Quantum Computing Midterm Exam

Instructions

- Answer all questions.
- Total marks: 60
- Clearly present your answers.
- You have 60 minutes to complete the exam.

Questions

1. Consider the following quantum circuit. If the input to the circuit is $|011\rangle$, determine its output. Please show your calculations at each stage of the circuit. [10 Marks]

2. Construct a **single** unitary matrix representing the entire quantum circuit. [10 Marks]

3. Create the reverse quantum circuit and also its unitary matrix. [5 Marks]

4. Demonstrate that the following qubits are not entangled by expressing individual qubits separately. Please clearly display their amplitudes. [5 Marks]

5. Design a quantum circuit for superdense coding when Alice and Bob share an entangled qubit B_{11}. [5 Marks]

6. Prove that the columns of the unitary matrix form an orthogonal basis. [5 Marks]

7. You are given a classical function $f : \{0,1\}^n \rightarrow \{0,1\}$. The function returns true when .... The quantum representation of this function is $|x\rangle |y\rangle B_f = |x\rangle |y \oplus f(x)\rangle$. Determine the output of the following quantum circuit. [5 Marks]

8. Answer the following 15 multiple-choice questions and fill in the blanks. To answer these questions, you must have a deep understanding of quantum computing concepts. [15 Marks]