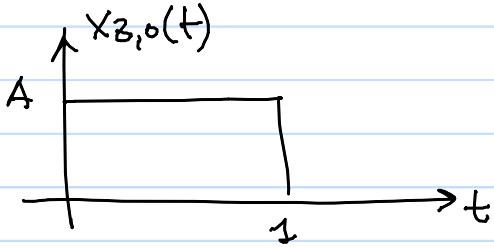
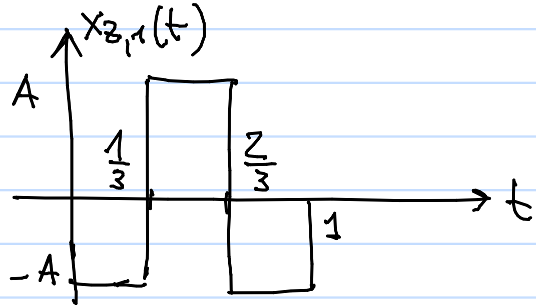
1.



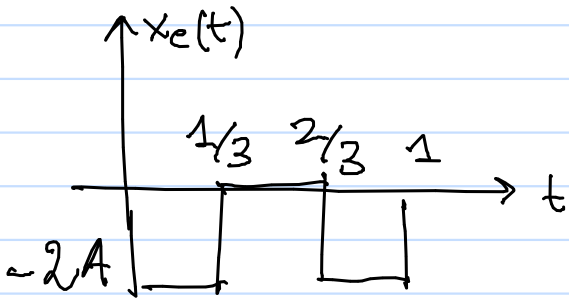


a. $E_b = A^2 \Rightarrow A = \sqrt{E_b}$

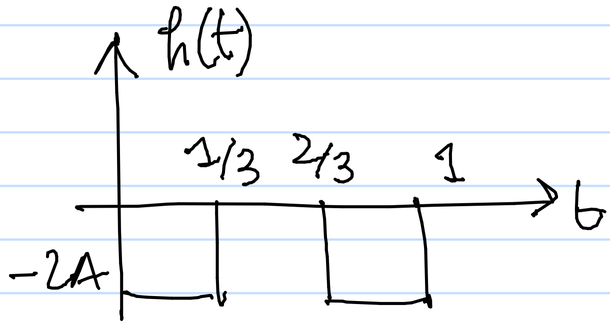
b. $\int_0^1 x_{3,0}(t)\, x_{3,1}(t)\, dt = -\int_0^{1/3} E_b\, dt + \int_{1/3}^{2/3} E_b\, dt - \int_{2/3}^{1} E_b\, dt$

$= -\frac{1}{3} E_b$

c. Matched filter

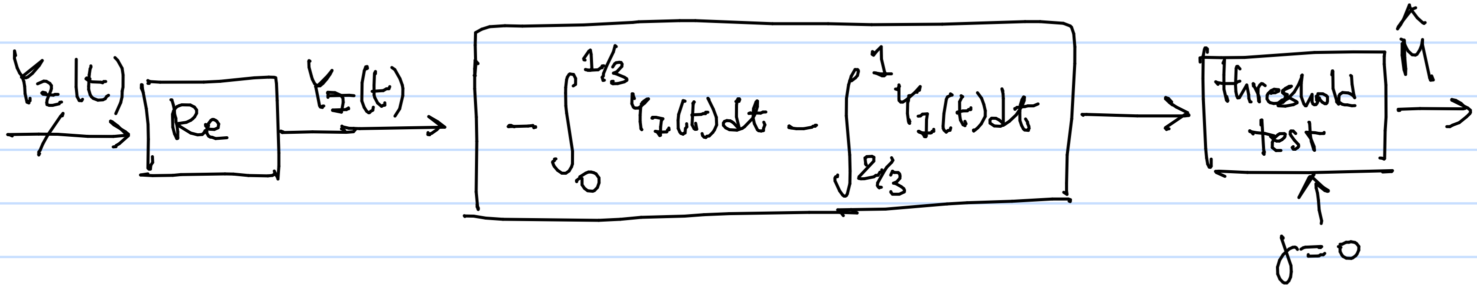


$\Longrightarrow$

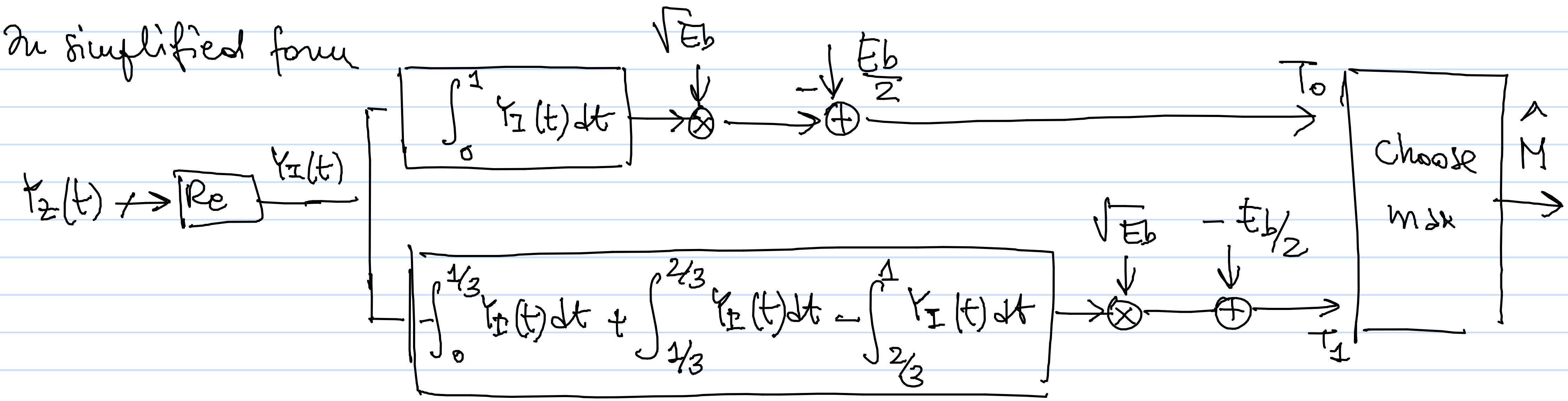


$$\gamma = \frac{E_1 - E_0}{2} = 0$$

d. After simplification:



e. In simplified form



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

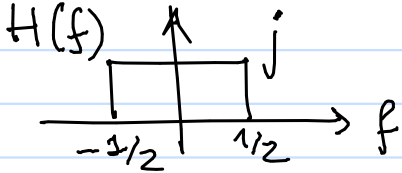
$$\Delta_E(0,1) = \int_0^1 (X_{Z,1}(t) - X_{Z,0}(t))^2 dt = 2E_b + \frac{2}{3}E_b = \frac{8}{3}E_b$$

$$\Rightarrow P_b(E) = Q\left(\sqrt{\frac{4E_b}{3N_0}}\right)$$

2. $x_{z,0}(t) = \sqrt{E_b/2}\,\text{sinc}(t) + j\sqrt{E_b/2}\,\text{sinc}(t)$

$x_{z,1}(t) = j\sqrt{E_b}\,\text{sinc}(t)$

a.



$$m_0 = \text{Re}\{ x_{z,0}(t) * h(t) \big|_{t=0} \}$$

$$= \text{Re}\{ j\sqrt{E_b/2}\,\text{sinc}(t) - \sqrt{E_b/2}\,\text{sinc}(t) \big|_{t=0} \} = -\sqrt{E_b/2}$$

$$m_1 = \text{Re}\{ x_{z,1}(t) * h(t) \big|_{t=0} \}$$

$$= \text{Re}\{ \sqrt{E_b}\,\text{sinc}(t) \big|_{t=0} \} = \sqrt{E_b}$$

$$\sigma^2_{N_I} = \frac{N_0}{2} \int |H(f)|^2 df = \frac{N_0}{2}$$

b. If $\pi_0 = \pi_1 = 1/2$, the MAPBD coincides with the minimum distance decoder and hence we have $\hat{M} = 1$ since

$$(2 \cdot 3 - 1)^2 < (2 \cdot 3 + 1/\sqrt{2})^2$$