Solution:

1) \[ E_x = \int_{-\infty}^{+\infty} \left( \sin^2(t-3) + \text{mc}^2(t+2) + \text{mc}(t-3) \text{mc}(t+2) \right) dt \]

\[ = \int_{-\infty}^{+\infty} \text{mc}^2(t-3) dt + \int_{-\infty}^{+\infty} \text{mc}^2(t+2) dt = \int_{-\infty}^{+\infty} \text{mc}^2 \cdot \delta(t) \, dt = \text{mc} \cdot \delta(0) = 1 \]

\[ = \int_{-\infty}^{+\infty} \text{mc}(t-3) \text{mc}(t+2) \, dt = \int_{-\infty}^{+\infty} \text{rect}(t) \cdot e^{-j \omega x} \cdot e^{-j \frac{2\pi}{5} x} \, dx \]

\[ = \int_{-\infty}^{+\infty} \text{rect}(t) \cdot e^{-j \frac{2\pi}{5} x} \, dx = \text{mc} \cdot (-5) = 0 \]

\[ E_x = 2 \]

\[ \text{For even } \]

\[ \frac{1}{1 + 0.2 e^{-j \frac{2\pi}{5} x}} \leftrightarrow (-0.2)^k \text{ } 1_0(k) = x_1(k) \]

\[ \frac{1}{1 - 0.1 e^{j \frac{2\pi}{5} x}} \leftrightarrow (0.1)^{-k} \text{ } 1_0(-k) = x_2(k) \]

\[ X(t) = X_1(t) \cdot X_2(t) \quad \rightarrow \quad x(k) = x_1 \ast x_2(k) \]

\[ x_1(k) \]

\[ x_2(k) \]

\[ k \leq 0 \quad x(k) = \sum_{h=0}^{+\infty} (-0.2)^k (0.1)^{-k(h-h)} = 0.1 \sum_{h=0}^{+\infty} (-0.02)^h \]

\[ = (0.1) \frac{1}{1 + 0.02} \]
\[ k > 0 \]

\[ \sum_{l=0}^{\infty} (0.1)^{-h} (-0.2)^{k-h} = (-0.2)^{k} \frac{1}{1 + 0.02} \]

\[ E_x = \left( \frac{1}{1.02} \right)^2 \sum_{l=0}^{\infty} (0.1)^{-2h} + \left( \frac{1}{1.02} \right)^2 \sum_{l=1}^{\infty} (-0.2)^{2l} \]

\[ E_x = \left( \frac{1}{1.02} \right)^2 \left[ \frac{1}{1 - 0.01} + \frac{1}{1 - 0.04} - 1 \right] \]

3) \( b(kt) \) è un segnale indipendente in quanto \( a(kt) \) è un segnale indipendente

\[ P[b(kt) = 1] = P[a(kt) = 1] + P[a(kt) = 2] = 0.4 \]

\[ P[b(kt) = -1] = 0.6 \]

\[ M_b = E[b^2(kt)] = E[1] = 1 \]

\[ M_b = 0.4 \cdot 1 + 0.6 \cdot (-1) = -0.2 \]

\[ \delta^2_b = M_b - m^2_b = 1 - 0.04 \]

\[ R_b(t) = \delta^2_b \cdot T + m^2_b \delta^2_b(t) \left\langle \text{seno indipendente} \right\rangle \]

4) Il processo ha banda \( \frac{1}{T} = 5 \text{ MHz} \)

Teorema di Shannon: \( \frac{2}{T} = 10 \text{ bit/s/Hz} \)

Durata uniforme, \( (\text{SNR})_{db} = 6 \text{ m} \Rightarrow m = 8 \text{ bit/comepute} \)

Se avere \( (\text{SNR})_{db} > 45 \)

Flusso: 80 Mbit/s. 64-QAM \( \Rightarrow 6 \text{ bit/segno} \)

Occorre trasmettere 80 Mbit/s. Benche tramite

webse: 80/16 MHz. 6 con roll-off 0.25, Benche

webse: \( B = 1.25 \cdot \frac{80}{2} \text{ MHz} \)
\( C(t) = G(t)L(t)H(t) \) è la banda ampiezza 1. Per avere \( C(t) \) di tipo unità, deve essere \( C(t) = V_0T \text{rect}(fT) \), e dunque

\[
H(t) = k \text{rect}(fT) \quad (\text{in modo da limitare il rumore})
\]

\[
C(t) = k V_0 T \frac{l_0 I}{3} \text{rect}(fT) \quad C(t) = \frac{k V_0 T l_0 \text{rect}(fT)}{3}
\]

\[
V_0' = \frac{k V_0 l_0}{3}
\]

\[
\delta_m^2 = \frac{R_0 E}{3} = \frac{R_0 k^2}{3}
\]

\[
P_c = P\left[ q_k = 1, m_k > -\frac{V_0'}{2} \right] + P\left[ q_k = 0, -\frac{V_0'}{2} < m_k < \frac{V_0'}{2} \right] + P\left[ q_k = -1, m_k < -\frac{V_0'}{2} \right]
\]

\[
P_c = \frac{1}{4} \phi\left(\frac{V_0'}{2\delta_m}\right) + \frac{1}{2} \left[ \phi\left(\frac{V_0'}{2\delta_m}\right) - \phi\left(-\frac{V_0'}{2\delta_m}\right) \right] + \frac{1}{4} \phi\left(\frac{V_0'}{2\delta_m}\right)
\]

\[
P_e = 1 - P_c = \frac{3}{2} Q\left(\frac{V_0'}{2\delta_m}\right)
\]