}$, show that $\frac{\partial T_{\mu\gamma}}{\partial x_{\mu}} = 0$

16. A neutral pion of rest mass 'm' and relativistic momentum p = $\frac{3}{4}$ mc decays into photons.One of the photons is emitted in same direction as the original pion, and the other in the opposite direction. Find the relativistic energy of each photon?

PART – C

Answer any **FOUR** questions: 4 x 12.5 = 50 marks

17. Discuss the time dependent perturbation theory with reference to sinusoidal perturbation and obtain an expression for transition probability.
18. (a) Explain in detail the structure of Spacetime. (b) Two lumps of clay, each of rest mass (m), collide head-on at $\frac{3}{5}$ c if they stick together, what is the mass (M) of the composite lump? (8+4.5)
19. Show that Dirac equation gives positive and negative energy solutions. Explain pair production and pair annihilation in the energy spectrum of a free Dirac particle.
20. Discuss the effect of time reversal in the time – dependent Schrodinger equation. (b) If $\psi_+(r)$ and $\psi_-(r)$ are the eigen functions of the parity operator belonging to even and odd eigenstates, show that they are orthogonal.
21. Discuss the procedure for quantization of complex scalar field. From the discussion explain the annihilation, creation and particle number operators.
22. What are Einstein's A & B coefficients? Prove the following (a) If the source temperature is 1000 K, in the optical region (λ = 5000 Å). The emission is predominantly due to spontaneous transitions. (b) If the source temperature is 300 K in the microwave region (λ = 1 cm), the emission is predominantly due to stimulated emission.

****