# Quantum Computing
Homework March 11th

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## Contents

# 1 Formula

## 1.1 Hadamard Gate

Hadamard Gate make a superposition state

$$H = \frac{1}{\sqrt{2}} \begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix} \tag{1}$$

For example with 0,1 Basis...

$$H \cdot |0\rangle = \frac{|0\rangle + |1\rangle}{\sqrt{2}} \tag{2}$$

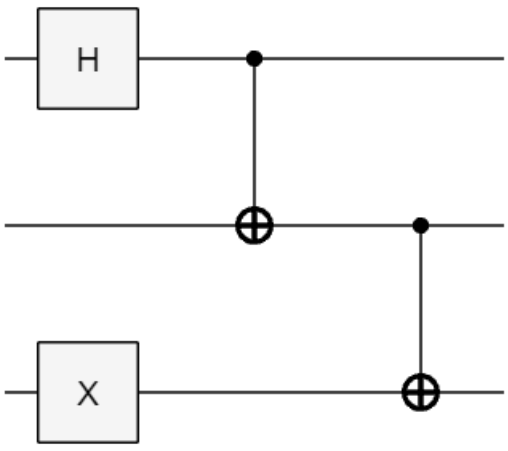
$$H \cdot |1\rangle = \frac{|0\rangle - |1\rangle}{\sqrt{2}} \tag{3}$$

## 1.2 Controlled-X Gate

Controlled gate act on 2 or more qubits and it can be used to entangle and disentangle Bell States.

| $x$ | $y$ | $y$ | $y + x$ |
|---|---|---|---|
| $\|0\rangle$ | $\|0\rangle$ | $\|0\rangle$ | $\|0\rangle$ |
| $\|0\rangle$ | $\|1\rangle$ | $\|0\rangle$ | $\|1\rangle$ |
| $\|1\rangle$ | $\|0\rangle$ | $\|1\rangle$ | $\|1\rangle$ |
| $\|1\rangle$ | $\|1\rangle$ | $\|1\rangle$ | $\|0\rangle$ |

# 2 Quantum Circuit



## 3 Simulation

The Results of Simulation with initial state($|110\rangle$)

MATLAB Code

```
gate01 = [hGate(1), cxGate(1,2), xGate(3), cxGate(2,3)];

circuit01 = quantumCircuit(gate01);

figure(1);
set(gcf,'color',[1 1 1]);
plot(circuit01);

sim01 = simulate(circuit01,'110');

f1 = formula(sim01,"Basis",'z');
f2 = formula(sim01,"Basis",'x');

histogram(sim01)
```

Results

$$f1 = 0.70711 * |010\rangle - 0.70711 * |101\rangle \tag{4}$$

$$f2 = 0.5 * |++-\rangle - 0.5 * |+-+\rangle + 0.5 * |-++\rangle - 0.5 * |---\rangle \tag{5}$$

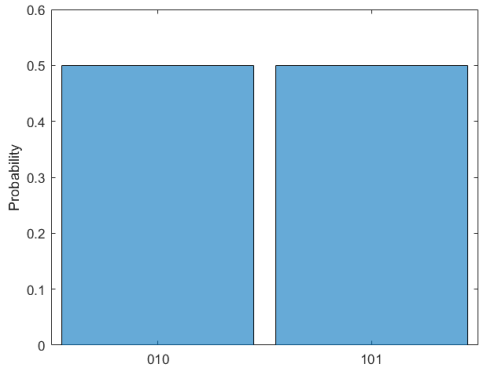



Figure 1: Historgram