(a) 00 01 11 10

(b) $d_{min} = (2i-1-M)d - (2(i-1)-1-M)d$.

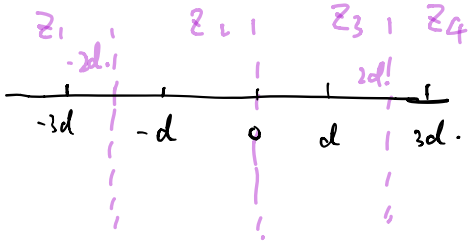
$= 2d$.

(c) for 4-PAM

$$E_S = \frac{1}{4}\sum_{i=1}^{4} E_i = \frac{1}{4}\left(\left(\frac{1}{2}d_{min}\right)^2 \cdot 2 + \left(\frac{3}{2}d_{min}\right)^2 \cdot 2\right)$$

$$d_{min} = \sqrt{\frac{4}{5}E_S}$$

(d)



(e) $r(t) = \begin{cases} -3d + n(t) & \text{for } A_1 \\ -d + n(t) & \text{for } A_2 \\ d + n(t) & \text{for } A_3 \\ 3d + n(t) & \text{for } A_4 \end{cases}$

(f) for inner point

$$P_{ei} = P\left(|n| > \frac{1}{2}d_{min}\right) = 2Q\left(\frac{d_{min}}{\sqrt{2N_0}}\right)$$

$$= 2Q\left(\sqrt{\frac{2}{5}\frac{E_S}{N_0}}\right)$$

for outer point

$$P_{eo} = \frac{1}{2}P_{ei} = Q\left(\sqrt{\frac{2E_S}{5N_0}}\right)$$

$$P_e = \frac{1}{2}P_{ei} + \frac{1}{2}P_{eo} = \frac{3}{2}Q\left(\sqrt{\frac{2E_S}{5N_0}}\right)$$