# LOYOLA COLLEGE (AUTONOMOUS), CHENNAI – 600 034

M.Sc. DEGREE EXAMINATION – PHYSICS

THIRD SEMESTER – NOVEMBER 2007

**PH 3808 - RELATIVITY AND QUANTUM MECHANICS**

**AC 19**

Date : 26/10/2007 Dept. No. Max. : 100 Marks
Time : 9:00 - 12:00

**PART A** (10 x 2m =20m)

**Answer ALL questions**

1. Find the determinant value of the Loerntz transformation matrix.
2. State the relation between relativistic energy and relativistic momentum.
3. Define 4-current and write down the continuity equation in terms of it.
4. State the covariant form of Lorentz force equation.
5. Define differential scattering cross-section.
6. Distinguish between Born approximation and the partial wave analysis of the scattering theory.
7. Distinguish the first order transition from the second order of the time dependent perturbation theory with the help of a schematic diagram.
8. What is 'dipole approximation' in radiation theory?
9. What is the Dirac Hamiltonian?
10. State any two constraints on the Dirac matrices.

**PART B** (4 x 7 1/2m= 30m)

**Answer any FOUR questions**

11. Event A happens at point ( $x_A= 15$, $y_A= 3$, $z_A= 6$) and at time $t_A$ given by $ct_A= 15$; event B occurs at (10, 8, 1) and $ct_B= 5$, both in system S. Find the velocity of a frame S**'** in which both the events occur at the same point.
12. Bring out the transformations in the components of electric field between two inertial frames of reference.( You may choose a charged capacitor to be at rest in one of the frames)
13. Explain the kinematics of scattering process and obtain a relation between the scattering cross-section and scattering amplitude.
14. Discuss the time-dependent perturbation theory to obtain an expression for the amplitude of first order transition.
15. Explain the significance of the negative energy states the Dirac's relativistic wave equation

**PART C** (4 x 12 1/2m= 50m)

**Answer any FOUR questions**

16. a) Explain the structure of space-time (Minkowski) diagram and bring out its salient features.
    b) Explain the theory of Compton scattering to obtain the wavelength of the scattered beam
17. Define the electromagnetic field strength tensors and establish the covariant formulation of Maxwell's equations.
18. Discuss the partial wave analysis of scattering theory and obtain the optical theorem for the scattering cross-section.
19. Discuss the time dependent perturbation theory with reference to harmonic perturbation and obtain an expression for the transition probability per unit time.
20. Obtain the plane wave solutions of Dirac's relativistic wave equation for a free particle.

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