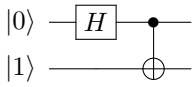
Quantum Programming Languages
CSCE 790 Section 008 Homework 1
Due: January 30, Thursday, 1pm

1. **No cloning property**

   (a) (2 points) Prove that we do not have $U(|\phi\rangle \otimes |0\rangle) = |\phi\rangle \otimes |\phi\rangle$ for all $|\phi\rangle \in$ **Qubit**, where U is a 2-qubit unitary.

   (b) (2 points) Under what circumstances we can copy a qubit?

2. Consider the following circuit.

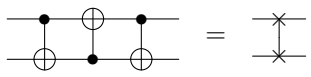


   (a) (2 points) Calculate the resulting state β_{01}.

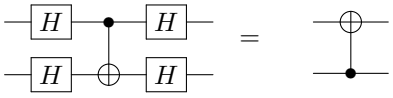
   (b) (2 points) Prove that there does not exist two single qubit states $|\phi_1\rangle$ and $|\phi_2\rangle$ such that $\beta_{01} = |\phi_1\rangle \otimes |\phi_2\rangle$.

3. Determine the correctness of the following circuit identities. If an identity is true, prove it; otherwise, show why it is not true.

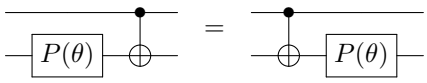
   (a) (2 points) Note: the circuit on the right hand side denotes the two-qubit swap gate.



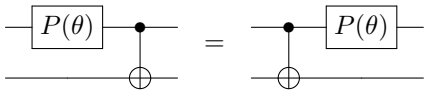
   (b) (2 points)



   (c) (2 points)



   (d) (2 points)



   (e) (2 points)