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

SUBJECT CODE : 19PH/PC/QM44

M.Sc. DEGREE EXAMINATION - APRIL 2022
PHYSICS
FOURTH SEMESTER

COURSE : MAJOR – CORE
PAPER : QUANTUM MECHANICS – II
TIME : 3 HOURS **MAX. MARKS : 100**

SECTION – A

Answer all the questions: **(10 x 3 = 30)**

1. Write down the properties of Dirac matrices.
2. Derive Hamiltonian classical field equation.
3. Obtain expression for probability density and probability current density in the dirac formalism.
4. Define creation, annihilation and number operators with necessary relations.
5. What do you mean by lamb shift?
6. Find the velocity at which the mass of a particle is double its rest mass.
7. Explain dipole approximation.
8. State Fermi's golden rule for perturbation theory.
9. What are called identical particles? Give explanation.
10. Define proper time of frame of reference.

SECTION – B

Answer any five questions: **(5 x 5 = 25)**

11. Enumerate the salient features of Minkowski's space - time diagram.
12. Derive the first order transition probability for a system driven by constant perturbation.
13. Show that $(\boldsymbol{\alpha}.\boldsymbol{A})(\boldsymbol{\alpha}.\boldsymbol{B}) = (\boldsymbol{A}.\boldsymbol{B}) + \boldsymbol{i}\boldsymbol{\sigma}'.(\boldsymbol{A}\times\boldsymbol{B})$**,** where A and B commute with $\boldsymbol{\alpha}$ and $\boldsymbol{\sigma}' = \begin{bmatrix}\boldsymbol{\sigma} & \mathbf{0}\\ \mathbf{0} & \boldsymbol{\sigma}\end{bmatrix}$.
14. Write short notes on symmetric and antisymmetric wavefunction with necessary explanation.
15. Calculate the kinetic energy of an electron moving with a a velocity of 0.98 times the velocity of light in the laboratory system.
16. Obtain the expression for Dirac's equation in the covariant form.
17. Give detailed explanation on the quantization of Schrodinger equation.

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SECTION – C

Answer any <u>three</u> questions: **(3x 15 = 45)**

18. Illustrate on Klein Gordon field and its quantisation process based on the quantum field theory.
19. Prove that the Dirac electron has a magnetic moment of $\mu = \frac{e\hbar}{2mc}\sigma$.
20. What is Compton effect? Discuss its theory and importance.
21. Summarize Enistein's A and B co-efficeints and obtain the necessary relation between them.
22. Explain the concept of exchange degeneracy. Show the working phenomenon of permutation operators in wavefuctions.

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