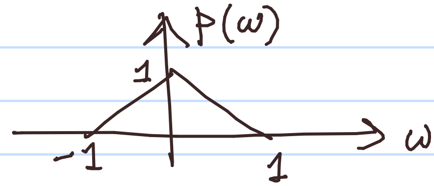
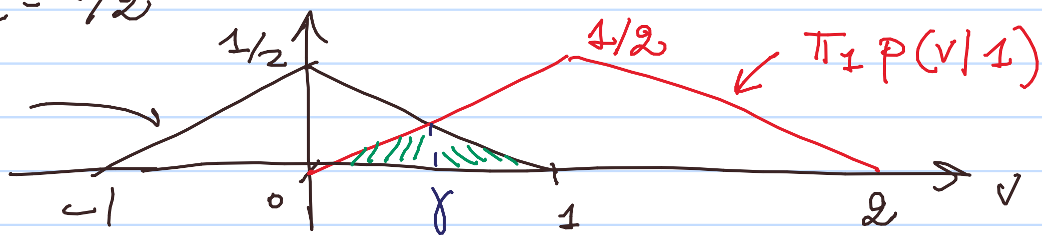
1. $m_0 = 0$, $m_1 = 1$

$V = m_i + W$, $W \sim p(\omega)$



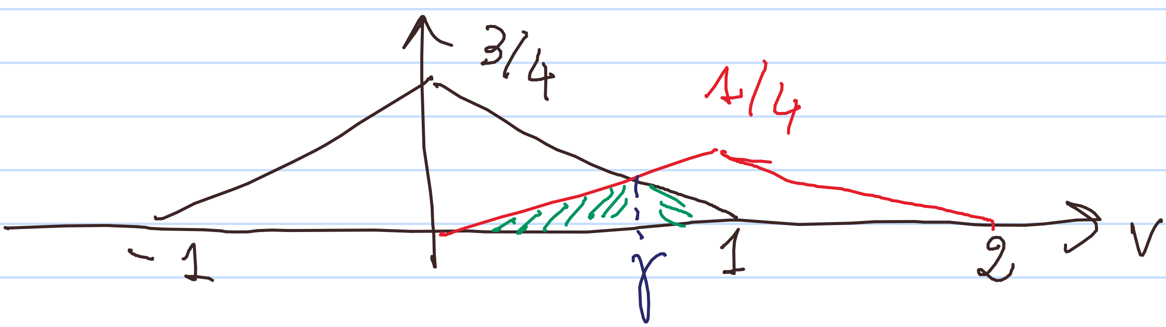
a. $\pi_0 = \pi_1 = 1/2$



b. $P_B(E) = 2\int_0^{\gamma} \left(\frac{1}{2}x\right)dx$

$$= \left[\frac{x^2}{2}\right]_0^{1/2} = \frac{1}{8}$$

c. $\pi_0 = 3/4$ $\pi_1 = 1/4$

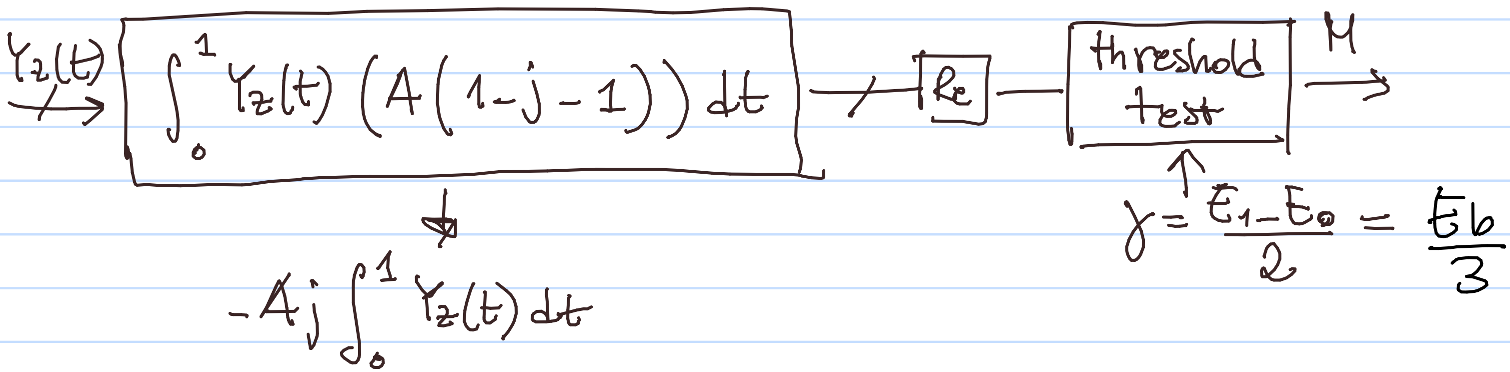


$$\frac{3}{4}(1-\gamma) = \frac{1}{4}(\gamma) \Rightarrow \gamma = 3/4$$

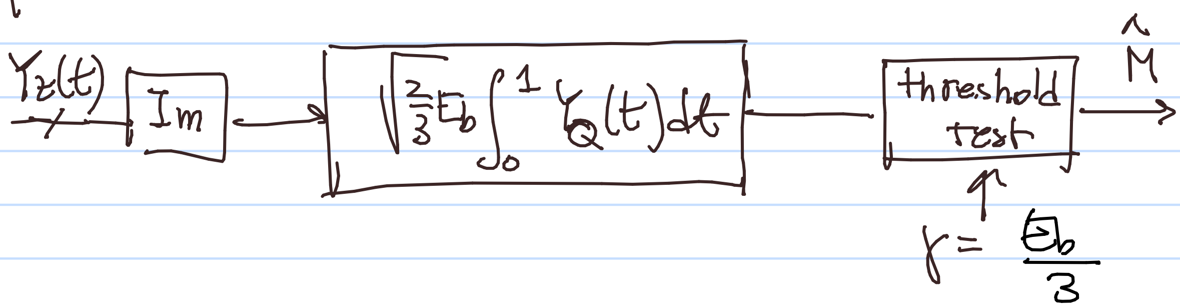
2. $\begin{cases} x_{z,0}(t) = A\,\mathrm{rect}(t) \\ x_{z,1}(t) = A(1+j)\,\mathrm{rect}(t) \end{cases}$ $\quad (\pi_0 = \pi_1 = 1/2)$

a. $\begin{aligned} E_0 &= A^2 \\ E_1 &= 2A^2 \end{aligned} \Rightarrow \frac{1}{2}A^2 + A^2 = \frac{3}{2}A^2 = E_b \Rightarrow A = \sqrt{\frac{2}{3}E_b}$

b. Single-correlator



equivalent to



c. $P_B(E) = Q\left(\sqrt{\frac{\Delta_E(0,1)}{2N_0}}\right)$

$$\Delta_E(0,1) = \int_0^1 |j\,\mathrm{rect}(t)|^2 dt \times A^2$$

$$= A^2 = \frac{2}{3}E_b$$

$$\Rightarrow P_B(E) = Q\left(\sqrt{\frac{E_b}{3N_0}}\right)$$

d. loss wrt BPSK

$$\frac{2}{1/3} = 6 \simeq 7.78\,dB$$

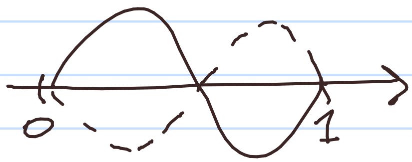
3. $K_b = 3$

$$x_{z,i}(t) = \begin{cases} A e^{j2\pi i t} & 0 \le t \le 1 \\ 0 & \text{otherwise} \end{cases}$$

a. $A = \sqrt{3E_b}$

b. $$\int_0^1 x_{z,i}(t)\, x^*_{z,k}(t)\, dt = A^2 \int_0^1 e^{j2\pi(i-k)t}\, dt \qquad (i \neq k)$$

$$= A^2 \left(\int_0^1 \cos(2\pi(i-k)t)\, dt + j\int_0^1 \sin(2\pi(i-k)t)\, dt \right) = 0$$



$i - k = \pm 1$

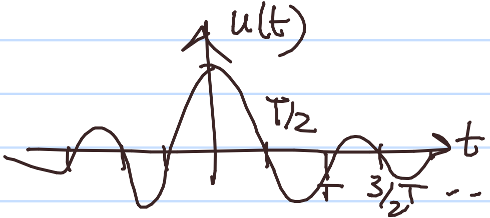
$i - k = \pm 2$

$\vdots$

$$\Rightarrow \Delta_E(i,k) = 2 \times 3E_b = 6E_b \qquad i \neq k$$

$\{(6E_b, 7)\}$ conditional distance spectrum for all waveforms

4. $u(t) = \frac{1}{\sqrt{T/2}} \operatorname{sinc}\left(\frac{2t}{T}\right)$



$R_u(\tau) = \operatorname{sinc}\left(\frac{2t}{T}\right)$

since $R_u(kT) = 0$ for all $k \neq 0$, the waveform satisfies Nyquist criterion.