Exercises

Note: By the end of nine lectures, you should be able to do the following exercises.

1. Using the Dirac notation for the gates, show that (a) $Z = HXH$, (b) $Y = -HYH$, and (c) $X = HZH$ for the single qubit gates.

2. Find the output state of the following circuit when the input state is $|00>$, $|01>$, $|10>$, and $|11>$. For each of the four combinations, draw the input and output states on two Bloch spheres, with one Bloch sphere representing first qubit and the second sphere representing second qubit.

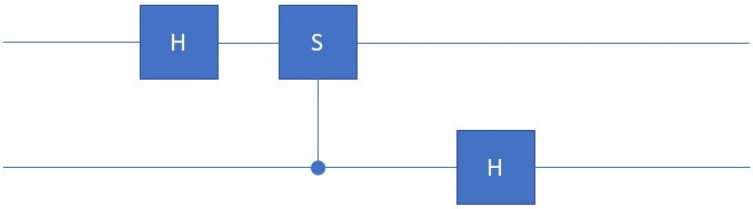

Figure 1: Circuit for Q. No. 2.

3. Implement Berstein–Vazirani circuit for secret bit string $s = 1011$ and run your code on *ibmq_athens* and *ibmq_5_yorktown* (or any other two quantum computers) for 1000 and 5000 shots (on each of these quantum computers). By comparing your results with the simulator's results, can you decide which of these quantum computers has less noise?

4. We developed a teleportation circuit to transfer state of a qubit state from one place to another, if both the sender and the receiver has $|\psi>^{00}$ Bell state shared between them. Work out the circuit if both parties had $|\psi>^{01}$ Bell state instead of the 00 state.

5. Implement the circuit for four-bit QFT in qiskit without putting measurements at the end. Simulate the circuit use statevector_simulator for inputs 0000, 0101, 1010, and 1111. Plot the output state vector on multiple Bloch spheres. See Intro 1 notebook for help on state vector simulator.

6. Devise an algorithm to perform inverse QFT, for general n bit input. Now, implement four-bit IQFT circuit in qiskit. Combine the QFT and IQFT circuit and implement measurements at the end of the combined circuit. Now, simulate the combined circuit for imputs 0000, 0101, 1010, and 1111. If your IQFT circuit is correct, your out put should be the same as input.