1.) A

2.) D

3.) C

4.) –

5.) 12B2 $\quad \underbrace{0001}_{1} \mid 0010 \quad 1011 \quad 0010$

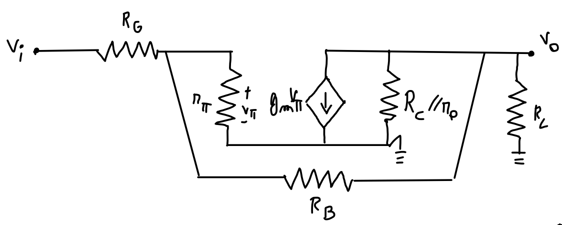
$2^{-3}+2^{-5}+2^{-7}+2^{-8}+2^{-11} \approx 0.17$

C

II a) Paralelo - Paralelo

Transimpedância: $A_f = \dfrac{V_2}{I_1}$

b)



$$A = \begin{bmatrix} 200\mu & 0 \\ 80m & 100\mu \end{bmatrix}$$

$$B = \begin{bmatrix} 10\mu & -10\mu \\ -10\mu & 10\mu \end{bmatrix}$$

$g_m = \dfrac{I_C}{V_T} = 80\,mS$

$r_\pi = \dfrac{\beta_0}{g_m} = 5k\Omega$

A:

$y_{11} = \dfrac{I_1}{V_1}\Big|_{V_2=0} = \dfrac{1}{r_\pi}$ $\qquad y_{12} = \dfrac{I_1}{V_2}\Big|_{V_1=0} = 0$

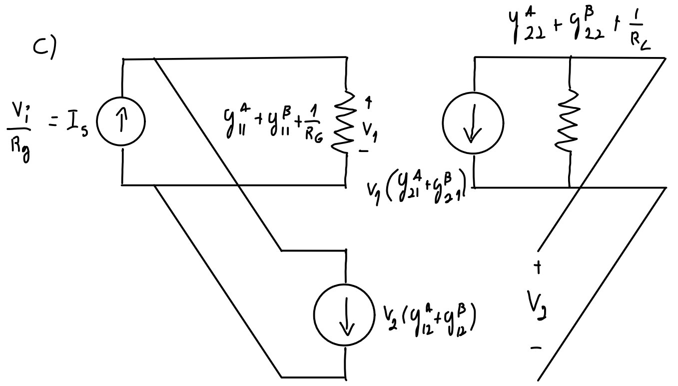
$y_{21} = \dfrac{I_2}{V_1}\Big|_{V_2=0} = g_m$ $\qquad y_{22} = \dfrac{I_2}{V_2}\Big|_{V_1=0} = \dfrac{1}{R_C}$

B:

$y_{11} = \dfrac{I_1}{V_1}\Big|_{V_2=0} = \dfrac{1}{R_B}$ $\qquad y_{12} = \dfrac{I_1}{V_2}\Big|_{V_1=0} = -\dfrac{1}{R_B}$

$y_{21} = \dfrac{I_2}{V_1}\Big|_{V_2=0} = -\dfrac{1}{R_B}$ $\qquad y_{22} = \dfrac{I_2}{V_2}\Big|_{V_1=0} = \dfrac{1}{R_B}$

c)



$$A' = -\frac{y_{21}^A + y_{21}^B}{\left(y_{11}^A + y_{11}^B + \frac{1}{R_G}\right)\left(y_{22}^A + y_{22}^B + \frac{1}{R_L}\right)} = -314.80\,k\Omega$$

$\beta' = y_{12}^A + y_{12}^B = -10\mu S$

d) $A_f = \dfrac{A'}{1 + A'\beta} = -75.89\,k\Omega$

$K_V = \dfrac{V_o}{V_i} = \dfrac{A_f}{R_i} = -75.89$

e)

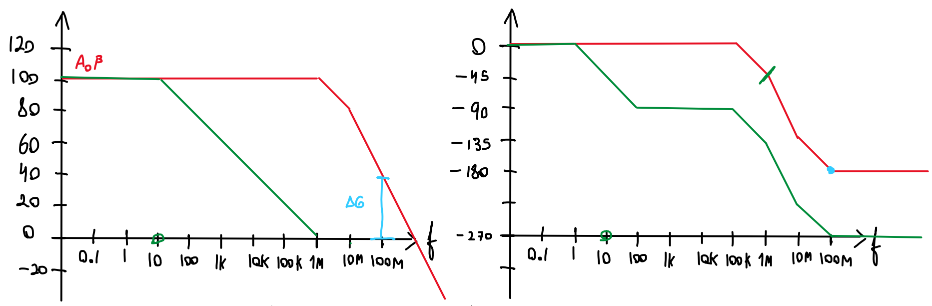
$A_0 = 140\,dB$

$\omega_{P_1} = 2\pi \times 10^6\ rad/s$

$\omega_{P_2} = 2\pi \times 10^7\ rad/s$

$A_f = 40\,dB = \dfrac{1}{\beta} \Leftrightarrow \beta = -40\,dB$

$A_0 \cdot \beta = 100\,dB$



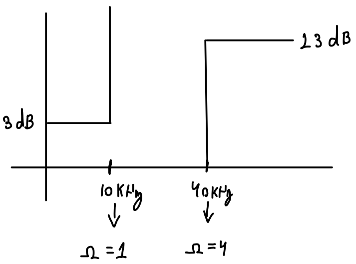
$\Delta G = -40\,dB$ → É negativo → Não é estável

$\Delta\phi = -180°$ → É tangente → Não é instável

⇒ É marginalmente estável

$\omega_p = 2\pi \times 10\ rad/s$

III a) aplanamento máximo → Butterworth



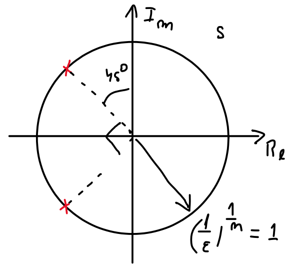
$A(\Omega) = 10 \log(1 + \varepsilon^2 \Omega^{2m})$

$A(1) = 3\,dB \Rightarrow 3\,dB = 10 \log(1 + \varepsilon^2 1^{2m}) \Leftrightarrow$

$\Leftrightarrow \sqrt{10^{\frac{3}{10}} - 1} = \varepsilon = 1$ //

$A(4) = 23\,dB \Rightarrow 23\,dB = 10 \log(1 + 4^{2m})$

$\Rightarrow m = 2 \rightarrow A(4) = 24\,dB > 23\,dB$ //



$m = 2$

$\varepsilon = 1$

$H(S) = S^2 + \sqrt{2}\,S + 1$

$$T(s) = \frac{1}{H(S)}\bigg|_{S = \frac{s}{\omega_p}} = \frac{1}{\frac{s^2}{\omega_p^2} + \frac{\sqrt{2}}{\omega_p} s + 1} = \frac{\omega_p^2}{s^2 + \sqrt{2}\,\omega_p s + \omega_p^2} = \frac{3.95 \times 10^9}{s^2 + 88.86 \times 10^3 s + 3.95 \times 10^9}$$

b) Rauch

$Y_1 = \frac{1}{R}$ $\quad Y_3 = \frac{1}{R}$ $\quad Y_5 = sC_5$

$Y_2 = sC_2$ $\quad Y_4 = \frac{1}{R}$

$$\frac{V_0}{V_i} = \frac{-Y_1 Y_3}{(Y_1 + Y_2 + Y_3 + Y_4) Y_5 + Y_3 \cdot Y_4} =$$

$$= \frac{\frac{1}{R^2}}{s^2 C_2 C_5 + \frac{3}{R} C_5 s + \frac{1}{R^2}} = \frac{\frac{1}{R^2 C_2 C_5}}{s^2 + \frac{3}{R C_2} s + \frac{1}{C_2 C_5 R^2}}$$

$$\omega_p^2 = \frac{1}{C_2 C_5 R^2} \Leftrightarrow R = \sqrt{\frac{1}{C_2 C_5 \omega_p^2}} = 11.23\,K\Omega$$

$$\frac{3}{R C_2} = \sqrt{2}\,\omega_p \Leftrightarrow \frac{3}{\sqrt{2}\,\omega_p C_2} = R = 11.25\,K\Omega$$

c) Concordo, passa-banda tem bobine flutuante ⇒ 2 GIC ⇒ 4 Ampop é muito dispendioso

IV a) $s = \frac{2}{T} \frac{1 - z^{-1}}{1 + z^{-1}} \Rightarrow z^{-1} = \frac{2 - sT}{2 + sT}$

$$T(s) = T(z)\bigg|_{z^{-1} = \frac{2 - sT}{2 + sT}} = \frac{0{,}8\left(1 - \frac{2 - sT}{2 + sT}\right)}{1 - 0{,}6\,\frac{2 - sT}{2 + sT}} = \frac{0{,}8\,(2 + sT - 2 + sT)}{2 + sT - 1.2 + 0.6\,sT} = \frac{1.6\,sT}{1.6\,sT + 0.8} = \frac{s}{s + \frac{0.8}{1.6T}} = \frac{s}{s - 25 \times 10^3}$$

f) $25\,KHz = \frac{f_s}{2} \Rightarrow A(z) = A(s)\Big|_{s \to \infty} = 1 \rightarrow 0\,dB$