QP Code: R251G016 | Reg. No | | | | | | | | | | | AY 24

GANDHI INSTITUTE OF ENGINEERING AND TECHNOLOGY, ODISHA, GUNUPUR

(GIET UNIVERSITY)

M. Sc. (First Semester - Regular) Examinations, February – 2025

24MPHPC11004 – Quantum Mechanics - I

Time: 3 hrs | Maximum: 60 Marks

Answer ALL questions

(The figures in the right hand margin indicate marks)

PART – A **(2 x 5 = 10 Marks)**

		CO #	Blooms Level
Q.1.	Answer ***ALL*** the questions		
a.	Difference between Hermitian and anti-Hermitian operators.	CO1	K2
b.	Define Hermitian Adjoint. State its properties.	CO1	K2
c.	Write Energy Eigen values of a harmonic oscillator	CO2	K1
d.	Find the matrix of [L_+, L_-].	CO3	K2
e.	Discuss the addition of two angular momenta.	CO4	K2

PART – B **(10 x 5 = 50 Marks)**

		Marks	CO #	Blooms Level
	Answer ***ALL*** the questions			
2.a.	Define Kets, Bras and Bra-ket. Mention their properties with examples.	7	CO1	K2
b.	State Position – momentum commutation relation	3	CO1	K1
	(OR)			
c.	Explain Schmidt method of orthogonalisation. Find its general form.	10	CO1	K2
3.a.	Show that $\mathrm{Tr}(\hat{A}\hat{B}) = \mathrm{Tr}\,(\hat{B}\hat{A})$. Where $A=\begin{pmatrix} 8-2i & 4i & 0 \\ 1 & 1 & 1-i \\ -8 & i & 6i \end{pmatrix}$, $B=\begin{pmatrix} -i & 2 & 1-i \\ 6 & 1+i & 3i \\ 1 & 5+7i & 0 \end{pmatrix}$	7	CO1	K2
b.	Distinguish between dimension and basis of a vector space.	3	CO1	K1
	(OR)			
c.	State and explain expansion theorem.	5	CO1	K1
d.	Discuss the operator representation in matrix form.	5	CO2	K2
4.a.	Mention the Eigen values and Eigen functions of Lz and L^2.	3	CO3	K1
b.	Explain the matrix representation of orbital angular momentum operators.	7	CO4	K2
	(OR)			
c.	Obtain the commutation relation between the L^2, L_Z, $L_\pm$, Lx, and Ly	10	CO3	K2
5.a.	Show that $(\vec{\sigma}\cdot\vec{A})(\vec{\sigma}\cdot\vec{B}) = \vec{A}\cdot\vec{B} + i\vec{\sigma}\cdot(\vec{A}\times\vec{B})$	6	CO4	K2
b.	Mention the properties Pauli spin matrices.	4	CO4	K1
	(OR)			
c.	Show that Pauli matrices are Hermitian, traceless and have determinants equal to -1.	3	CO4	K1
d.	Obtain eigen value equation in terms of spinors and operators S^2 and S_Z.	7	CO4	K1
6.a.	Define total angular momentum operator J with its properties and obtain the Eigen values of J_Z and J^2.	4	CO4	K2
b.	Obtain C.G. coefficients matrix (only) in case of J_1= 1 and J_2 =1/2.	6	CO4	K2
	(OR)			
c.	Describe the matrix representations of total angular momentum J^2, J_Z, $J_\pm$, Jx, and Jy	10	CO4	K2

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