22PHP207N

PSG COLLEGE OF ARTS & SCIENCE
(AUTONOMOUS)

MSc DEGREE EXAMINATION MAY 2025
(Second Semester)

Branch - **PHYSICS**

QUANTUM MECHANICS- II

Time: Three Hours Maximum: 75 Marks

SECTION-A (10 Marks)
Answer **ALL** questions
ALL questions carry **EQUAL** marks (10 × 1 = 10)

Module No.	Question No.	Question	K Level	CO
1	1	What is the main limitation of semiclassical treatment? a) It cannot account for wave-particle duality. b) It is only applicable to macroscopic systems. c) It fails to describe phenomena at the atomic scale accurately. d) It ignores the probabilistic nature of quantum mechanics.	K1	CO1
	2	What is the semiclassical approximation commonly used for in quantum mechanics? a) Describing the motion of particles in strong gravitational fields b) Studying the behavior of particles in electromagnetic fields c) Solving the hydrogen atom wavefunction d) Calculating atomic energy levels	K2	CO1
2	3	What physical quantity does the Born approximation allow us to calculate in scattering problems? a) Probability density b) Momentum c) Energy eigenvalues d) Wave function	K1	CO2
	4	In which type of scattering does the Born approximation work best? a) Elastic scattering b) Inelastic scattering c) Resonant scattering d) Radioactive scattering	K2	CO2
3	5	Which of the following is a limitation of the variation method? a) It always provides the exact ground state energy. b) It requires knowledge of the exact wave function. c) It may converge to a local minimum rather than the global minimum. d) It is only applicable to systems with known potentials.	K1	CO3
	6	What physical quantity does the variation method allow us to calculate? a) Probability density b) Energy eigenvalues c) Momentum d) Wave function	K2	CO3
4	7	In the hole theory, what is the relationship between a hole and an electron? a) They are the same particle with opposite charges. b) They are independent particles with different properties. c) They are entangled particles. d) They cannot exist simultaneously in the same region.	K1	CO4
	8	What is the significance of the Dirac sea in the hole theory? a) It represents a sea of virtual particles that fill all negative energy states. b) It describes the behavior of electrons in a vacuum. c) It explains the wave-particle duality of particles. d) It represents the concept of wavefunction collapse.	K2	CO4
5	9	What happens when a number operator acts on an eigenstate of the system? a) It creates a superposition of different eigenstates. b) It collapses the state to one of its eigenstates. c) It changes the state to a different eigenstate. d) It has no effect on the state.	K1	CO5

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5	10	Which mathematical property of creation and annihilation operators ensures the preservation of the normalization of states? a) They are anti-commuting. b) They commute with each other. c) They are Hermitian conjugates of each other. d) They satisfy the commutation relations.	K2	CO5

SECTION - B (35 Marks)

Answer **ALL** questions

ALL questions carry **EQUAL** Marks (5 × 7 = 35)

Module No.	Question No.	Question	K Level	CO
1	11.a.	Obtain the selection rules for rules for the dipole transition.	K2	CO1
		(OR)		
	11.b.	Explain about three and four level Laser Schemes.		
2	12.a.	Derive the expression for scattering amplitude using Green's function technique.	K2	CO2
		(OR)		
	12.b.	State and prove optical theorem.		
3	13.a.	Find an expression for the electron density n(r) in the Thomas Fermi model interms of the Thomas Fermi function χ (x).	K4	CO3
		(OR)		
	13.b.	Explain the central field approximation.		
4	14.a.	Explain how Klein- Gordon equation leads to positive and negative probability density values.	K3	CO4
		(OR)		
	14.b.	Shoe that $A \times P + P \times A = -i\hbar\nabla \times A$ if P is treated as a differential operator.		
5	15.a.	Explain the term creation and annihilations in field equations.	K5	CO5
		(OR)		
	15.b.	Derive an expression for quantization of non- relativistic Schrodinger equation.		

SECTION -C (30 Marks)

Answer **ANY THREE** questions

ALL questions carry **EQUAL** Marks (3 × 10 = 30)

Module No.	Question No.	Question	K Level	CO
1	16	Explain the Einstein's coefficients spontaneous and induced emission of radiation.	K2	CO1
2	17	Explain the Partial wave method of determining the Scattering process.	K2	CO2
3	18	State and prove the Variational principle for obtaining approximate energies. Use it to find the ground state energy of helium.	K3	CO3
4	19	Use Dirac's equation to show that electron is endowed with a spin1/2.	K3	CO4
5	20	Obtain the Hamiltonian formulation of field.	K4	CO5

Z-Z-Z END