KAMARAJ COLLEGE (Autonomous)

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(Affiliated to Manonmaniam Sundaranar University, Tirunelveli)

(3 Pages) **Reg. No:……**

Question Code: 26E03303 **Course Code : 24PMPH31**

PG Degree - End Semester Examinations, April 2026

Third Semester

M.Sc., PHYSICS

Quantum Mechanics-II

(For those who joined in July 2024 onwards)

Time : 3Hours **Maximum : 75 Marks**

PART – A (10 × 1 = 10 Marks)

Answer ALL Questions

Choose the correct answer :

CO:1 K:1 1. The Born approximation is most applicable when

(a) Energy of the incident particle is high (b) Energy of the incident particle is low

(c) The potential is very strong (d) The target is very large

CO:1 K:2 2. The dimensions of the scattering amplitude f(Θ) is

(a) Inverse length (b) Length

(c) Dimensionless (d) Length squared

CO:2 K:1 3. A perturbation V(t)=λsinωt is applied to a 1D harmonic oscillator. The selection rule for a transition from the ground state(0) is

(a) $\Delta n = 0$ (b) $\Delta n = +1$

(c) $\Delta n = +2$ (d) $\Delta n = \pm 3$

CO:2 K:2 4. In an adiabatic process, the transition probability between different Eigen states is

(a) Very high (b) Negligible

(c) Unity (d) Dependent only on the initial

CO:3 K:1 5. For a particle with charge q and mass m, the probability current density J is related to the charge current density J_C by

(a) $J_C = J/q$ (b) $J_C = Jq$

(c) $J_C = Jq^2$ (d) $J_C = J$

CO:3 K:2 6. The Klein-Gordan equation describes particles with:

(a) Spin - $^1/_2$ and relativistic effects
(b) Spin - 0 and relativistic effects
(c) Non-relativistic spin-1 particles
(d) Only electromagnetic interactions

CO:4 K:1 7. The matrices appearing in the Dirac equation are called

(a) Pauli matrices
(b) Spin matrices
(c) Gamma matrices
(d) Rotation matrices

CO:4 K:2 8. The bilinear covariant are important because they

(a) Solve Klein-Gordon equation
(b) Remove negative energy states
(c) From Lorentz invariant physical quantities
(d) Describe Bosons

CO:5 K:1 9. The Euler-Lagrange equation is obtained from

(a) Newton's laws
(b) Schrodinger equation
(c) Maxwell equation
(d) Principle of least action

CO:5 K:2 10. The term ½ ħω in Hamiltonian represents

(a) Particle mass
(b) Zero point energy
(c) Charge
(d) Spin

PART – B (5 X 5 = 25 Marks)

Answer ALL Questions choosing either (a) or (b).
Answer should not exceed 250 words.

CO:1 K:4 11. (a) Simplify the theory Of Scattering Amplitude in Quantum Mechanics.

(OR)

(b) Analyze the theory of Yukawa Potential.

CO:2 K:3 12. (a) Identify the equation of Einstein's A and B Coefficients.

(OR)

(b) Derive the Selection rules for electric Dipole Radiation.

CO:3 K:4 13. (a) Simplify the Plane wave Solution of Dirac Equation.

(OR)

(b) Analyze the Interpretation of Negative Energy States.

CO:4 14. (a) List the Properties of the gamma matrices.

K:4

(OR)

(b) Explain the concept of Bilinear covariant.

CO:5 15. (a) Construct the equations of the Hamiltonian formulation.

K:3

(OR)

(b) Identify an expression for Creation, Annihilation and Number operators.

PART – C (5 X 8 = 40 Marks)

Answer ALL Questions choosing either (a) or (b).
Answer should not exceed 600 words.

CO:1 16. (a) Briefly explain about the Born approximation and its Validity in Quantum Theory.

K:5

(OR)

(b) Explain i) Scattering length and Effective range theory for S wave.

ii)Optical Theorem.

CO:2 17. (a) Discuss about Constant Perturbation.

K:6

(OR)

(b) Elaborate the Adiabatic Approximation and Sudden Approximation

CO:3 18. (a) Discuss the Klein – Gordon Equation and its significance.

K:4

(OR)

(b) Analyze the Magnetic Moment of an Electron Due to its Spin.

CO:4 19. (a) Build the Covariant form of the Dirac Equation.

K:6

(OR)

(b) Discuss about the Feynman‘s theory of Positron.

CO:5 20. (a) Determine the Euler Lagrange equation based on the classical fields.

K:5

(OR)

(b) Explain the Second Quantization of K-G field.