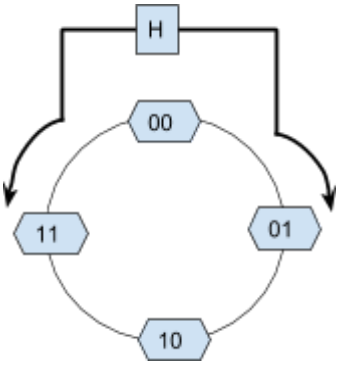
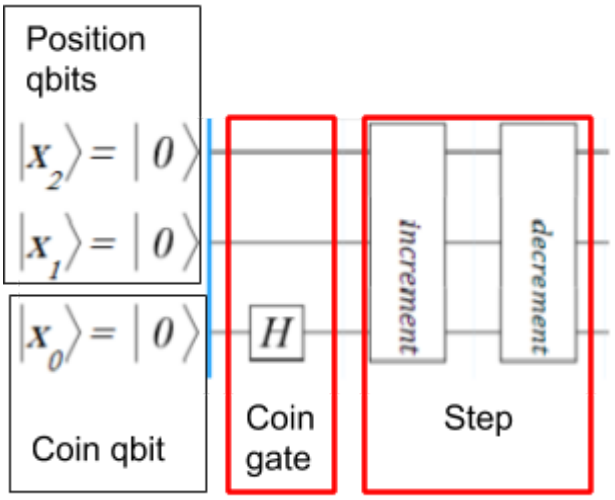
**Lab4 - Simple Quantum Walk on a circle**

**Exercise T1 THEORY**

We consider simple quantum walk example on a 4-point circle.



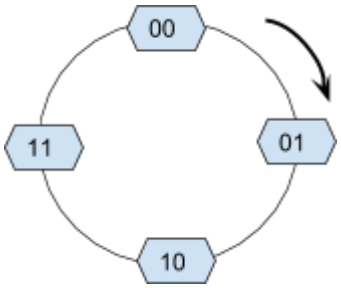



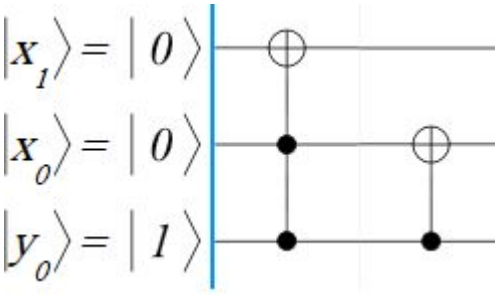

After applying H coin and the step gates, walker state changes according the following:

|position> ⊗ |0> becomes $\frac{1}{\sqrt{2}}$ (|position-1> ⊗ |0>+|position+1> ⊗ |1>)
|position> ⊗ |1> becomes $\frac{1}{\sqrt{2}}$ (|position-1> ⊗ |0>-|position+1> ⊗ |1>)

Calculate walker state after applying H coin and step gates once and twice.

**Exercise Q1 QUIDE**
Implement increment gate for two qbit x register in QUIDE. Observe that the gate acts on X register in a way:
|00>-> |01>-> |10>->|11>->|00> etc.

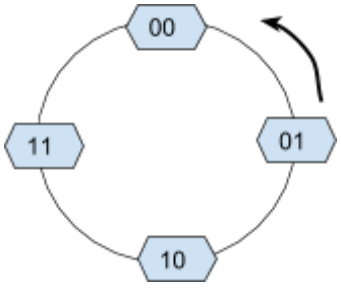


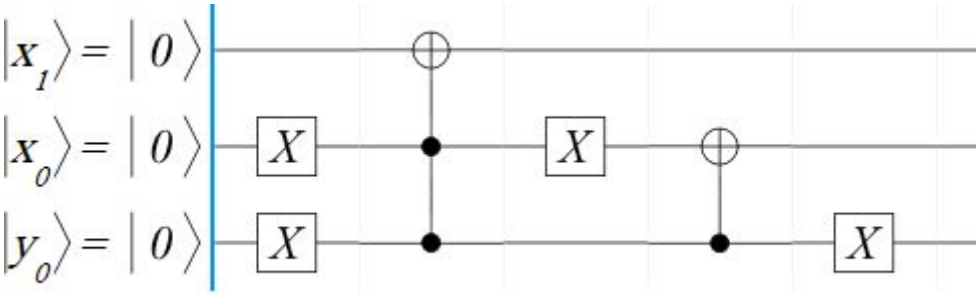




**Exercise Q2 QUIDE**

Implement decrement gate for two qbit x register in QUIDE. Observe that the gate acts on X register in a way:

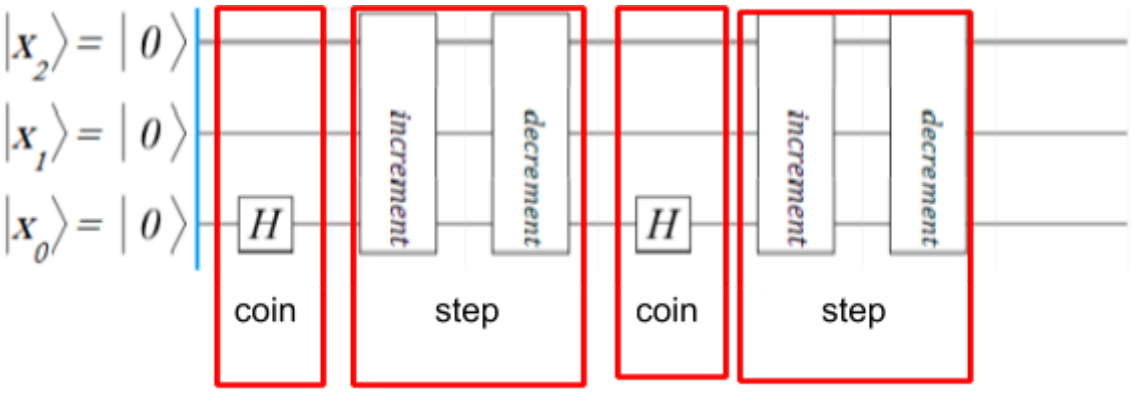
|00>-> |11>-> |10>->|01>->|00> etc.

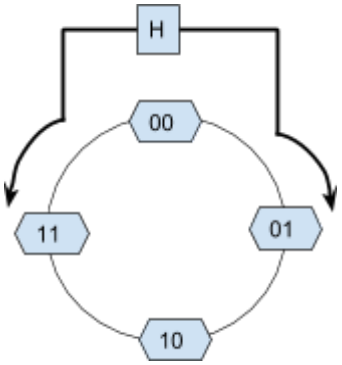



**Exercise Q3 QUIDE**

Implement quantum walk step on a 4-point circle according to the circuilt:




Fill the table and check with your calculations from exercise 1

| **Probability of finding walker at position** | | | | |
|---|---|---|---|---|
| **Number of steps** | **\|00>** | **\|01>** | **\|10>** | **\|11>** |
| **0** | **1** | | | |
| **1** | | | | |
| **2** | | | | |
| **3** | | | | |

The exercise is a simple example of a walk, but more complex quantum walks can be used for image processing

**Exercise I1 IBM**
Run IBM circuit implementing Toffoli gate with flips . Add more gates to build and test increment gate.

**Exercise I2 IBM (Optional)**
Using results from exercise I2 try to build decrement gate and perform one step of quantum walk. Compare results of the IBM simulator and real device.