

3 qubits

Find QFT for  $|x\rangle = |x_2 x_1 x_0\rangle$

$$|x\rangle = \frac{1}{\sqrt{8}} \sum_{y_2, y_1, y_0 \in \{0,1\}} e^{2\pi i x (4y_2 + 2y_1 + y_0)/8} |y_2 y_1 y_0\rangle$$

$$= \frac{1}{\sqrt{2}} \sum_{y_2 \in \{0,1\}} e^{2\pi i x (4y_2/8)} |y_2\rangle \otimes \frac{1}{\sqrt{2}} \sum_{y_1 \in \{0,1\}} e^{2\pi i x (2y_1/8)} |y_1\rangle \otimes \frac{1}{\sqrt{2}} \sum_{y_0 \in \{0,1\}} e^{2\pi i x (y_0/8)} |y_0\rangle$$

$$\frac{1}{\sqrt{2}} \sum_{y_2 \in \{0,1\}} e^{2\pi i x (4y_2/8)} |y_2\rangle$$

$$= \frac{1}{\sqrt{2}} [ |0\rangle + e^{2\pi i x/2} |1\rangle ]$$

$$= \frac{1}{\sqrt{2}} [ |0\rangle + e^{\pi i x} |1\rangle ]$$

$$x = 4x_2 + 2x_1 + x_0$$

$$= \frac{1}{\sqrt{2}} [ |0\rangle + e^{2\pi i x_0/2} |1\rangle ]$$

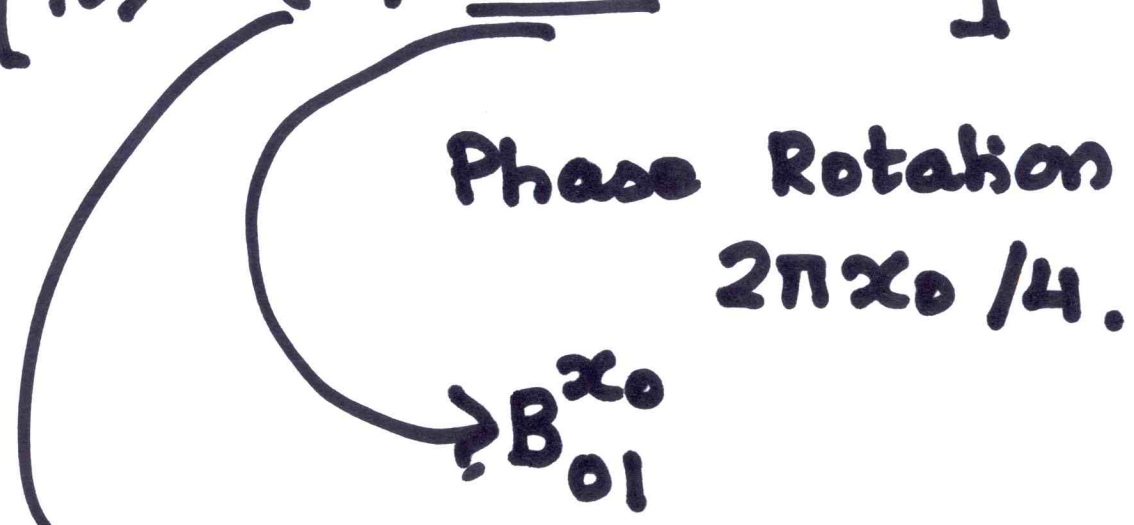
$$= \frac{1}{\sqrt{2}} [ |0\rangle + (-1)^{x_0} |1\rangle ]$$

2nd term

$$\frac{1}{\sqrt{2}} [ |0\rangle + e^{2\pi i x/4} |1\rangle ]$$

$$x = 4x_2 + 2x_1 + x_0.$$

$$= \frac{1}{\sqrt{2}} [ |0\rangle + (-1)^{x_1} \frac{e^{2\pi i x_0/4}}{1} |1\rangle. ]$$



Hadamard.

$$B_{jk} = \frac{2\pi}{2^{k-j+1}}$$

Third term

$$\sum_{y_0=0}^1 e^{2\pi i (4x_2 + 2x_1 + x_0) \cdot y_0 / 8} |y_0\rangle$$

$$= \left[ |0\rangle + e^{2\pi i (4x_2 + 2x_1 + x_0) / 8} |1\rangle \right]$$

$$= \left[ |0\rangle + (-1)^{x_2} e^{2\pi i x_1 / 4} \cdot e^{2\pi i x_0 / 8} |1\rangle \right]$$

$$B_{12}^{x_1}$$

$$B_{02}^{x_0}$$

$$B_{jk} = \frac{2\pi}{2^{k-j} + 1}$$

$$\frac{1}{\sqrt{2}} [ |0\rangle + (-1)^{x_0} |1\rangle ] \otimes \frac{1}{\sqrt{2}} [ B_{01}^{x_0} ( |0\rangle + (-1)^{x_1} |1\rangle ) ]$$

$$\otimes \frac{1}{\sqrt{2}} [ B_{01}^{x_0} B_{12}^{x_1} ( |0\rangle + (-1)^{x_2} |1\rangle ) ]$$