LOYOLA COLLEGE (AUTONOMOUS), CHENNAI – 600 034

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

FOURTH SEMESTER – **APRIL 2014**

PH 4810 - QUANTUM MECHANICS - II

Date : 27/03/2014 Dept. No. Max. : 100 Marks

Time : 01:00-04:00

PART A

Answer **ALL** the questions: (10 × 2 = 20)

1. Explain the Fermi golden rule.
2. What is Dipole moment approximation?
3. A nuclear particle was observed to break into two fragments and move in opposite directions. The velocity of each was found to be 0.8c relative to the laboratory. What was the velocity of one fragment relative to the other?
4. Two events occurring at the same place in an inertial frame are separated by a time interval of 4 secs. What is the spatial difference between these two events in an inertial frame in which the events are separated by a time interval of 6 secs.
5. If α and β are dirac matrices prove that $\alpha_x\alpha_y\alpha_z = \frac{1}{2}[\alpha_x\,\alpha_y\,\alpha_z\,\beta, \beta]$
6. Prove $[S_x, S_y] = i\hbar\sigma_z$
7. Illustrate exchange degeneracy with an example.
8. Show that the symmetry character of a wave function does not change with time.
9. Write a short note on Bhaba scattering.
10. What do you mean by Bremsstrahlung and pair production.

PART – B

Answer any **FOUR** questions (4 × 7.5 = 30)

11. Explain the terms transition rate and selection rules.
12. Which of the following can be classified under electric dipole transitions? (i) $1s \longrightarrow 2s$ (ii) $1s \longrightarrow 2p$ (iii) $2p \longrightarrow 3d$ (iv) $3s \longrightarrow 5d$.
13. (a) Discuss the condition for interval between events to be invariant. (4)
    (b) Event A happens at point ($x_A = 5$, $y_A = 3$, $z_A = 0$) and at time t_A given by $ct_A = 15$, event B occurs at (10, 8, 0) and $ct_B = 5$, both in system S. What is the invariant interval between A and B. (3.5)
14. Prove that the parity of spherical harmonics $Y_{l,m}(\theta, \varphi)$ is $(-1)^l$.
15. List and explain the configuration space rules for Feynman graphs.

PART – C

Answer any **FOUR** questions (4 × 12.5 = 50)

16. What are Einstein's A & B coefficients? Evaluate the Einstein coefficient for spontaneous emission.
17. (a) Explain the salient features of Minkowski's space time diagram. (6.5)
    (b) Two lumps of clay each of mass (rest) m, collide head – on at 3/5 c. They stick together. What is the mass of the composite lump? (6)
18. 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.
19. (a) Wave functions possess even or odd parity. Explain.
    (b) Explain the effect of parity operator on the observables r, p and L.
20. Discuss the procedure for quantization of complex scalar field. From the discussion explain the annihilation, creation and particle number operators.

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