1. **Decode Alice's message - BB84**

   In this exercise you will build quantum circuits to encode and decode key bits as per the BB84 Quantum Key Distribution (QKD) scheme. The overall idea is as follows.

   ALICE:

   (i) Chooses a 100-bit long random string. This string decides whether she will encode the data in the Z or X basis.

   (ii) Chooses another string of 100 bits that will correspond to the raw key.

   (iii) Finally you will build a function for Alice to encode her raw key in the bases as per her random string.

   BOB:

   (i) Chooses a 100-bit long random string.

   (ii) Next, make measurements on the state sent by Alice either in the X or Z basis, based on this random string.

   Sifting: Choose only those mesurement values for which the basis choice of Alice and Bob match.

   Decode: Finally use the sifted key to decrypt the given encrypted message!

2. **Quantum Teleportation:**

   Write a program that creates a quantum teleportation circuit. Telport the state of your choice, of the form $\alpha|0\rangle + \beta|1\rangle$, with non-zero α and β. Please clearly state -

   - Initial state that you are trying to teleport - in $q0$

   - Which qubits are entangled and which bell state you are using for the teleportation - in $q1$ and $q2$.

   - The post processing i.e the unitary applied on $q2$ to get the encoded state onto it.

3. **Quantum teleportation using GHZ-like state:**

This exercise is based on the idea on reference [https://www.cs.memphis.edu/ kanyang/paper/J IJTP.pdf]. In this teleportation protocol, Alice distributes a GHZ-like state given as,

$$\frac{1}{2} \left(|001\rangle + |010\rangle + |100\rangle + |111\rangle \right).$$

The state that she would like to transfer is say, $\alpha|0\rangle + \beta|1\rangle$. This state can either be transfered to Bob or Charlie while the other party acts as an controller. For example, here are the steps to get the state teleported from Alice to Charlie.

(i) Do a Bell measurement on the first two qubits with Alice

(ii) Do a Z basis measurement on the third qubit, the qubit with Bob.

(iii) Based on the results from Alice's Bell measurement and Bob's Z basis measurement apply local unitary on 3. Based on the results from Alice's Bell measurement and Bob's Z basis measurement apply local unitary on Charlies qubit and show that the state is successfully teleported.