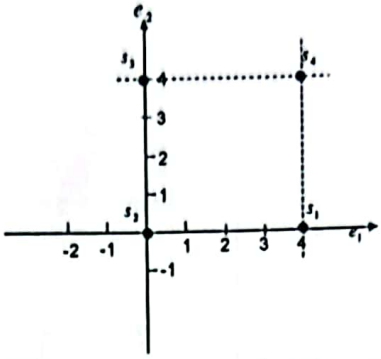
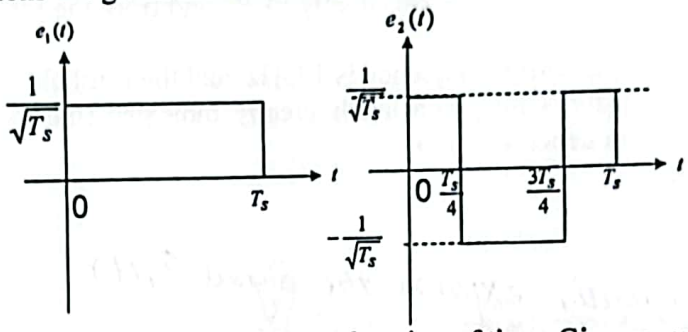
Solution

Quiz 6:

Consider the constellation below:



a) Give the expression for the probability of bit error assuming that the noise spectral height is $N_0/2$. Make all substitutions.
b) Give the average energy per bit
c) Assume that the basis functions are given below. Let T_s be the symbol duration



Sketch and mathematically express the signal $s_4(t)$ as a function of time. Give complete description.

(a) Probability of Bit error ($N_0/2$)

$$P(\text{bit error}) = Q\left(d_{xy}/\sqrt{2N_0}\right)$$

- First find the euclidean distance, As All points are symmetric so we calculate from Origin. (S_2)

$$d_{21} = \sqrt{(4)^2+(0)^2} = \boxed{4} \; ; \; d_{23} = \sqrt{(4)^2+(0)^2} = \boxed{4} \; ; \; d_{24} = \sqrt{(4)^2+(4)^2} = \boxed{4\sqrt{2}}$$

P(Symbol error) :

$$= \frac{1}{M} \sum_{i}^{M} \sum_{j}^{M} Q\left(d_{xy}/\sqrt{2N_0}\right)$$

$$= \frac{1}{4}\left[Q\left(4/\sqrt{2N_0}\right) + Q\left(4/\sqrt{2N_0}\right) + Q\left(4\sqrt{2}/\sqrt{2N_0}\right)\right]$$

(b) Average Energy

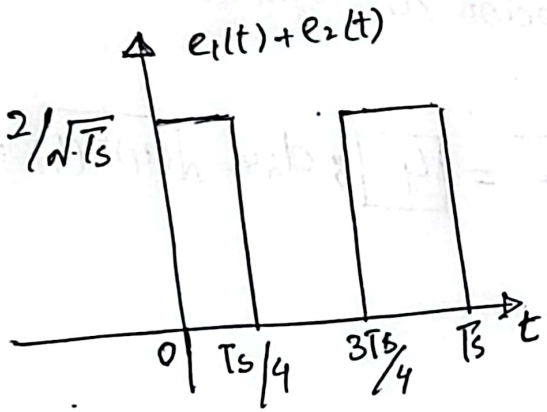
- distance square at each point.

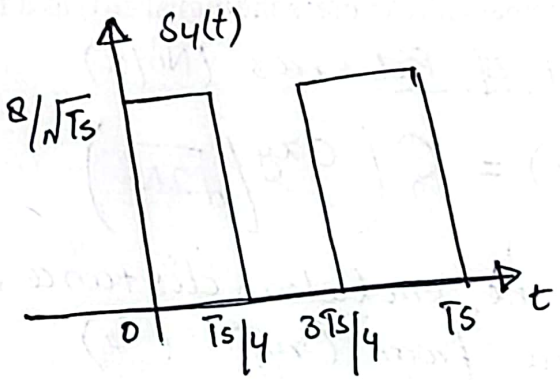
$$E_{AVG} = \frac{|s_1|^2+|s_2|^2+|s_3|^2+|s_4|^2}{4} = \frac{4^2+0^2+4^2+(4\sqrt{2})^2}{4} = 16 \text{ Joule/sym}$$

(c) Sketch & mathematically express the signal $s_4(t)$

$$s_4(t) = 4e_1(t) + 4e_2(t)$$

$$s_4(t) = 4[e_1(t) + e_2(t)]$$





$$s_4(t) = \begin{cases} 8/\sqrt{N T_s} & 0 < t < T_s/4 \\ & 3T_s/4 < t < T_s \\ 0 & \text{else where.} \end{cases}$$