Reg. No .... Name **24P2019**

M. Sc. DEGREE END SEMESTER EXAMINATION - MARCH 2024

SEMESTER 2 - PHYSICS

COURSE : 21P2PHYT06 - QUANTUM MECHANICS I

(For Regular 2023 Admission and Improvement/Supplementary 2022/2021 Admissions)

Duration : Three Hours Max. Weights: 30

PART A

Answer any 8 questions **Weight: 1**

1.	Write down the three properties of the rotation operator R.	(U, CO 1, CO 2)
2.	Write the expression for the finite rotation operator and infinitesimal rotation operator.	(U, CO 1, CO 2)
3.	In the ket space spanned by the operator A write the matrix representation of the general operator X.	(R, CO 2)
4.	State and explain Erhenfest's theorem.	(U, CO 1, CO 2)
5.	Describe a stationary state and a nonstationary state.	(U, CO 1, CO 2)
6.	Write down the Pauli spin matrices.	(R, CO 1)
7.	How can you obtain the position space wavefunction$\psi_\alpha(x')$ from momentum space wave function $\phi_\alpha(p')$?	(A)
8.	Show that for a quantum mechanical SHO, $[N, H] = 0$	(A, CO 3)
9.	Prove $[A, B]^\dagger = -[A, B]$	(A, CO 1, CO 2, CO 3)
10.	Write the expression for the energy of an electron in an hydrogen atom.	(R, CO 4)

(1 x 8 = 8)

PART B

Answer any 6 questions **Weights: 2**

11.	In the $\|jm\rangle$ basis forms by the eigenkets of J^2 and J_z show that $\langle jm\|J_-J_+\|jm\rangle = (j-m)(j+m+1)\hbar^2$ here J_+ and J_- are the ladder operators.	(A, CO 3)
12.	Arrive at the expression for the momentum operator in the position basis.	(U, CO 2)
13.	Obtain the commutation relation $[J^2, J_x]$.	(A, CO 3)
14.	A Hermition operator O has two normalized eigen states $\|1\rangle$ and $\|2\rangle$ with eigen values 1 and 2 respectively. Two states $\|u\rangle = cos\theta\|1\rangle + sin\theta\|2\rangle$ and $\|v\rangle = cos\phi\|1\rangle + sin\phi\|2\rangle$ such that $\langle u\|v\rangle = 0$ and $\langle u\|O\|v\rangle = \frac{7}{4}$ find the possible values of θ and ϕ.	(A, CO 1, CO 3, CO 4)
15.	Distinguish between Heisenberg and Schrodinger pictures.	(U)
16.	Obtain the equation of motion in the Heisenberg picture.	(U, CO 1, CO 2)

17. Prove $[p_i, p_j] = 0$ using the commutation property of the translation operators. (A, CO 1, CO 2, CO 3)

18. Show that the expectation value in the Schrodinger picture is same as the expectation value in the Heisenberg picture. (A, CO 3)

(2 x 6 = 12)

PART C

Answer any 2 questions **Weights: 5**

19. Using the commutation algebra of angular momentum operators, find the eigen values of J^2 and J_z. (A, CO 3, CO 4)

20. (a) Derive the generalized uncertainity relation.
(b) Show that linear momentum is a generator of translation. (U, CO 2)

21. Obtain the eigen kets and eigenvalues of a simple harmonic oscillator. (A, CO 2, CO 3)

22. Derive the Generalized uncertainity principal. (U, CO 1)

(5 x 2 = 10)

OBE: Questions to Course Outcome Mapping

CO	Course Outcome Description	CL	Questions	Total Wt.
CO 1	Define the formalism of Non relativistic Quantum Mechanics.	R	1, 2, 4, 5, 6, 9, 14, 16, 17, 22	17
CO 2	Demonstrate principles of quantum mechanics.	U	1, 2, 3, 4, 5, 9, 12, 16, 17, 20, 21	22
CO 3	Apply the principles of quantum mechanics to specific quantum mechanical systems.	A	8, 9, 11, 13, 14, 17, 18, 19, 21	22
CO 4	Solve specific problems in quantum mechanics	A	10, 14, 19	8

Cognitive Level (CL): Cr - CREATE; E - EVALUATE; An - ANALYZE; A - APPLY; U - UNDERSTAND; R - REMEMBER;