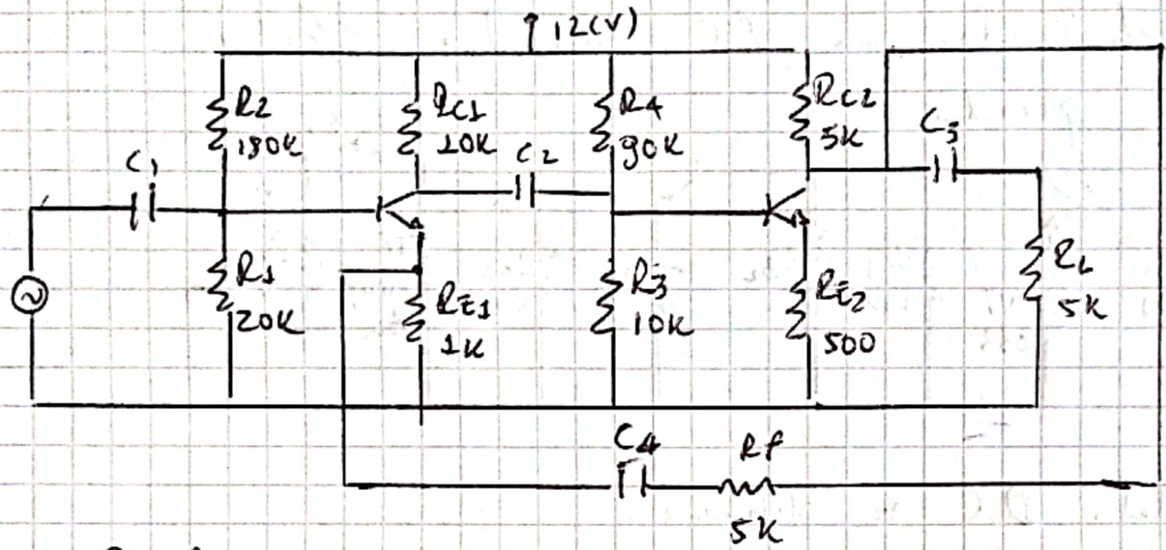
Solución Parcial 3B - Electrónica analógica.

1. Hallar β, A, A_f, R_{in}, R_{out}, Z_{inf}, Z_{outf}.



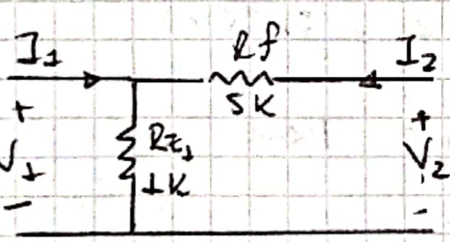
$\beta_T = 100$

→ Realimentación de voltaje: V_o

→ Comparación de voltaje: V_s

→ Parámetros "h"

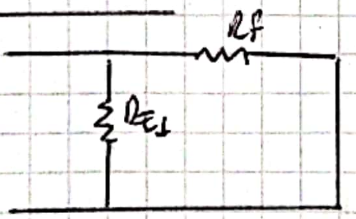
→ La red de realimentación es:



$$V_1 = h_{11f} + h_{12f} V_2$$

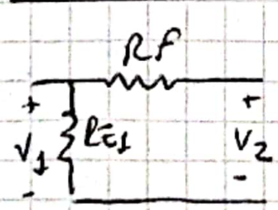
$$I_2 = h_{21f} + h_{22f} V_2$$

$$h_{11f} = \left.\frac{V_1}{I_1}\right|_{V_2=0}$$



$$\Rightarrow h_{11f} = R_{E1} // R_f = 833\ \Omega$$

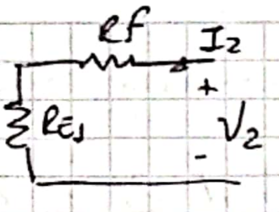
$$h_{12f} = \left.\frac{V_1}{V_2}\right|_{I_1=0}$$



$$V_1 = \frac{V_2 R_{E1}}{R_1 + R_f} \Rightarrow \frac{V_1}{V_2} = \frac{R_{E1}}{R_{E1} + R_f}$$

$$\Rightarrow h_{12f} = \beta = 0.166.$$

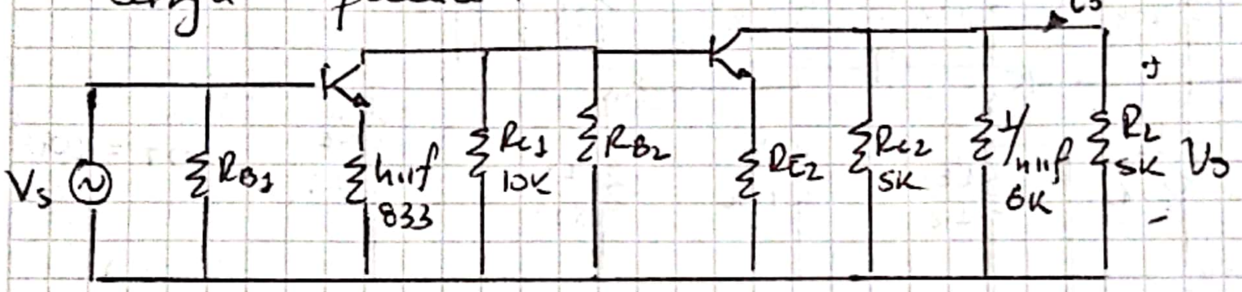
$h_{22f} = \frac{I_2}{V_2}\Big|_{I_1=0}$



$\Rightarrow h_{22f} = \frac{1}{R_{E1}+R_f} = 1.66\times10^{-4}$ ℧

$\Rightarrow 1/h_{22f} = 6K\Omega$.

El amplificador en AC con los efectos de carga queda:



Del modelo D.C se obtiene:

$I_{CQ1} = \frac{V_{BB1}-V_{BE}}{\frac{R_{B1}}{\beta_1}+R_{E1}}$ $\qquad V_{BB1} = \frac{V_{CC}R_1}{R_1+R_2} = 1.2(V)$

$R_{B1} = R_1 // R_2 = 18K\Omega$.

$I_{CQ1} = 423\ \mu A$

$I_{CQ2} = \frac{V_{BB2}-V_{BE}}{R_{B2}/\beta_1 + R_{E2}}$ $\qquad V_{BB2} = \frac{V_{CC}R_2}{R_1+R_2} = 1.2(V)$

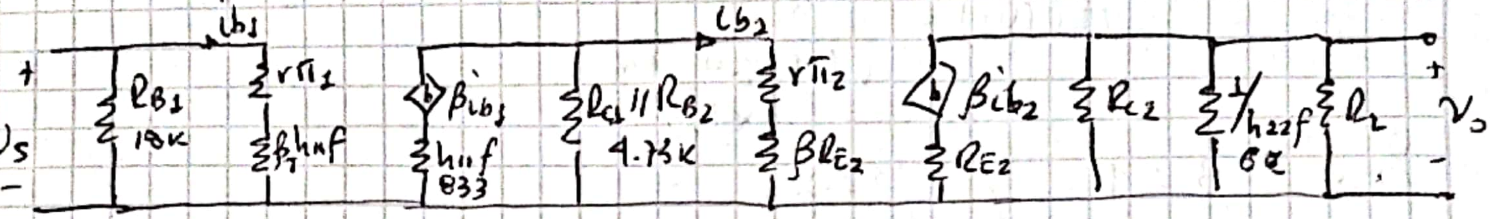
$R_{B2} = R_3 // R_4 = 9K\Omega$.

$I_{CQ2} = 847\ \mu A$.

$r\pi_1 = \frac{\beta 26mV}{I_{CQ1}} = 6.1K\Omega$.

$r\pi_2 = \frac{\beta 26mV}{I_{CQ2}} = 3.05K\Omega$

Modelo híbrido en lazo abierto:



$R_{in} = R_{B1} // (r\pi_1 + \beta h_{11f}) \approx 15 K\Omega$

$R_{out} = R_L // 1/h_{22f} // R_{C2} \approx 1.76 K\Omega$.

$A = \frac{V_o}{V_s}$ $V_s = i_{b1}(r\pi_1 + \beta h_{11f}) \Rightarrow i_{b1} = \frac{V_s}{(r\pi_1 + \beta h_{11f})}$

$$i_{b2} = \frac{-\beta i_{b1} (R_{C1} // R_{B2})}{(R_{C1} // R_{B2}) + r\pi_2 + \beta_f R_{E2}} = \frac{-473 \times 10^3 i_{b1}}{4.73K + 3.05K + 100(500)} = -8.18 i_{b1}$$

$$\Rightarrow i_{b2} = \frac{-8.18 V_s}{(r\pi_1 + \beta h_{11f})} = -9.16 \times 10^{-5} V_s$$

$$i_o = \frac{-\beta i_{b2} (R_2 // 1/h_{22f})}{(R_{C2} // 1/h_{22f}) + R_L} = \frac{-272 \times 10^3 i_{b2}}{7.72 \times 10^3} = -35.32 i_{b2}$$

Pero $V_o = i_o R_L$ e $i_{b2} = -9.16 \times 10^{-5} V_s$

Reemplazando:

$$A = \frac{V_o}{V_s} = 35.32 * 5K * 9.16 \times 10^{-5} = 16.17$$

$$A_f = \frac{A}{1 + \beta A} = \frac{16.17}{1 + (0.166)(16.17)} \approx 4.4$$

$$Z_{inf} = R_{in}(1 + \beta A) = 15K(1 + 0.166 * 16.17) = 55.2 K\Omega$$

$$Z_{outf} = \frac{R_{out}}{1 + \beta A} = \frac{1.76 K\Omega}{(1 + 0.166 * 16.17)} = 477.7 \Omega.$$

2. a) Determinar estabilidad de un amplificador con:

$$A(jw) = \frac{80}{\left(1 + \frac{jw}{6\times10^4}\right)^6}$$

Para : $\beta = 1$ y $\beta = 0.1$

Se halla la frecuencia de $-180°$ (ω_{180}):

$$\Rightarrow -180° = -6\tan^{-1}\left(\frac{\omega_{180}}{6\times10^4}\right) \Rightarrow \omega_{180} = 6\times10^4 \tan\left(\frac{180}{6}\right)$$

$$\omega_{180} = 3.46\times10^4 \text{ rad/s.}$$

Ahora se evalúa la función de magnitud:

Para $\beta = 1$

$$|\beta A|_{\omega_{180}} = \frac{80}{\left[\sqrt{1 + \left(\frac{3.46\times10^4}{6\times10^4}\right)^2}\right]^6} = 33.8 \therefore \text{ es inestable}$$

Para $\beta = 0.1$

$$|\beta A|_{\omega_{180}} = \frac{80(0.1)}{\left[\sqrt{1 + \left(\frac{3.46\times10^4}{6\times10^4}\right)^2}\right]^6} = 3.38 \therefore \text{ es inestable}$$

b) Margen de ganancia de -18 dB, $\beta = ?$

$$\Rightarrow 20\log(A) = -18 \Rightarrow A = 10^{-18/20} = 0.126$$

$$\Rightarrow |\beta A|_{\omega_{180}} = 0.126 \Rightarrow \frac{\beta\, 80}{\left[\sqrt{1 + \left(\frac{3.46\times10^4}{6\times10^4}\right)^2}\right]^6} = 0.126$$

$$\Rightarrow \beta = \frac{0.126\left[\sqrt{1 + \left(\frac{3.46\times10^4}{6\times10^4}\right)^2}\right]^6}{80} = 0.0037$$

β debe valer 0.0037 para tener un margen de ganancia de -18 dB.