

STELLA MARIS COLLEGE (AUTONOMOUS), CHENNAI – 600 086
(For the candidates admitted from the academic year 2023-2024 and thereafter)

M.Sc. DEGREE EXAMINATION, APRIL 2026
BRANCH III - PHYSICS
FOURTH SEMESTER

COURSE : CORE

PAPER : QUANTUM MECHANICS II

SUBJECT CODE : 23PH/PC/QM44

TIME : 3 HOURS

MAX. MARKS: 100

Q. No.	SECTION A ANSWER ALL QUESTIONS (10 x 3 = 30)	CO	KL
1	What is spontaneous emission and stimulated emission?	1	1
2	Define Exchange Degeneracy in a system of identical particles.	1	1
3	State and explain the Pauli Exclusion Principle	1	1
4	Write expressions for charge and current densities in Dirac theory.	1	1
5	Write expressions for energy-momentum four vector and force four vector.	2	2
6	What are the four Dirac Matrices and what is their primary commutation relation?	2	2
7	Define Einstein A and B coefficients and state their physical meaning	2	2
8	Distinguish between contravariant and covariant vectors	2	2
9	Explain the need for field quantization	3	3
10	What is the physical significance of Creation and Annihilation operators in field theory?	3	3
Q. No.	SECTION B Part A ANSWER ANY TWO QUESTIONS (2 x 5 = 10)	CO	KL
11	State and prove Fermi's Golden Rule and mention its physical significance	3	3
12	What are unitary operators? Prove that Product $\hat{A}\hat{B}$ of two unitary operator \hat{A} and \hat{B} is also a unitary operator	3	3
13	A photographic plate shows a track of cosmic ray particle, placed in a magnetic field that its energy is 870 MeV and its momentum is 720 MeV/c. What is the mass of the particle?	3	3

Part B			
ANSWER ANY SIX QUESTIONS (6 x 5 = 30)			
14	Briefly explain the selection rules for electric dipole transitions.	4	4
15	Analyse the role of parity operator in quantum mechanics. Discuss parity conservation and non-conservation	4	4
16	Starting from four-vector formalism, derive the energy-momentum relation	4	4
17	Derive the Klein–Gordon equation and interpret its physical limitations	4	4
18	Starting from Lagrangian density, derive the Euler–Lagrange field equations.	4	4
19	Derive the transition probability for a system under harmonic perturbation and analyse the resonance condition.	4	4
20	Construct symmetric and antisymmetric wavefunctions for a two-particle system.	4	4
21	Write a short note on time reversal.	4	4
SECTION C			
ANSWER ANY TWO QUESTIONS (2 x 15 = 30)			
Q. No.		CO	KL
22	Discuss in detail time dependent perturbation theory. Obtain its first and second order transitions	5	5
23	What is Compton effect? Obtain Compton shift with necessary theory	5	5
24	Derive Dirac's relativistic equation for a free particle also obtain Dirac matrices from it	5	5
25	Discuss quantization of Schrodinger equation	5	5
