M.Sc. Examination 2018
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 four** from the following : 2×4=8
   i) Compare and contrast classical bits and qubits.
   i) State and explain No-cloning theorem.
   iii) When a set of quantum gates is called universal"?
   iv) Write down the Shor algorithm.
   v) Compare the Probabilistic Turing Machine and Probabilistic Quantum Turing Machine.
2. a) Write down the expression for Discrete Fourier Transform and hence define and describe Quantum Fourier Transform(QFT).
   b) Consider a two qubit state and write down the expression for QFT and hence prove that QFT operator is unitary.
   c) Give the Quantum Circuit for such QFT. (2+2)+3+1=8
3. a) X, Y and Z are Pauli matrices. Prove that X, Y an Z are unitary.
   b) Find the value of (i) Z.X-X.Z. (ii) Y.Z-Z.Y and (iii) X.Y – YX. 1.5+4.5+2=8
   c) Prove that $XR_y(\theta)X = R(-\theta)$ where $R_y(\theta)$ is the rotation matrix about y axis.
4. a) What is Quantum oracle?
   b) Write down Grover's search algorithm step by step.
   c) Apply Grover's search algorithm to find out a state $x_0 = 011$ from a search space of size N = 8. 1+2+(2+3)=8
      i)Find out the number of operations to be performed.
      ii) Find out the probability of finding the correct state
      iii) Compare the complexity of Grover's search with that of classical search. Comment on it.
5. Factor the number 15 into two co-prime number with shor algorithm find out the complexity of the Shor algorithm and hence prove that it does not depend, in general, on the conjecture difficulty on factoring a large composite number. Do you think that the Shor algorithm is optimal? Comment on it. 5+2+1=8
6. What do you mean by quantum superposition? Describe Schrodingers Cat and consequence of measurement of superposition? What is quantum entanglement? Write down and explain the properties of Bell's states. Prove that Bell's states are entangled. 1+2+2+2+1=8

P.T.O.

7. a) Compare and contrast Classical Cryptography and Quantum Cryptography.
   b) Explain how the security of quantum key cryptography is anthenhiated with the Heisenberg's uncertainty principle?
   c) Describe with an example how the Quantum key can be generated during communication between two distant parties without the presence of Eve. 2+2+4=8

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