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Gandhi Institute of Engineering and Technology University, Odisha, Gunupur
(GIET UNIVERSITY)

M.Sc. (First Semester - Regular) Examinations, January – 2026

24MPHPC11004 – Quantum Mechanics-I

(Physics)

Time: 3 hrs | Maximum: 60 Marks

(The figures in the right hand margin indicate marks)

PART – A **(2 x 5 = 10 Marks)**

Q.1. Answer ***ALL*** questions

		CO #	Blooms Level
a.	Define Linear space and Hilbert space with example.	CO1	K1
b.	Define Linear transformation and Unitary transformation.	CO2	K1
c.	Find [L+, L-].	CO3	K1
d.	Obtain the Eigen value of spin ½ particles.	CO4	K1
e.	Mention the properties Pauli spin matrices.	CO5	K1

PART – B **(10 x 5 = 50 Marks)**

Answer ***ALL*** the questions

		Marks	CO #	Blooms Level
2. a.	Discuss about the different operators used in QM and its properties with examples. Prove that for a Hermitian operator, all of its eigen values are real and the eigen vectors corresponding to different eigen values are orthogonal.	10	CO1	K1
	(OR)			
b.	State and prove expansion theorem.	5	CO1	K1
c.	What are Hermitian Operators? Mention its properties. Show that the Eigen values of Hermitian operators are real.	5	CO1	K1
3.a.	Discuss about the Matrix representation of an Operator? Find the inverse of the matrix: $\begin{bmatrix} 3 & -1 & 1 \\ -15 & 6 & -5 \\ 5 & -2 & 2 \end{bmatrix}$	10	CO2	K2
	(OR)			
b.	Discuss about the Commutator algebra and all its special properties?.	10	CO2	K2
4.a.	What are the pictures of Quantum Dynamics? Derive the equations of motion in the three pictures. Compare all the three Quantum pictures.	10	CO3	K2
	(OR)			
b.	Show that [Lz, L+] = hL+ and $\vec{L}\times\vec{L} = ih\vec{L}$.	5	CO3	K2
c.	Prove that the operators L^2 and L_z commute.	5	CO3	K2
5.a.	Determine the matrix form of L_x, L_y, L_Z, L_+, L_-.	5	CO4	K1
b.	Determine the Eigen values of L^2 and L_z.	5	CO4	K1
	(OR)			
c.	Define total angular momentum operator **J** and explain its properties. Obtain the eigen values of $\mathbf{J_Z}$ and $\mathbf{J^2}$.	10	CO4	K1
6.a.	Explain Pauli spin matrices and their properties with all necessary commutation relations among them. Show that: $(\vec{\sigma}\cdot\vec{A})(\vec{\sigma}\cdot\vec{B}) = \vec{A}\cdot\vec{B} + i\vec{\sigma}\cdot(\vec{A}\times\vec{B})$	10	CO5	K1
	(OR)			
b.	Explain about the Addition of Angular momentum and C. G Coefficient. Find the C. G Coefficient for $J_1 = \frac{1}{2}$ and $J_2 = \frac{1}{2}$	10	CO5	K3

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