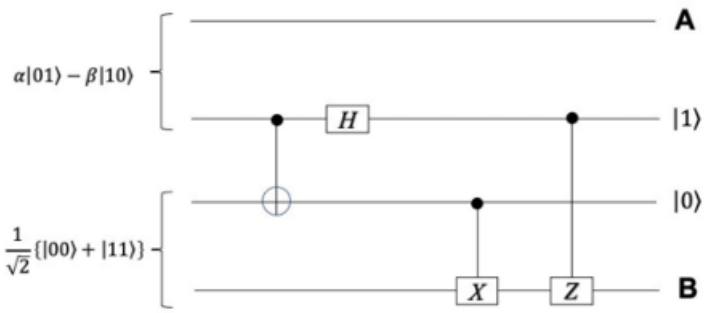
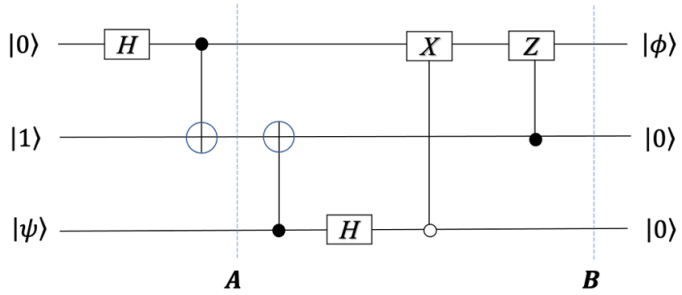
SOC
Quantum Symphony
June 10, 2022

Assignement 1

1. For the circuit below, find the final state at **A** and **B**



2. Consider the quantum state $|\psi\rangle = \alpha\,|0\rangle + \beta\,|1\rangle$ and the initial joint state $|\Psi\rangle = |0\rangle \otimes |1\rangle \otimes |\psi\rangle$. What is the joint state $|\Psi\rangle$ of the system at A, and the state $|\phi\rangle$ at B?



3. The quintessential three-qubit multiparty entangled states are the GHZ and W states:

$$|\psi\rangle_{\mathrm{GHZ}} = \frac{1}{\sqrt{2}}(|000\rangle + |111\rangle)$$

$$|\psi\rangle_{\mathrm{W}} = \frac{1}{\sqrt{3}}(|001\rangle + |010\rangle + |100\rangle).$$

Draw circuits that create the GHZ and W states.

4. Draw a 3-qubit gate, using only Toffoli gates, that implements a controlled swap operation, where the swap is applied to the two target qubits depending on a single control qubit and show the truth table when control is on.

5. Code up the following circuits :
   (a) A circuit that swaps the states of two qubits
   (b) A circuit that takes the computational basis to Hadamard basis
   (c) Circuits drawn in questions 3 and 4
   (d) A circuit that decrements a three bit number by 1 and stores the result in the same qubits that are used for the input

Best wishes