Exo 2 :

1)

PSK :

$$E_{16\text{-PSK-symbole}} = A^2$$

$$E_{16\text{-PSK-bit}} = \frac{A^2}{4}$$

QAM :

$$E_1 = 2B^2$$
$$E_2 = 10B^2$$
$$E_3 = 18B^2$$
$$E_4 = 10B^2$$

$$\Rightarrow E_{16\text{-QAM-sym}} = \frac{E_1 + E_2 + E_3 + E_4}{4}$$
$$= 10B^2$$

$$E_{16\text{-QAM-bit}} = \frac{10B^2}{4}$$

2)

$$E_{16\text{-PSK-sym}} = E_{16\text{-QAM-sym}}$$

$$\Rightarrow A^2 = 10B^2 \Rightarrow B = \frac{A}{\sqrt{10}}$$

$$d_{min\ 16\text{-PSK}} = 2A \sin\frac{\pi}{16}$$

$$d_{min\ 16\text{-QAM}} = 2B$$

$$\Rightarrow d_{min\ 16\text{-PSK}} = \sqrt{10}\, d_{min\ 16\text{-QAM}} \sin\frac{\pi}{16}$$

$$\Rightarrow d_{min\ 16\text{-PSK}} < d_{min\ 16\text{QAM}}$$

$\Rightarrow$ 16-QAM est meilleur que 16-PSK.

Exo 1:

1] $V_I = \dfrac{V_{4-QAM}}{K V_0}$

$$V_{4-QAM} = \begin{cases} \frac{3A}{2}\cos(2\pi f_0 t) \\ \frac{A}{2}\cos(2\pi f_0 t + \pi) \\ \frac{A}{2}\cos(2\pi f_0 t) \\ \frac{A}{2}\cos(2\pi f_0 t + \pi) \end{cases}$$

$$\Rightarrow V_I = \begin{cases} \frac{3A}{2KE_0} \\ -\frac{3A}{2KE_0} \\ \frac{A}{2KE_0} \\ -\frac{A}{2KE_0} \end{cases}$$

2]