

# Quantum Computing

## Assignment 3

### (Working with QASM )

Instructions: The assignment is self explanatory. Try yourself, as these concepts will be used for later assignments.

## Section 1

**Play with Bell states** Write down code in QASM for Creating the following Bell states (Do not use Drag and Drop option)

1.  $|\psi_1\rangle = 1/\sqrt{2}(|00\rangle + |11\rangle)$
2.  $|\psi_2\rangle = 1/\sqrt{2}(|00\rangle - |11\rangle)$
3.  $|\psi_3\rangle = 1/\sqrt{2}(|01\rangle + |10\rangle)$
4.  $|\psi_4\rangle = 1/\sqrt{2}(|01\rangle - |10\rangle)$
5.  $|\psi_5\rangle = 1/\sqrt{2}(|000\rangle + |111\rangle)$
6.  $|\psi_6\rangle = 1/\sqrt{2}(|000\rangle - |111\rangle)$

Run one of the above programs on actual hardware, and rest can be run on a simulator. Compare the output of actual hardware and simulator, if any.

## Section 2

**Toffoli Gate** Note: CCNOT(Toffoli Gate) is a third qubit gate with two controlled qubits. If both controlled qubits are 1 then the target qubit will be flipped. Write down a QASM program where you need to design a four qubits-controlled gate with three qubits acting as control qubits. If all three controlled qubits are equal to one, flip the target qubit.  
Hint: Use Two Toffoli gates and additional qubits if required.

## Section 3

**Toffoli Gate** Toffoli Gate is a Universal Gate. Write QASM program to perform the followings:

1. Toffoli gate act as AND Gate.
2. Toffoli gate act as NOT Gate.

## Section 3

**Half Adder** Write down a QASM Program to create half adder.  
Hint: Make use of CCNOT and CNOT