

M.Sc. Examination, 2019
Semester-IV
Computer Science
Course : MCSO-49
(Quantum Computing)

Time : 3 Hours

Full Marks : 40

Questions are of value as indicated in the margin

Answer Question No.1 and **any four** from the rest.

1. Answer any eight from the following : 2×4=8
 - i) What do you mean by superposition of quantum states?
 - ii) Explain what do you understand by quantum entanglement.
 - iii) State and explain No-cloning theorem.
 - iv) What is Heisenberg Uncertainty Principle? Explain.
 - v) What do you mean by Raw Key and Shifted Key in the context of Quantum Key Distribution (QKD).
 - vi) Define the complexity class BPP (Bounded-error Probabilistic Polynomial time).
2.
 - a) If X, Y and Z are Pauli matrices then prove that $X^2 = Y^2 = Z^2$.
 - b) Explain the properties of Bell States. Draw a quantum circuit that produces Bell states. Prove that Bell states are entangled.
 - c) Name four Quantum gates which do not have classical analogue.
 - d) If $|\varphi\rangle = a|0\rangle + b|1\rangle$ then *find the value of $P(0)$ and $P(1)$* using appropriate measurement operators. 2+2+2+2=8
3.
 - a) Define Quantum Fourier Transform.
 - b) Write down the two qubit Quantum Fourier Transform Matrix. Prove that such Quantum Fourier Transform Matrix is Unitary.
 - c) Draw the two-qubit Quantum Fourier Transform circuit and write down the transformed states. 1+4+(2+1)=8
4.
 - a) State Shor algorithm and write down its complexity.
 - b) What do you mean by entangled pair quantum registers?
 - c) What are the various steps of Shor algorithm? Describe how the integer 15 could be factorized using Shor algorithm. Comment on its power and nature. 2+1(4+1)=8
5.
 - a) Why quantum key Cryptography is so powerful? Compare and contrast RSA cryptography and Quantum key Cryptography.
 - b) Write down various steps of BB84 Quantum Key Distribution (QKD) protocol. Exploit following assumptions how secret Quantum Key could be generated using BB84 QKD protocol. Assume that Alice has used randomly generated qubit string 100100101 to communicate Bob through quantum channel in absence of Eve there necessary photon polarization states have been used by Alice to prepare qubit.
 - c) Explain briefly how the presence of Eve could be detected by the QKD distribution protocols. (2+1)+4+1=8

P.T.O.

(2)

6. a) Compare the Grover's search algorithm with classical linear search.
- b) How many steps are required for Grover's search algorithm to search an element from the search space $N = 2^n$. Describe all the steps to search an element x_0 for $n = 3$. Calculate the probability of finding such an element.
- c) How the probability of finding the desired element depends on the size of the search space.
- $2 + (4 + 1) + 1 = 8$
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