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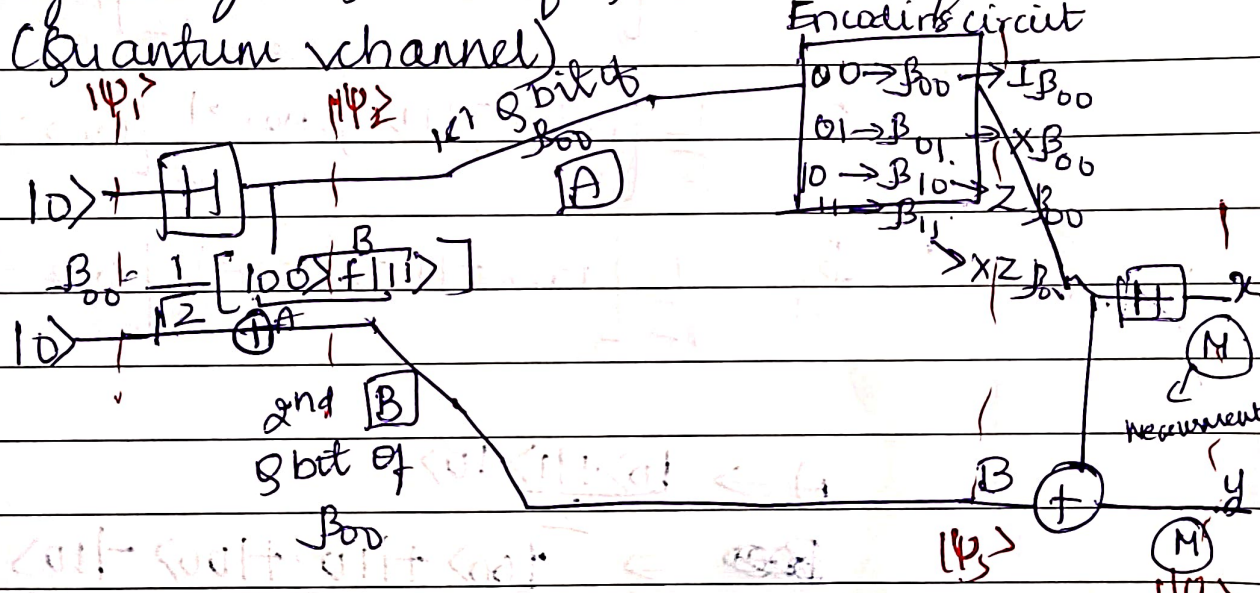
Superdense coding

→ Reverse of quantum teleportation

→ It is a quantum teleportation protocol where a sender (Alice) sends two classical bits of information to a receiver (Bob) by physically transmitting only one bit, provided they share a pre-entangled pair of qubits (a bell pair) beforehand.

→ Transmits 2 bits of classical information by using 1 qubit of quantum information (quantum channel)



Encoding of A

$\beta_{00} = \frac{1}{\sqrt{2}}[|00\rangle + |11\rangle]$ (A, B)

To sent Q channel	Encoded state
00 $(I \otimes I)\beta_{00}$	$\frac{1}{\sqrt{2}}[|00\rangle + |11\rangle]$
01 $(X \otimes I)\beta_{00}$	$\frac{1}{\sqrt{2}}[|10\rangle + |01\rangle]$
10 $(Z \otimes I)\beta_{00}$	$\frac{1}{\sqrt{2}}[|00\rangle - |11\rangle]$
11 $(ZX \otimes I)\beta_{00}$	$\frac{1}{\sqrt{2}}[|10\rangle - |01\rangle]$

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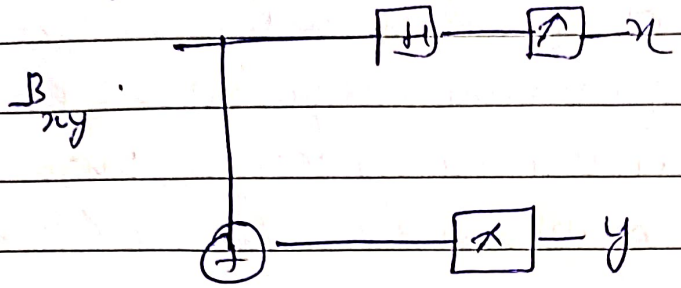
Decoding of β



State received by B

$\beta_{00} = \frac{1}{\sqrt{2}}[|00\rangle + |11\rangle] \xrightarrow[CNOT]{CX} \frac{1}{\sqrt{2}}[|00\rangle + |10\rangle]$ → (A)

$\beta_{01} = \frac{1}{\sqrt{2}}[|01\rangle + |10\rangle] \xrightarrow[CNOT]{CX} \frac{1}{\sqrt{2}}[|01\rangle + |11\rangle]$ → (B)

$\beta_{10} = \frac{1}{\sqrt{2}}[|00\rangle - |11\rangle] \xrightarrow[CNOT]{CX} \frac{1}{\sqrt{2}}[|00\rangle - |10\rangle]$ → (C)

$\beta_{11} = \frac{1}{\sqrt{2}}[|01\rangle - |10\rangle] \xrightarrow[CNOT]{CX} \frac{1}{\sqrt{2}}[|01\rangle - |11\rangle]$ → (D)

$A \rightarrow \frac{|0\rangle + |1\rangle}{2} |0\rangle$

$\Rightarrow \frac{|00\rangle + |10\rangle + |00\rangle - |10\rangle}{2}$

$\Rightarrow \frac{2|00\rangle}{2}$

$\Rightarrow |00\rangle$

$B \rightarrow |01\rangle$

$C \rightarrow |10\rangle$

$D \rightarrow |11\rangle$