## LOYOLA COLLEGE (AUTONOMOUS), CHENNAI - 600 034

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

## THIRD SEMESTER - APRIL 2016

## PH 3808 - RELATIVITY AND QUANTUM MECHANICS

Date: 25-04-2016 Time: 09:00-12:00 Dept. No.

Max.: 100 Marks

## Answer ALL questions

- 1. Explain the invariant interval of two events in relativistic mechanics and define the term "spacelike" events.
- 2. Write down the expression for the kinetic energy of a relativistic particle and verify that it reduces to  $\frac{1}{2}$  $mv^2$  when the speed of the particle v << c, the speed of light

PART A

- 3. What are the components of a current density 4-vector? Write down the equation of continuity in covariant form.
- 4. Can you transform a pure magnetic field in one inertial frame of reference into a pure electric field in another inertial frame of reference or vice versa? - Reason out your answer.
- 5. Define differential scattering cross section.
- 6. Write down the Schrodinger equation for the radial wave function.
- 7. What do you understand by a selection rule?
- 8. What is meant by first and second order perturbation?
- 9. Write down the Dirac matrices in terms of the (2x2) Pauli spin matrices and unit matrix.
- 10. Explain briefly the significance of the negative energy states of the Dirac equation.

## PART B

# Answer any FOUR questions

**Answer any FOUR questions** 

- 11. (a) Explain the salient features of Minkowski's space time diagram. (b) A pion at rest decays into a muon and a neutrino. Find the energy of the outgoing muon, in terms of the two masses  $m_{\pi}$  and  $m_{\mu}$ (assume  $m_v = 0$ ) (3 + 4.5)
- 12. Establish the invariance of **E.B** under Lorentz transformation.
- 13. Outline the Green's function method of obtaining a formal solution of the Schrodinger wave equation in scattering theory.
- 14. Discuss the time-dependent perturbation theory to obtain an expression for the amplitude of first order transition.
- 15. Set up the Klein- Gordon equation and prove that there exists an equation of continuity for a relativistic particle. Interpret the equation.

## PART C

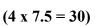
16. a) Discuss the work-energy theorem in relativity.

b) Explain the theory of Compton scattering to obtain the wavelength of the scattered beam.

- 17. Establish the covariant formulation of Maxwell's equations.
- 18. Outline the partial wave analysis of the scattering theory to obtain an expression for the scattering amplitude.
- 19. Discuss the time evolution of a quantum mechanical system in the case of constant perturbation and obtain the Fermi's Golden rule.
- 20. Obtain the plane wave solutions of the Dirac's relativistic wave equation of a free particle.

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## $(4 \times 12.5 = 50)$





 $(10 \times 2 = 20)$