

PSG COLLEGE OF ARTS & SCIENCE
(AUTONOMOUS)

MSc DEGREE EXAMINATION DECEMBER 2024

(First Semester)

Branch - PHYSICS

QUANTUM MECHANICS- I

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	If the matrix A of transformation is unitary, the linear transformation is said to be -----transformation. a.orthogonal b. unitary c.similarity d. nontrivial	K1	CO1
	2	Which of the following statement is WRONG, regarding Hilbert space? a. It is a vector space b. It has complex and countable dimensions c. All infinite series occurring in it are divergent d. wavefunctions associated with it are represented as vector sum of its components along the axes.	K2	CO1
2	3	A -----operator is defined as an operator which, when applied to a state, creates a new state with a raised or lowered eigenvalue. a. Momentum b. energy c. time d. ladder	K1	CO2
	4	According to Dirac, each wave function ψ can be associated with a state vector called ----and the complex conjugate wave function are associated with the quantity called -----. a. Ket, bra b. bra, ket c. bra, Hermite d. Ket, Hermite	K2	CO2
3	5	-----is NOT an example of perturbation theory. a. systems with linear contributions to the equation of motion b. systems with nonlinear contributions to the equation of motion c. tiny shifts in the spectral lines caused by electric field d. alterations to an objects orbit due to gravitational interactions with other bodies	K1	CO3
	6	The WKB approximation will be suitable in cases where the V is a. smooth and varying function of position b. constant potential c. infinite potential d. discrete	K2	CO3
4	7	Which of the following statement is WRONG in the case of adiabatic approximation? a. The perturbation is turned fast b. The solutions of schrodinger wave equations are approximated by means of instantaneous H c. $\langle m \frac{\partial H}{\partial t} k \rangle$ should be appreciable d. It occurs in the collision of gas molecules	K1	CO4
	8	In sudden approximation the variation of ----- cannot be neglected. a. $\frac{\partial V}{\partial t}$ b. $\frac{\partial \omega}{\partial t}$ c. $\frac{\partial H}{\partial t}$ d. $\frac{\partial \psi}{\partial t}$	K2	CO4
5	9	The state vector changes with time, but the operator remains constant with time is called a. Schrodinger picture b. Interaction picture c. Heisenberg picture d. Dirac picture	K1	CO5
	10	The method of second quantization can be applied to ----- system. a. many particle b. single particle c. degenerate d. nondegenerate	K2	CO5

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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.	Find the eigen values and the eigenvectors of the matrix $\begin{bmatrix} 1 & 1 & 1 \\ 1 & 2 & 3 \\ 1 & 3 & 6 \end{bmatrix}$	K2	CO1
		(OR)		
	11.b.	Show by example how the operators are represented into a matrix form.		
2	12.a.	Show that an operator which commutes with J_x and J_y , commutes with J_z also.	K4	CO2
		(OR)		
	12.b.	Build the angular momentum matrices for $j=1/2$, and $j=3/2$.		
3	13.a.	Discuss the time independent perturbation theory and obtain expressions for the first order correction to energy and eigen function.	K3	CO3
		(OR)		
	13.b.	Discuss the stationary perturbation theory for the degenerate case.		
4	14.a.	Compare adiabatic and sudden approximation methods.	K4	CO4
		(OR)		
	14.b.	Analyze the time dependant perturbation for a Harmonic perturbation.		
5	15.a.	Describe Schrodinger picture.	K3	CO5
		(OR)		
	15.b.	Describe Heisenberg Picture.		

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	Prove that the transformation from x to p is unitary and evaluate the transformation matrix.	K4	CO1
2	17	Obtain Clebch Gordan coefficients for the addition of orbital and spin angular momentum for electron in p state.	K4	CO2
3	18	Describe the WKB approximation method for the solution of Schrodinger wave equation in a potential field and discuss its validity.	K4	CO3
4	19	Develop Fermi Golden rule for constant perturbation that acts for a short interval of time. Apply it to find the transition rate of α sattering.	K4	CO4
5	20	Analyze the method of Second Quantisation.	K4	CO5

Z-Z-Z END