Total No. of Questions – [06] Total No. of Printed Pages: 2

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 discuss the use of quantum gates, operators in building its quantum circuit. 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. How is data passed to the quantum algorithms in IBM Qiskit?
III. Which quantum gates and operators are used in building its quantum circuit and why?
IV. Describe Quantum Circuit for the algorithm.

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? What are the steps in developing a quantum algorithm using IBM Qiskit? 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 IBM Qiskit?
ii. Features and Libraries in IBM Qiskit to build various gates and operators in building quantum circuits
iii. Steps involved in writing a program for Quantum Algorithm in IBM Qiskit
iv. What is the difference between using a simulator backend vs a transpiler?

Q2 b What is Simon's Algorithm? What problem does it solve? Describe the following [6]

points related to the use of Simon's Algorithm:

i. What is Simon's Algorithm?
ii. Classical vs Quantum Solution involving Simon's Algorithm
iii. Quantum Circuit for Simon's Algorithm?
iv. How is exponential speed up achieved using Simon's algorithm?

Q.3 a How is hyperparameter tuning implemented in Machine Learning, Deep Learning and Quantum Machine Learning? Explain based on below points: [4]

i. Hyperparameter optimization in Classical Machine Learning
ii. Hyperparameter optimization in Classical Deep Learning
iii. Hyperparameter optimization in Quantum Machine Learning

Q.3 b Use Shor's Integer Factorization Algorithm to factor a large integer. Answer respect to the following points: [6]

i. The algorithm
ii. Solving the period finding problem by applying quantum phase estimation for a specific large integer
iii. Quantum Circuit for the Shor's Algorithm applied to solve integer factorization for a large integer

OR

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

i. Why to use quantum kernels to identify feature spaces?
ii. Application of quantum kernels to solve a multi-class classification problem.

Q.4 b Apply the Grover's Algorithm to solve an unstructured graph search problem. Explain in detail, with respect to the following points: [6]

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

Q.5 a Describe the applications of Quantum Neural Networks and Variational Quantum Algorithms to problems associated with Machine/Deep Learning or Quantum Chemistry. Focus on below areas: [4]

i. Quantum Data vs Classical Data and Quantum Algorithms vs Classical Algorithms
ii. Pick up either any Machine Learning problem of Quantum Chemistry problem to justify use of Quantum Algorithms as opposed to Classical Algorithms

Q.5 b What are Variational Quantum Boltzmann Machines? State its one application. Answer based on below points: [6]

I. What are Quantum Boltzmann Machines?
II. How do we realize Quantum Boltzmann Machines?
III. Automatic differentiation for the QBM training

OR

Q.6 a Define below terms related to Quantum Neural Network Models? Explain with respect to below points: [4]

i. Universality of Quantum Neural Networks

ii. Quantum Perceptron
iii. Quantum Convolutional Neural Networks (QCNNs)
iv. Dissipative Quantum Neural Networks

Q.6 b How do you implement a Quantum feedforward Neural Network? Explain the steps in detail considering below points: [6]

i. Step 1: Encoding: Preparing the encoding states using Quantum Hypergraph States
ii. Step 2: Single Nodes (neurons): Discuss Quantum implementation of artificial neurons with its Quantum Circuit
iii. Step 3: Build the feed-forward network