22PHP103N/22PHP103

PSG COLLEGE OF ARTS & SCIENCE
(AUTONOMOUS)

MSc DEGREE EXAMINATION DECEMBER 2023
(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	$A=PBP^{-1}$ of matrix A by invertible matrix P is called -------- a. orthogonal transformation b. linear transformation c. similarity transformation d. Unitary transformation	K1	CO1
	2	A 2x2 matrix can have ---------- number of eigen values and --------- number of eigen vectors a. 2,2 b. 2,1 c. 1,2 d. 2,3	K2	CO1
2	3	----------coupling is the construction of an N-electron eigenstate of the total atomic angular momentum operator out of the N individual electronic angular momentum eigenstates. a. LS b. angular momenta c. spin d. isospin	K1	CO2
	4	J+ and J- operators are referred as----- and -----operators. a. Raising and lowering b. Lowering and raising c. Bra ket d. Dirac and Hamiltonian	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	$\frac{\lambda\frac{\partial V}{dx}}{4\pi(E-V)}$ must be equal to ----------gives the validity of WKB approximation. a.1 b. 0 c.< 1 d.> 1	K2	CO3
4	7	--------- can be used to calculate the transition probabilities between two states and their corresponding life times. a. Perturbation constant b. Fermi Golden rule c. Adiabatic approximation d. sudden approximation	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 operator changes with time, while the state vector remain constant with time is called a. Heisenberg picture b. Schrodinger picture c. Interaction picture d. Dirac picture	K1	CO5
	10	The method of----------the basic framework for the formulation of many-body quantum systems. a. second quantization b. first quantisation c. sudden approximation d. Dirac approximation	K2	CO5

Cont...

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.	Show that the eigen functions belonging to different eigenvalues are orthogonal.	K2	CO1
		(OR)		
	11.b.	Show that a Hermitian matrix remains Hermitian after transformation by unitary matrix.		
2	12.a.	Derive the commutation relation of J^2 with components J_x, J_y, J_z.	K3	CO2
		(OR)		
	12.b.	Determine the matrix elements of J_+ and J_-		
3	13.a.	Obtain the expression for the eigen values and eigen functions in the first order non- degenerate stationary perturbation theory.	K3	CO3
		(OR)		
	13.b.	Discuss the stationary perturbation theory for the degenerate case.		
4	14.a.	Obtain the expression for transition probability per unit in the first order when constant perturbation acts on a system?	K4	CO4
		(OR)		
	14.b.	Explain adiabatic and sudden approximation.		
5	15.a.	Analyze the time dependent perturbation for a Interaction picture.	K4	CO5
		(OR)		
	15.b.	Discuss the time dependent perturbation for a Harmonic perturbation.		

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	(i)Show that the Eigenvalues of a diagonal matrix are its diagonal elements (ii)Diagonalise the following matrices (i) $\begin{bmatrix} \frac{4}{3} & \frac{\sqrt{2}}{3} \\ \frac{\sqrt{2}}{3} & \frac{5}{3} \end{bmatrix}$ (ii) $\begin{matrix} Cos\theta & -sin\theta & 0 \\ sin\theta & cos\theta & 0 \\ 0 & 0 & 1 \end{matrix}$	K4	CO1
2	17	Obtain Clebsch Gordan coefficients for the addition of orbital and spin angular momentum for electron in p state.	K4	CO2
3	18	Outline WKB method for a one dimensional case and derive the connection formulae. Apply the method to obtain the quantization condition for a bound state.	K4	CO3
4	19	Derive Fermi Golden rule for constant perturbation that acts for a short interal of time. Apply it to find the transition rate of α scattering.	K4	CO4
5	20	Describe the method of Second quantisation.	K4	CO5

Z-Z-Z END