Course Code : PHT 154 **QVRU/RS – 22 / 1235**

Second Semester B. Tech. (Artificial Intelligence and Machine Learning / Cyber Security) Examination

INTRODUCTION TO QUANTUM COMPUTING

Time : 3 Hours] [Max. Marks : 60

Instructions to Candidates :—

(1) All questions are compulsory.
(2) Assume suitable data wherever necessary.
(3) Answer written with suitable steps will be given full weightage.

1. (A) How does the Schrodinger's time dependent wave equation justify the presence of electron in an atom ? 2(CO2)

(B) What is phasor ? What is its significance with reference to electron behavior. 2(CO2)

(C) Let $c_1 = -4 + 2i$ and $c_2 = -6 - 3i$. Compute c_1/c_2. 2(CO1)

(D) State the properties of Matrix multiplication. 2(CO1)

(E) With respect to inner product define what is skew symmetric property ? 2(CO1)

(F) What is Hadamard matrix ? 2(CO1)

(G) Define what is bit and quantum bit. 2(CO4)

(H) The classical system is deterministic. Explain how. 2(CO2)

(I) What is reversible gate ? 2(CO3)

(J) What is normalization of ket ? 2(CO4)

2. (A) Give complex matrix

$$A = \begin{bmatrix} 5 & 4+5i & 6-16i \\ 4-5i & 13 & 7 \\ 6+16i & 7 & -2.1 \end{bmatrix}$$

Show that it is Hermitian.

Obtain AV for $V = [1\ 2+i\ \ 4-5i]^T$ 4(CO1)

(B) Find Tensor product of two vectors :

$$A = \begin{matrix} 1 & 5 \\ 3 & 7 \end{matrix} \quad \text{and} \quad B = \begin{matrix} 3 & 7 \\ 4 & 1 \end{matrix}$$

Are they commutative or not ? 3(CO1)

(C) Find transition matrix $M_{A \leftarrow B}$ for given set of vectors

$$A = \begin{bmatrix} 0 \\ 1 \end{bmatrix} \begin{bmatrix} 1 \\ 0 \end{bmatrix} \qquad B = \begin{bmatrix} 3 \\ 1 \end{bmatrix} \begin{bmatrix} -2 \\ 3 \end{bmatrix}$$ 3(CO1)

3. (A) In probabilistic system when a doubly stochastic matrix 'M' operates on a state 'X' in two different ways as $M^T X^T$ and XM, what does it represent ? Obtain the above for following :

$$M = \begin{bmatrix} 0 & \frac{1}{6} & \frac{5}{6} \\ \frac{1}{3} & \frac{1}{2} & \frac{1}{6} \\ \frac{2}{3} & \frac{1}{3} & 0 \end{bmatrix}$$

and

$$X = \begin{bmatrix} \frac{1}{3}, & 0, & \frac{2}{3} \end{bmatrix}$$ 4(CO2)

(B) In double slit experiment, the adjacency matrix for photon is

$$\begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ \frac{1}{\sqrt{2}} & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ \frac{1}{\sqrt{2}} & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & \frac{-1+i}{\sqrt{6}} & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & \frac{-1-i}{\sqrt{6}} & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & \frac{1-i}{\sqrt{6}} & \frac{-1+i}{\sqrt{6}} & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & \frac{-1-i}{\sqrt{6}} & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & \frac{1-i}{\sqrt{6}} & 0 & 0 & 0 & 0 & 1 \end{bmatrix}$$

Draw the weighted graphical representation of the experiment. 3(CO2)

(C) What is assembling systems ? 3(CO2)

4. (A) $V = \begin{bmatrix} 15 - 3.4i \\ 2.1 - 16i \end{bmatrix}$, Normalize the V and obtain the probability of it being found in state $|0\rangle$ and $|1\rangle$ 4(CO3)

(B) Find the commutator operator for–

$$\Omega_1 = \begin{pmatrix} 1 & -1-i \\ -1+i & 1 \end{pmatrix} \text{ and } \Omega_2 = \begin{pmatrix} 0 & -1 \\ -1 & 2 \end{pmatrix}$$ 3(CO3)

(C) What is variance, give its significance with reference to eigen values ? 3(CO3)

5. Write short notes on (any **Four**) :

(A) Landauer's principle and control gate.

(B) Classical and quantum computers

(C) Deutsch's Algorithm

(D) Control NOT gate

(E) Quantum gates. 10(CO2,3,4)