COEP Technological University

(COEP Tech)
A Unitary Public University of Government of Maharashtra
w.e.f 21st June 2022
(Formerly College of Engineering Pune)

Quantum Physics Tutorial Test

MIS No:
Name:
Division:

Time: 50 minutes
Marks: 30
Date: 16th April 2024

1. Let, $|\chi\rangle = -2i\,|\phi_1\rangle + 2i\,|\phi_2\rangle + 7\,|\phi_3\rangle$ where $\{\phi_i\}$ orthonormal bases. Calculate the expectation value of the operator, $\hat{A}$. Use operator A which is given in Q.8. (4M)

2. Consider the following two kets: (10M)

   $|\Psi\rangle = -3i\,|\phi_1\rangle + 2\,|\phi_2\rangle + (-i)\,|\phi_3\rangle$ and

   $|\chi\rangle = -2i\,|\phi_1\rangle + 2i\,|\phi_2\rangle + 7\,|\phi_3\rangle$ where $\{\phi_i\}$ orthonormal bases.

   i) Find the Hermitian conjugates of $|\Psi\rangle$, $|\chi\rangle$.
   ii) Calculate the operators $|\Psi\rangle\langle\chi|$ and $|\chi\rangle\langle\Psi|$. Are they equal?
   iii) Calculate $\langle\Psi'|\Psi'\rangle$ and $\langle\chi|\chi\rangle$. Are they orthogonal? If not, then find the norm/s.
   iv) Verify Schwarz inequality.
   v) Verify Triangular inequality.

3. Write the Ladder operators for orbital and spin angular momentum. (2M)
4. Write the Pauli metrices. (2M)
5. Evaluate $[L_x, L_y]$. (2M)
6. Evaluate the Hermitian operator for the given operator $A = \left(\hat{x}\frac{d}{d\hat{x}}\right)$. (2M)
7. Write the Jacobi identity of commutator. (2M)

8. Consider an operator $\hat{\mathbf{A}}$ and $\hat{B}$. (6M)

$$\hat{A} = \begin{pmatrix} 2 & i & 0 \\ 3 & 1 & 5 \\ 0 & -i & -2 \end{pmatrix} \text{ and } \hat{B} = \begin{pmatrix} 7 & 3i & -3 \\ 0 & 2i & 2 \\ 7i & 5 & 5i \end{pmatrix}$$

   (a) Calculate $A^{-1}B$. Is it equal to BA^{-1}?
   (b) Calculate $[A^{-1}, B]$.
   (c) Calculate $Tr[A^{-1}, B]$.