ESERCIZIO (2) COMPITINO 30/6/2005

(a)

$m = \frac{k_f V_m}{f_m}$ $\quad k_f = \frac{k}{2\pi} = \frac{80\pi \cdot 10^3}{2\pi} = 40 \cdot 10^3$ $\quad m = \frac{40 \cdot \frac{1}{2} \cdot 10^3}{10 \cdot 10^3} = (2)$

$y(t) = V_0 \cos(2\pi f_0 t + m \sin(2\pi f_m t)) = \cos(2\pi\, 10000000\, t + 2 \sin(2\pi\, 10000 t))$

(a)

$P_{y_B} = 0{,}95\, P_y \Rightarrow \quad 0{,}95 \frac{V_0^2}{2} = \frac{V_0^2 \sum_{n=-\infty}^{+\infty} J_n^2(m)}{8} \Rightarrow \quad \sum_{n=-\infty}^{+\infty} J_n^2(2) = J_0^2(2) + 2\sum_{n=1}^{\infty} J_n^2(2) = 0{,}95$

OTTENGO $\quad J_0^2(2) + 2J_1^2(2) + 2J_2^2(2) = \underbrace{0{,}0502 + 2 \cdot 0{,}333}_{0{,}7162} + 2 \cdot 0{,}1246 = 0{,}9654 > 95\% \quad n=2$

$B = 2 \cdot 2 \cdot f_m =$ (40 KHz.) OK

(b)

CORRETTO FUNZIONAMENTO: $\frac{S_i}{N_i}\Big|_{dB} \geq 13 + 10\log_{10}(m+1) = 13 + 10\log_{10} 3 = 17{,}77\ dB.$ $\quad N_i = N_0 f_m = 10^{-9} = -90\ dB$

$\frac{S_i}{N_i}\Big|_{dB} = P_{tx}|_{dB} - L|_{dB} - 10\log_{10}(N_0 f_m) \Rightarrow$

$P_{tx}|_{dB} = \frac{S}{N_i}\Big|_{dB} + L|_{dB} + 10\log_{10}(N_0 f_m) = 17{,}77 + 85 + 10\log_{10}(10^{-9}) = (2{,}77\ dB)$ OK

$P_{tx} = 10^{\frac{1{,}27}{10}} = 18{,}9\ W$ OK

(c)

$P_{tx} = 30\ W \quad P_{tx}|_{dB} = 10\log_{10}(30) = 14{,}77\ dB \Rightarrow \frac{S_i}{N_i}\Big|_{dB} = P_{tx}|_{dB} - L|_{dB} - 10\log_{10}(N_i) = 14{,}77 - 85 - (-90)$

$P_{rx} = 14{,}77 - 85 =$

$\frac{S_i}{N_i}\Big|_{dB} = 19{,}77\ dB.$ (17,77 RICHIESTO)

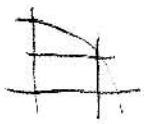
$\frac{S_u}{N_0}\Big|_{dB} = \frac{S_i}{N_i}\Big|_{dB} + F_m\Big|_{dB} = 19{,}77 + 10\log_{10}\left(\frac{3}{2} m^2\right) = 19{,}77 + 10\log_{10}\left(\frac{3 \cdot 6^2}{2}\right) = 19{,}77 + 7{,}78 = (27{,}55\ dB)$

OK

①

$P_{e_{dB}} = 10\log_{10} P_e = -40$

Dalla figura determino $\left.\frac{E_b}{N_0}\right|_{dB}$



$$\left.\frac{E_b}{N_0}\right|_{dB} = 11.5\,dB$$

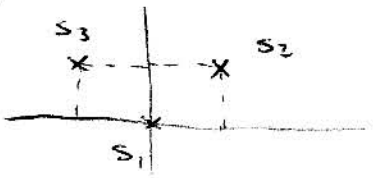
$$\left.\frac{E_b}{N_0}\right|_{dB} = P_{i\,dB} - N_{0\,dB} - 10\log_{10}\frac{\lceil \log_2 3 \rceil}{T_s}$$

$$\left.\frac{E_b}{N_0}\right|_{dB} + N_0 + 10\log_{10}\frac{2}{T_s} = P_{i\,dB}$$

$$11.5 - 110 + 60 = P_{i\,dB}$$

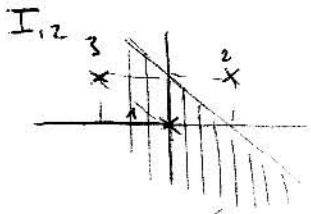
$$P_{i_{dB}} = -38.5\,dB \qquad P_i = 14 \cdot 10^{-4}$$

②

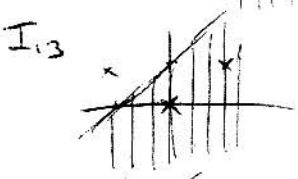



$I_i = \bigcap_{\substack{j=1 \\ (j\neq i)}}^{3} I_{ij} = I_{i2} \cap I_{i3}$ secondo il criterio MAP

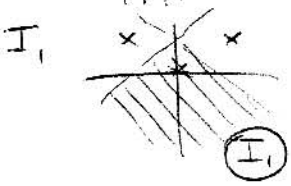
$I_{ij} = \{ \underline{r} \text{ t.c. } \langle \underline{r}(\underline{s}_i - \underline{s}_j) \rangle \geq \frac{N_0}{2} \ln\frac{P(s_j)}{P(s_i)} + \frac{(E_i - E_j)}{2} \}$ ($\ln \to 0$)




$I_{12} = \{ \underline{r} \text{ t.c. } r_y \leq -r_x + \sqrt{E_b} \}$

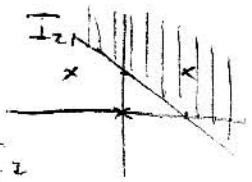


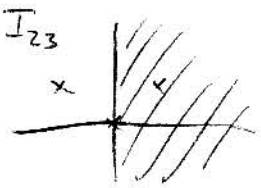

$I_{13} = \{ \underline{r} \text{ t.c. } r_y \leq r_x + \sqrt{E_b} \}$

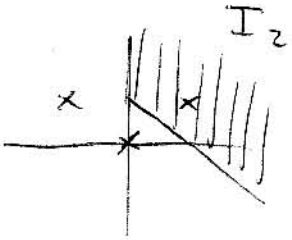




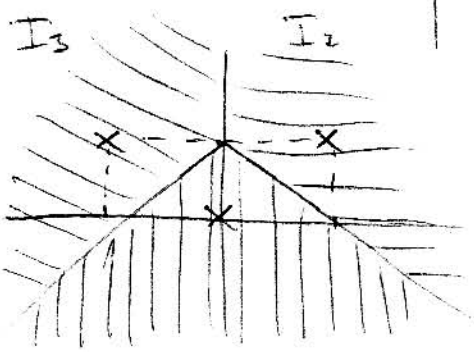





$I_2 = I_{21} \cap I_{23}$




③

| $D_{ij}$ | $s_1$ | $s_2$ | $s_3$ |
|---|---|---|---|
| $s_1$ | – | $\sqrt{2E_b}$ | $\sqrt{2E_b}$ |
| $s_2$ | $\sqrt{2E_b}$ | – | $2\sqrt{E_b}$ |
| $s_3$ | $\sqrt{2E_b}$ | $2\sqrt{E_b}$ | – |

$$B.U. = \frac{4}{3}Q\left(\sqrt{\frac{E_b}{N_0}}\right) = \frac{4}{3}Q\left(\sqrt{14.12}\right) = 1.21 \cdot 10^{-4}$$