1. a. $A^2 = E_b$ (note that $E_1 = A^2$)

$$\Rightarrow A = \sqrt{E_b}$$

b. $m_0 = \mathrm{Re}\{X_{2,0}(1)\} = \sqrt{E_b}$

$m_1 = \mathrm{Re}\{X_{2,1}(1)\} = \sqrt{E_b}$

c. $P_b(E) = Q\left(\sqrt{\eta}\right)$

$$\eta = \frac{(m_1 - m_0)^2}{4\sigma_{N_I}^2} = 0 \quad \Rightarrow P_b(E) = Q(0) = \frac{1}{2}$$

d.
$$x_e(t) = \begin{cases} \sqrt{E_b}\left(e^{-j2\pi t} - 1\right) & \text{for } t \in [0,1] \\ 0 & \text{otherwise} \end{cases}$$

e. $\int x_{2,0}(t)\, x_{2,1}^*(t)\, dt = E_b \int_0^1 e^{j2\pi t}\, dt = 0$

$m_0 = -E_b$

$m_1 = E_b$

$$\sigma_{N_I}^2 = \frac{N_0}{2}\Delta_E(0,1) = N_0 E_b$$

f. $P_b(E) = Q\left(\sqrt{\frac{E_b}{N_0}}\right) < \frac{1}{2}$ as long as $\frac{E_b}{N_0} > 0$

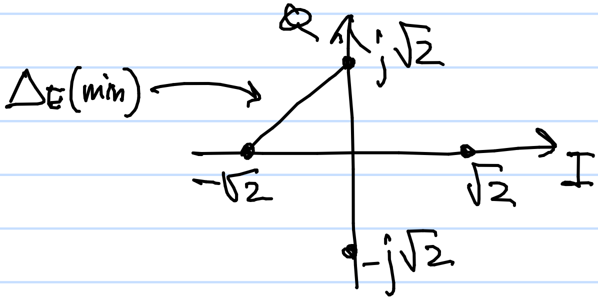
g.
$$Y_2(t) \longrightarrow \boxed{\sqrt{E_b}\int_0^1 Y_2(t)\left(e^{j2\pi t} - 1\right) dt} \longrightarrow \boxed{\mathrm{Re}} \longrightarrow \boxed{\text{threshold test}} \longrightarrow \hat{M}$$

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

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

b. Yes, we have $u(t) = \text{sinc}(t)$ and constellation Ω_d:

$$\{\sqrt{2}, -\sqrt{2}, j\sqrt{2}, -j\sqrt{2}\}$$



Rotated QPSK

c. $\Delta_E(min) = E_b\left((\sqrt{2})^2 + (\sqrt{2})^2\right) = 4E_b$

$$P_{WUB}(E) \approx \frac{1}{4}\left(8Q\left(\sqrt{\frac{2E_b}{N_0}}\right)\right)$$

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