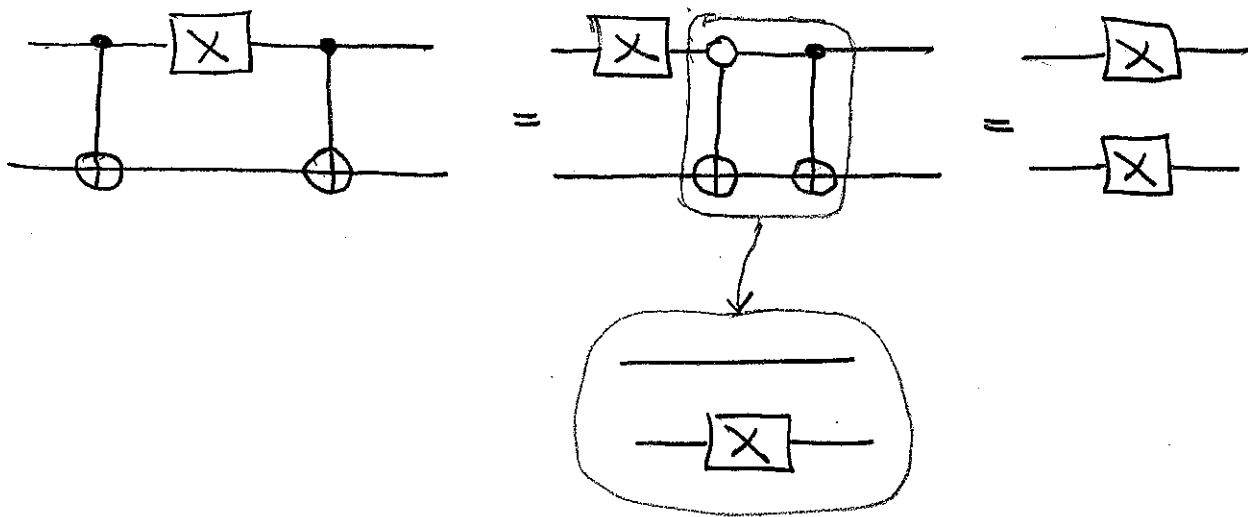
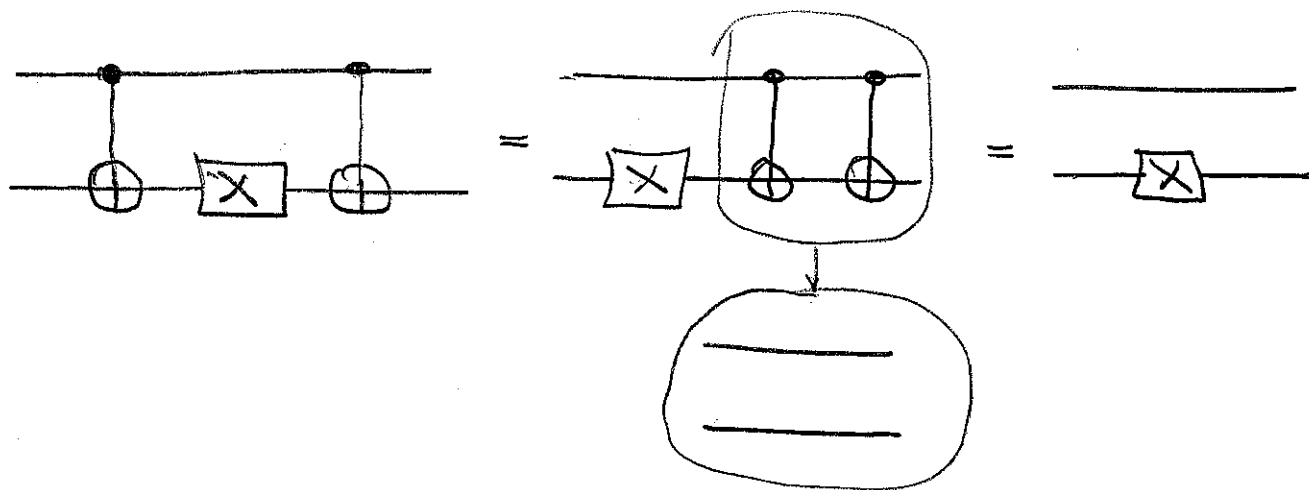


(a) C-C-NOT

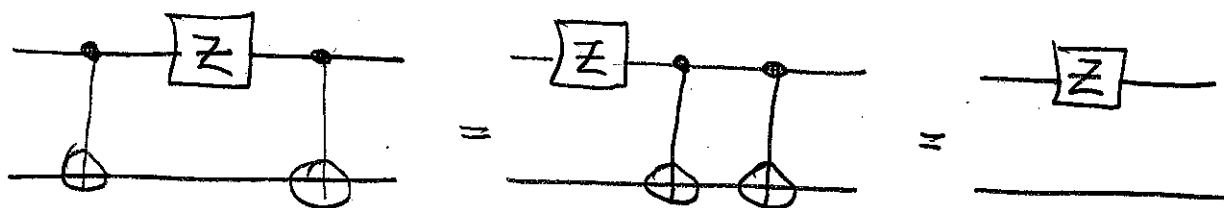
$$C(X \otimes I)C^\dagger = C(X \otimes I)C = X \otimes X$$



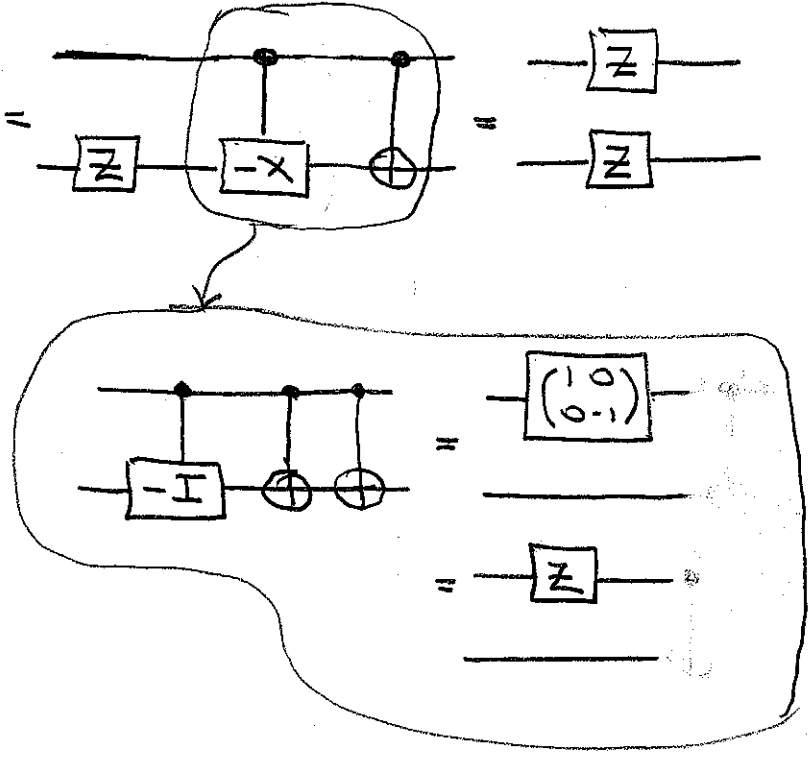
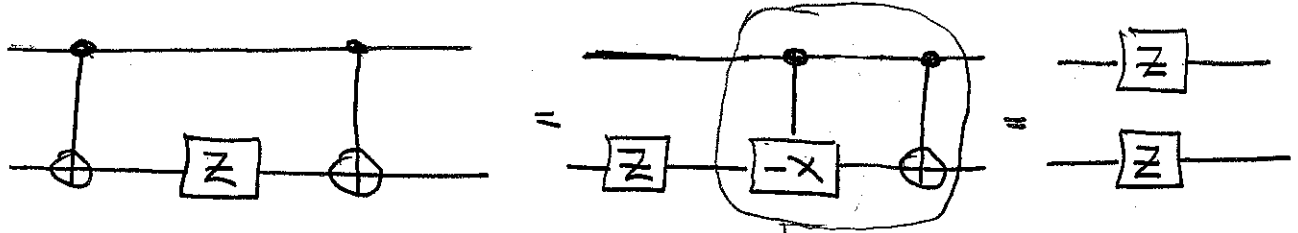
$$C(I \otimes X)C^\dagger = C(I \otimes X)C = I \otimes X$$



$$C(Z \otimes I)C^\dagger = C(Z \otimes I)C = Z \otimes I$$



$$C(I \otimes Z) C^\dagger = C(I \otimes Z) C = Z \otimes Z$$



$$C(X \otimes I) C^\dagger = X \otimes X$$

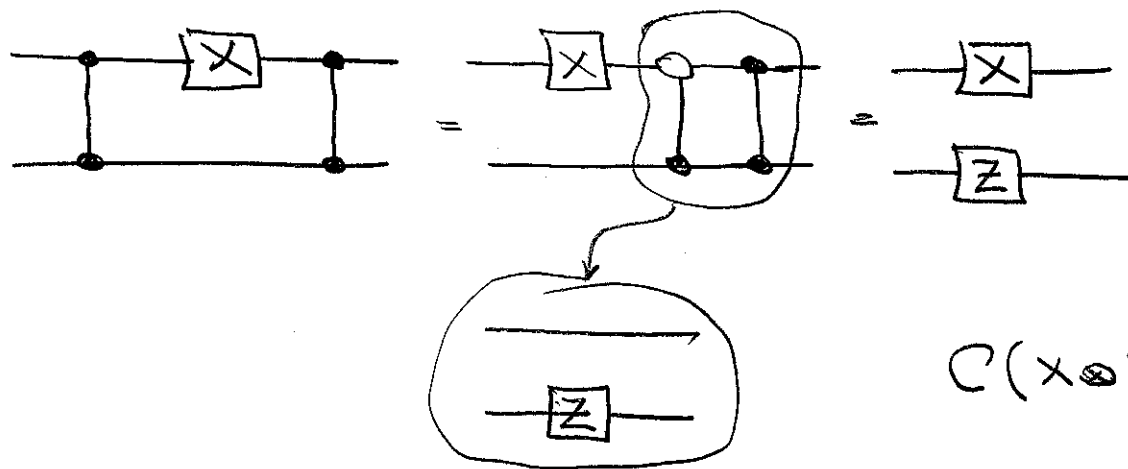
$$C(I \otimes X) C^\dagger = I \otimes X$$

$$C(Z \otimes I) C^\dagger = Z \otimes I$$

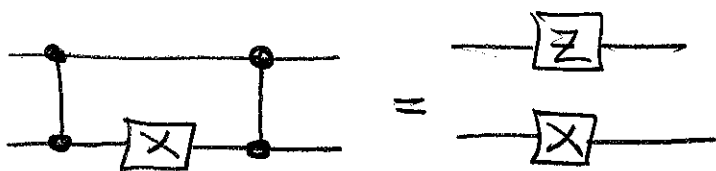
$$C(I \otimes Z) C^\dagger = Z \otimes Z$$



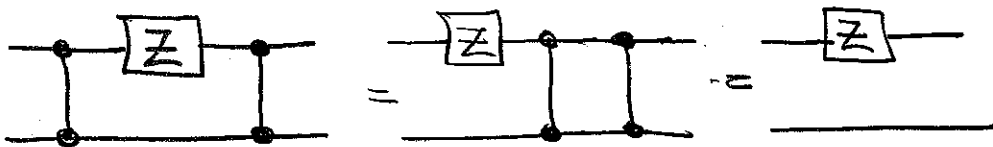
c)  $C = C$ -PHASE



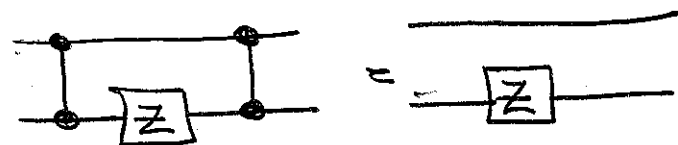
$$C(X \otimes I)C^\dagger = X \otimes Z$$



$$C(I \otimes X)C^\dagger = Z \otimes X$$



$$C(Z \otimes I)C^\dagger = Z \otimes I$$



$$C(I \otimes Z)C^\dagger = I \otimes Z$$

The full list is

$$C(I \otimes I) C^\dagger = I \otimes I$$

$$C(I \otimes X) C^\dagger = Z \otimes X$$

$$C(I \otimes Y) C^\dagger = Z \otimes Y$$

$$C(I \otimes Z) C^\dagger = I \otimes Z$$

$$C(Z \otimes I) C^\dagger = Z \otimes I$$

$$C(Z \otimes X) C^\dagger = I \otimes X$$

$$C(Z \otimes Y) C^\dagger = I \otimes Y$$

$$C(Z \otimes Z) C^\dagger = Z \otimes Z$$

$$C(X \otimes I) C^\dagger = X \otimes Z$$

$$C(X \otimes X) C^\dagger = Y \otimes Y$$

$$C(X \otimes Y) C^\dagger = -Y \otimes X$$

$$C(X \otimes Z) C^\dagger = X \otimes I$$

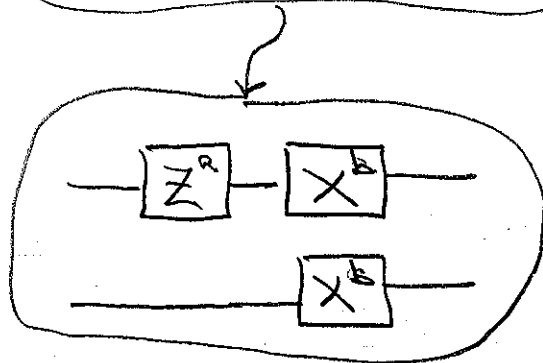
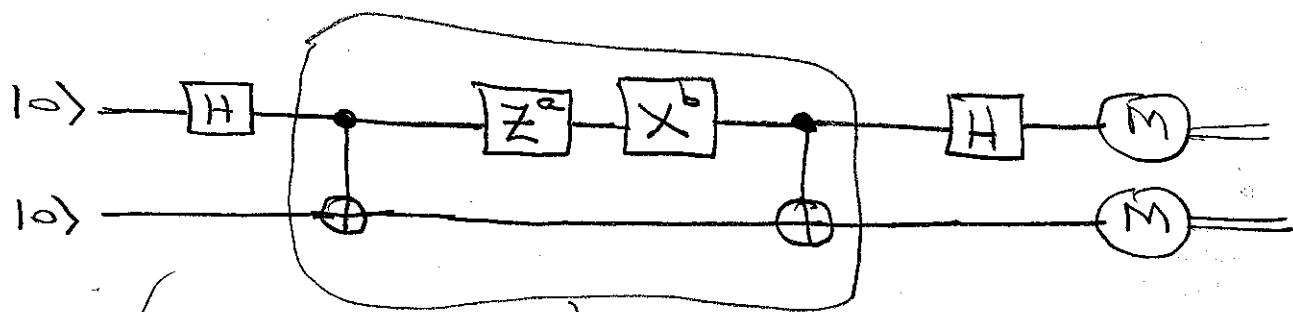
$$C(Y \otimes I) C^\dagger = Y \otimes Z$$

$$C(Y \otimes X) C^\dagger = -X \otimes Y$$

$$C(Y \otimes Y) C^\dagger = X \otimes X$$

$$C(Y \otimes Z) C^\dagger = Y \otimes I$$

(d) Superdense coding:



Using C-NOT transformations

