STELLA MARIS COLLEGE (AUTONOMOUS), CHENNAI-600086.
(For candidates admitted during the academic year 2019-2020 & thereafter)

M.Sc. DEGREE EXAMINATION - APRIL 2024
BRANCH III - PHYSICS
FOURTH SEMESTER

COURSE : MAJOR – CORE
PAPER : QUANTUM MECHANICS II
SUBJECT CODE : 19PH/PC/QM44
TIME : 3 HOURS **MAX. MARKS : 100**

SECTION – A

ANSWER ALL THE QUESTIONS: (10 x 3 = 30)

1. Distinguish between spontaneous and stimulated emission. Give expression for them using Einstein's coefficients.
2. What is harmonic perturbation? What is the effect of perturbation on a system on which it acts?
3. What is Minkowski force? How does it differ from other force equations?
4. What is metric tensor? Give an example.
5. Give the expression for Dirac matrices.
6. What is Lamb shift in a point-charge nucleus?
7. What is parity operator? How is an operator characterised as odd or even based on parity operator?
8. What do you understand by the term "identical particle" in quantum mechanics?
9. Give the expression for Lorentz gauge condition and Coulomb gauge condition.
10. What is pair production? Draw the Feynmann diagram for pair production.

SECTION – B

ANSWER ANY FIVE QUESTIONS: (5 x 5 = 25)

11. Show that the first order effect of a perturbation that varies simple harmonically in time is to transfer or receive a quantum of energy from the system on which it is acting.
12. On the basis of relativistic addition theorem of velocities show that the velocity of light is an absolute constant, independent of the frame of reference and that it is the maximum velocity attainable in nature.
13. Write the Klein-Gordon equation and give its physical interpretation.
14. Explain time-reversal invariance.
15. Discuss electron-photon interaction and represent them as Feynmann diagrams.
16. Show that the Dirac particle has a spin of 1/2ħ.
17. Starting from Dirac equation obtain the expression for probability and current density.

SECTION – C

ANSWER ANY THREE QUESTIONS: (3 x 15 = 45)

18. Discuss the time-dependent perturbation theory and obtain the expression for the first order correction to energy and wave-function.
19. Obtain the expression for Compton scattering formula taking into account the relativistic effects on electron velocity.
20. Derive the expression for magnetic moment of an electron using the covariant form of the Dirac equation for a free particle.
21. Discuss the exchange degeneracy arising between indistinguishable particles.
22. Give a detailed account of Bhabha scattering.

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