Seat No.: _____ *Enrolment No._____*

GUJARAT TECHNOLOGICAL UNIVERSITY

M. E. - SEMESTER – I • EXAMINATION – SUMMER • 2014

Subject code: 710107N **Date: 19-06-2014**

Subject Name: Quantum Theory & Algorithm Design

Time: 02:30 pm - 05:00 pm **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** Define and Explain following **07**

i. Trace

ii. Hermitian operator & Projection operator

(b) Define and Explain following **07**

i. Bloch vector

ii. Eigen values, Eigenvector.

Q.2 **(a)** Use Gram Schmidt process to construct an orthonormal basis set from **07**

$$|v_1\rangle = \begin{pmatrix} 1 \\ 2 \\ -1 \end{pmatrix}, |v_2\rangle = \begin{pmatrix} 0 \\ 1 \\ -1 \end{pmatrix}, |v_3\rangle = \begin{pmatrix} 3 \\ -7 \\ 1 \end{pmatrix},$$

(b) A three state system is in the state **07**

$$|\psi\rangle = \frac{1}{2}|0\rangle + \frac{1}{2}|1\rangle - \frac{i}{\sqrt{2}}|2\rangle$$

Write down necessary projection operators and calculate the probability Pr(0), Pr(1) and Pr(2).

OR

(b) Two quantum states are given by $|a\rangle = \begin{pmatrix} -4i \\ 2 \end{pmatrix}$, $|b\rangle = \begin{pmatrix} 1 \\ -1+i \end{pmatrix}$ **07**

(a) Find $|a+b\rangle$

(b) Calculate $3|a\rangle - 2|b\rangle$

(c) Normalize $|a\rangle$, $|b\rangle$

Q.3 **(a)** Suppose that **07**

$$|A\rangle = \frac{|0\rangle - i|1\rangle}{\sqrt{2}} \quad |B\rangle = \sqrt{\frac{2}{3}}|0\rangle + \frac{1}{\sqrt{3}}|1\rangle$$

i. Write down the product state $|A\rangle|B\rangle$

ii. Compute the density operator. Is this a pure state?

(b) A system is in the state **07**

$$|\psi\rangle = \frac{1}{\sqrt{6}}|0\rangle + \sqrt{\frac{5}{6}}|1\rangle$$

Measurement is made with respect to the observable X.
What is the expectation or average value?

OR

Q.3 **(a)** A two qubit system is in the state **07**

$$|\psi\rangle = \frac{1}{\sqrt{6}}|01\rangle + \sqrt{\frac{5}{6}}|10\rangle$$

Is the state normalized? An X gate is applied to the second qubit. After this is

done, what are the possible measurement results if both qubits are measured and what is respective probability of each measurement result?

(b) A system is in the state **07**

$$|\psi\rangle = \frac{2}{\sqrt{5}}|0\rangle + \frac{1}{\sqrt{5}}|1\rangle$$

Describe the probability of measuring 0 and 1 for this state in the POVM formalism.

Q.4 **(a)** What is divide and conquer approach? Explain with merge sort. **07**

(b) Explain Primôs algorithm and Explain with example. **07**

OR

Q.4 **(a)** Explain binary search tree with example. **07**

(b) Explain Huffman coding. **07**

Q.5 **(a)** What is dynamic programming? Solve following knapsack 0/1 problem using dynamic programming Consider a Knapsack having weight capacity W=6 and number of items are three, profit p_i = <1, 2, 3> weight q_i= <2, 3, 4> **07**

(b) Explain topological sorting. **07**

OR

Q.5 **(a)** Define and explain different asymptotic notations. **07**

(b) What is greedy approach? Solve following knapsack problem using greedy approach. Capacity of knapsack is 20. **07**

profit p_i = <25, 24, 15> weight q_i= <18, 15, 10>

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