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 Dept. No. Max. : 100 Marks
Time: 09:00-12:00

PART A

Answer ALL questions **(10 x 2 =20)**

1. Explain the invariant interval of two events in relativistic mechanics and define the term "space-like" events.
2. Write down the expression for the kinetic energy of a relativistic particle and verify that it reduces to ½ mv^2 when the speed of the particle $v << c$, the speed of light
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 **(4 x 7.5 = 30)**

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_π and m_μ (assume $m_\nu = 0$) **(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

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

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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