# MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
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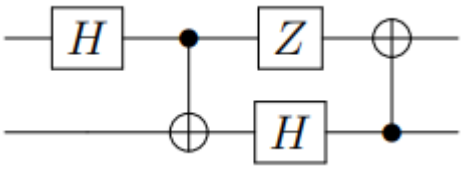
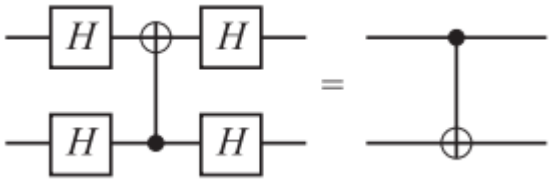
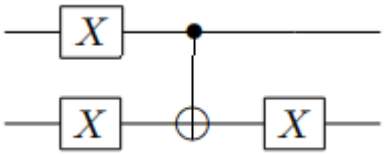
**II SEMESTER M. TECH (CSE/CSIS: Program Elective I)**
**END SEMESTER EXAMINATION, JUNE 27, 2022**
SUBJECT: FUNDAMENTALS OF QUANTUM COMPUTING (CSE 5025)
**REVISED CREDIT SYSTEM**

**Time: 3 Hours (2.00 PM-5.00 PM)** **MAX. MARKS: 50**

Note: Answer ALL the questions.

| | | |
|---|---|---|
| 1A | Let $\|\psi_1\rangle = \frac{1}{\sqrt{2}}(\|0\rangle + \|1\rangle)$ and $\|\psi_2\rangle = \frac{1}{\sqrt{5}}(3i\|0\rangle + \|1\rangle)$. Compute $\langle\psi_1 \| \psi_2\rangle$. | 03 |
| 1B | Consider the following two qubit state<br>$\|\psi\rangle = \frac{1}{3}\|00\rangle + \frac{2}{3}\|10\rangle - \frac{2}{3}\|11\rangle$<br>The first qubit is measured. What is the probability that the result is 0? What is the probability that the result is 1? For each possible result, write down the post-measurement state, and calculate the probability that a measurement of the second qubit will give 0 and 1. Write down the states after the second measurement. | 05 |
| 1C | Consider the following matrix<br>$M = \frac{1}{\sqrt{2}}\begin{pmatrix} 1 & i \\ i & 1 \end{pmatrix}$<br>Compute $M^\dagger M$. | 02 |
| 2A | Define quantum X, Y and Z gates and give its matrix representation. | 03 |
| 2B | Represent the following 2 qubit quantum circuit in the matrix form.<br>  | 05 |
| 2C | Illustrate No Cloning theorem with an example. | 02 |
| 3A | With quantum circuit implement NOT, AND, and OR gates using CCNOT gate. | 05 |
| 3B | Show that the two quantum circuits below are equivalent:<br>  | 03 |
| 3C | Prove that the following two qubit state is not entangled.<br>$\frac{\|00\rangle + \|01\rangle}{\sqrt{2}}$ | 02 |

| | | |
|---|---|---|
| 4A | Consider a CNOT gate whose control qubit (first input) is $\frac{1}{\sqrt{2}}\left(\|0\rangle+\|1\rangle\right)$ and target qubit (second input) is $\frac{1}{\sqrt{2}}\left(\|0\rangle-\|1\rangle\right)$. What are the states of the two output qubits? Repeat when the control qubit is $\|-\rangle=\frac{1}{\sqrt{2}}\left(\|0\rangle-\|1\rangle\right)$. | 03 |
| 4B | For the following combinations of *a*, *N*, apply Shor's algorithm to find the factors of *N*.<br>N = 21, a = 11. | 05 |
| 4C | Find the QFT for N=4 of the function<br>$\|f\rangle=\frac{1}{2}\left(\|00\rangle+\|01\rangle+\|10\rangle+\|11\rangle\right)$ | 02 |
| 5A | Apply Grover's algorithm on a system with N= 4 and solution is indexed by x = 2, | 05 |
| 5B | Consider the two qubit state is $\|\phi\rangle=\frac{1}{2}\|01\rangle+\frac{\sqrt{3}}{2}\|10\rangle$. Suppose that we feed $\|\phi\rangle$ into the following quantum circuit. What is the resulting two qubit state?<br>  | 02 |
| 5C | Show that $\frac{1}{\sqrt{2}}\left(\|01\rangle+\|10\rangle\right)$ is a stabilizer state and write down its stabilizer. | 03 |