Total No. of Questions – [06] Total No. of Printed Pages: 3

G.R. No.	

DECEMBER 2021 - ENDSEM EXAM

FINAL YEAR B. TECH (COMPUTER ENGINEERING)

(SEMESTER - I)

COURSE NAME: OPEN ELECTIVE-III

QUANTUM COMPUTING

COURSE CODE: IOEUA40184B

(PATTERN 2018)

Time: [1 Hr] **[Max. Marks: 30]**

Instructions to candidates:

1) **Answer Q.1 OR Q.2, Q.3 OR Q.4, Q.5 OR Q.6.**
2) **Figures to the right indicate full marks.**
3) **Use of scientific calculator is allowed.**
4) **Use suitable data where ever required.**

Q.1 a List at least 1 simple Quantum Algorithm and its application in solving a specific problem statement. In your answer, describe 4 areas around the algorithm and its associated problem statement as mentioned below: [4]

i. What problem the algorithm solves
ii. Why the algorithm is chosen over its classical counterpart
iii. Describe Quantum Circuit for the algorithm
iv. Explain how quantum speed up is achieved and state its value

Q.1 b What is Quantum Fourier Transform? Describe the following points related to the Quantum Fourier Transform Algorithm: [6]

i. What is Fourier Transform?
ii. What is Quantum Fourier Transform?
iii. What is Inverse Fourier Transform
iv. Application of Quantum Fourier Transform in Quantum Phase Estimation

OR

Q2 a What is a Quantum Algorithm? Why do we need Quantum Algorithms? What is the relationship between Quantum Circuits and Quantum Algorithms? In your answer, describe 4 areas around the fundamentals of quantum algorithm development as mentioned below: [4]

i. How to build a quantum algorithm using quantum circuits?
ii. Role of various gates and operators in building quantum algorithms
iii. Focus on key gates, operators and the concept of an oracle for developing a quantum algorithm
iv. What is algorithmic speed up and how quantum algorithms

can help in achieving the same?

Q2 b What is Quantum Phase Estimation Algorithm? Where is it used? Describe the following points related to the Quantum Phase Estimation Algorithm and the problem it solves: [6]

i. What is a Phase Estimation?
ii. What is Quantum Phase Estimation?
iii. What are the applications of Quantum Phase Estimation?
iv. Describe Quantum Circuit for the algorithm
v. Explain with example the relationship between Quantum Fourier Transform and Quantum Phase Estimation

Q.3 a What is Machine Learning? What is Deep Learning? Explain the problems that can be solved using quantum machine learning based on below points: [4]

i. Potential areas where machine learning and deep learning struggle
ii. Potential of Quantum Machine Learning in solving some specific problem domains
iii. Discuss the prospects for Quantum Machine Learning in the context of hybrid quantum-classical algorithms with one example to justify.

Q.3 b Discuss the Shor's Integer Factorization Algorithm in details, with respect to the following points: [6]

i. The problem of period finding
ii. Solving the period finding problem by applying quantum phase estimation
iii. Quantum Circuit for the Shor's Algorithm

OR

Q.4 a How will you solve the Binary Classification problem using Quantum Support Vector Machines and Quantum Kernel? Discuss the problem in brief by stating below points: [4]

i. How do you find multi-dimensional hyperplane using quantum kernels?
ii. Application of quantum kernels to solve a binary classification problem.

Q.4 b Discuss the Grover's Algorithm in details, with respect to the following points: [6]

i. The problem of unstructured search
ii. Creating the Oracle for Grover's Search Algorithm and Amplitude Amplification
iii. Quantum Circuit for the Grover's Search Algorithm

Q.5 a Describe the basics of Quantum Neural Networks and problems associated with Deep Learning using Quantum Computing. Focus on below areas: [4]

i. Barren Plateaus
ii. Trainability Issues in Quantum Neural Networks related to vanishing gradient problem

Q.5 b What is Quantum Approximate Optimization Algorithm (QAOA)? State its one application. Answer based on below points: [6]

I. Variational Quantum Eigen-solvers (VQE)
II. Quadratic Unconstrained Binary Optimization (QUBOs) and MaxCut
III. The QAOA Circuit
IV. Adiabatic Quantum Computing

OR

Q.6 a What is capacity in Classical Machine Learning. What is optimal capacity for Classical and Quantum Machine Learning Methods? Explain with respect to below points: [4]

i. Definition of Capacity in general for Machine Learning methods
ii. Optimal Capacity for Classical Machine Learning
iii. Optimal Capacity for Classical Deep Learning
iv. Optimal Capacity for Quantum Machine Learning

Q.6 b What is Quantum GANs? Explain Quantum Generative Adversarial Networks considering below points: [6]

i. What are (Quantum) Generative Adversarial Networks?
ii. How do we realize Quantum Generative Adversarial Networks?
iii. Quantum GANs for learning and loading Random Distributions