Solução do 1º Teste - 15/11/2004

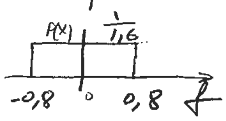
Grupo I

① $f_a \geq 2 f_{máx} \rightarrow f_a \geq 30\,kHz$

$R_b = N_b \cdot f_a = 8 \times 30 \times 10^3 = 240\,kbit/s$

$B_{min} = \frac{R_b}{2}(1+\alpha)\Big|_{\alpha=0} = \frac{R_b}{2} = \underline{\underline{120\,kHz}}$

② $s = \int_{-1}^{1} x^2 f(x) = \frac{1}{1,6}\int_{-0,8}^{0,8} x^2\,dx = \frac{1}{0,8}\int_0^{0,8} x^2\,dx = \frac{1}{0,8}\,\frac{0,8^3}{3} = \underline{0,21(3)\,W}$



$m_q = \frac{q^2}{12} = \frac{\left(\frac{2}{L}\right)^2}{12} = \frac{1}{3L^2} = \underline{5,086 \times 10^{-6}\,W}$

$L = 256 \left\{ \begin{matrix} +1 \\ -1 \end{matrix} \right.$ $\qquad L = 2^{N_b} = 2^8 = 256$

$\therefore \frac{S}{N_q} = 10\log_{10}\left(\frac{0,213(3)\,W}{5,086\times 10^{-6}\,W}\right) = \underline{46,2\,dB}$

③ $\frac{s}{m_q} = 3L^2 \frac{s}{\int_{-1}^{+1}\left(\frac{dx}{dy}\right)^2 f(x)\,dx}$ ← $s = 0,21(3)$; ↑ $L = 256$

$\int_{-1}^{1}\left(\frac{dy}{dx}\right)^{-2} f(x)\,dx = 2\int_0^{0,8}\left(\frac{dy}{dx}\right)^{-2}\frac{1}{1,6}\,dx =$

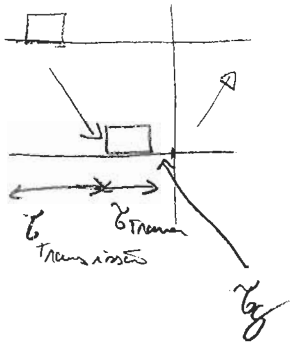
$= \frac{1}{0,8}\left[\int_0^{1/A}\left(\frac{A}{1+\ln A}\right)^{-2}dx + \int_{\frac{1}{A}}^{0,8}\left(\frac{0 + A/x}{1+\ln A}\right)^{-2}dx\right] =$

$= \frac{1}{0,8}\left(\frac{1+\ln A}{A}\right)^2\left[\int_0^{1,14\times 10^{-2}} 1\,dx + \int_{1,14\times 10^{-2}}^{0,8} x^2\,dx\right] =$

$= 4,879\times 10^{-3}\left[1,14\times 10^{-2} + \frac{0,8^3}{3} - \frac{(1,14\times 10^{-2})^3}{3}\right] = \underline{8,88\times 10^{-4}}$

$\therefore \frac{S}{N_q} = 10\log_{10}\left(\frac{3\times 256^2 \times 0,21(3)}{8,88\times 10^{-4}}\right) = \underline{\underline{76,7\,dB}}$ → Ganho elevado! Há ganho até $\frac{1}{A}$ e em $\left[\frac{1}{A}, 0,8\right]$ Tem-se $\frac{s}{m_q} = c^{te}$.

(4)



$$\tau_{Total} = 2\times(\tau_{Transmissão} + \tau_{Trama} + \tau_g)$$

$$N T_b = 2\times\left(\frac{l}{v_g} + N T_{b_0} + \tau_g\right)$$

$$\frac{N}{R_b} = 2\times\left(\frac{l}{v_g} + \frac{N}{R_{b_0}} + \tau_g\right)$$

$$\Leftrightarrow \frac{N}{2R_b} - \frac{N}{R_{b_0}} - \tau_g = \frac{l}{v_g} \rightarrow l = \left(\frac{N}{2R_b} - \frac{N}{R_{b_0}} - \tau_g\right) v_g$$

$$\Rightarrow l \leq 14,66\ km$$

Grupo II

(I)

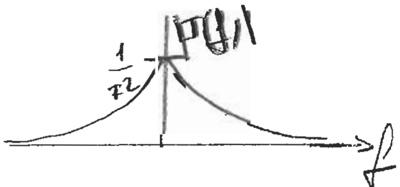
$$\begin{cases} |H_c(f) \cdot I(f)| = 1 \longrightarrow |I(f)| = \dfrac{1}{(F+|f|)^2} \\ \arg\{H_c(f)\} + \arg\{I(f)\} = -2\pi f \tau_2 \end{cases}$$

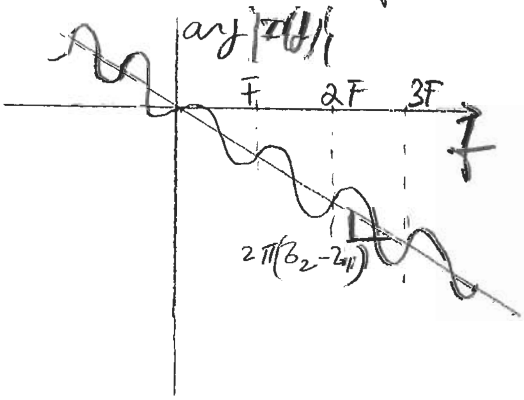
$$\hookrightarrow -2\pi f \tau_1 - \operatorname{sen}\left(\frac{2\pi}{F} f\right) + \arg\{I(f)\} = -2\pi f \tau_2 \Leftrightarrow$$

$$\Leftrightarrow \arg\{I(f)\} = -2\pi f \tau_2 + 2\pi f \tau_1 + \operatorname{sen}\left(\frac{2\pi}{F} f\right)$$

$$\arg\{I(f)\} = -2\pi f(\tau_2 - \tau_1) + \operatorname{sen}\left(\frac{2\pi}{F} f\right)$$

Assim

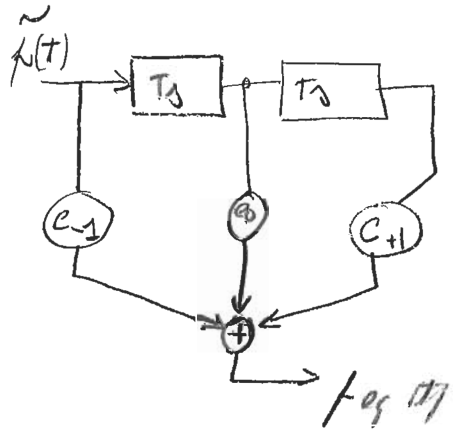




(2)

$$\begin{bmatrix} p_0 & p_{-1} & p_{-2} \\ p_1 & p_0 & p_{-1} \\ p_2 & p_1 & p_0 \end{bmatrix} \begin{bmatrix} c_{-1} \\ c_0 \\ c_1 \end{bmatrix} = \begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix} \Leftrightarrow \begin{bmatrix} 0,8 & 0,2 & 0,1 \\ -0,3 & 0,8 & 0,2 \\ 0,2 & -0,3 & 0,8 \end{bmatrix} \begin{bmatrix} c_{-1} \\ c_0 \\ c_1 \end{bmatrix} = \begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix}$$

$$\Rightarrow \begin{bmatrix} c_{-1} \\ c_0 \\ c_1 \end{bmatrix} = \begin{bmatrix} -0,31 \\ 1,02 \\ 0,46 \end{bmatrix} \rightarrow$$



(3)

$$f_{er} = l + \frac{f_r - 1}{1/l} = l + l(f_r - 1) = l f_r$$

$$F_{er} = L + F_r = 40\,dB + 13\,dB = \underline{53\,dB}$$

$$13\,dB \leftarrow 10\log_{10}(20)$$

$$f_{sis} \approx m\, f_{er}$$

$$F_{sis} \approx 10\log_{10}(m) + F_{er} = \underbrace{10\log_{10}(5)}_{7\,dB} + 53\,dB = \underline{60\,dB}$$

$$f_{sis} = \frac{S_i/n_i}{S_o/n_o} = \frac{n_o}{n_i} \Rightarrow N_o = N_i + F_{sis} = 10\log_{10}(kTB) + 60\,dB$$

$$B = R_b/2 = \frac{200\ \text{kbit/s}}{2}$$

$$g_{sis} = \frac{S_o}{S_i} = 1$$

$$= -204 + 10\log_{10}(100 \times 10^3) + 60\,dB$$

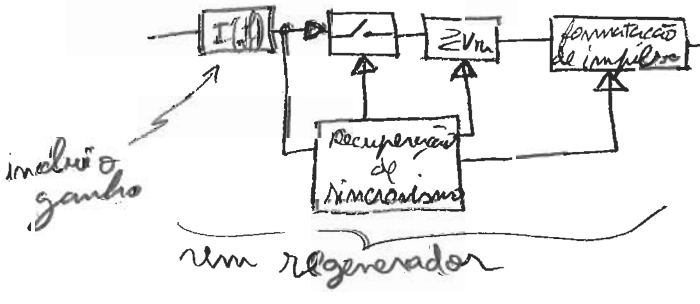
$$= \underline{-94\,dBW}$$

$$\rightarrow n_o = 10^{-9,4}\,W = \underline{398,1 \times 10^{-12}\,W} \rightarrow P_b = Q\left(\frac{A}{2\sigma}\right) = Q\left(\sqrt{\frac{A^2}{4\sigma^2}}\right) = Q(\sqrt{14})$$

$$\sigma^2 = n_o$$

$$P_b = Q(3,74) \simeq \underline{10^{-4}}$$

(4) com regeneradores P_b seria $< 10^{-4}$. comentar...



→ Como o código NRZ não possui riscas no seu espectro, tem de ser aplicado um circuito de recuperação de sincronismo em malha fechada.