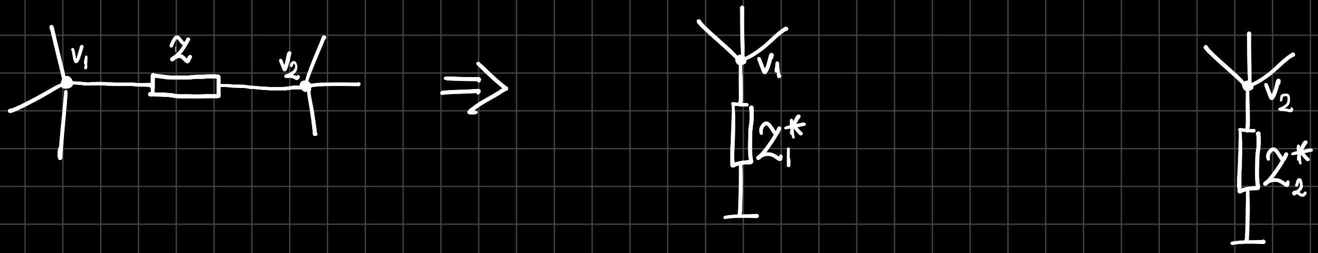
Respuesta en Alta (Basicamente repaso de Miller)

Preliminares:

Miller de tensiones:



$$Z_1^* = Z\left(1 - \frac{V_2}{V_1}\right) \qquad Z_2^* = Z\left(1 - \frac{V_1}{V_2}\right)$$

Capacitancias Internas:

$$\boxed{f_T = \frac{1}{2\pi} \frac{g_m}{C_\pi + C_\mu}}$$

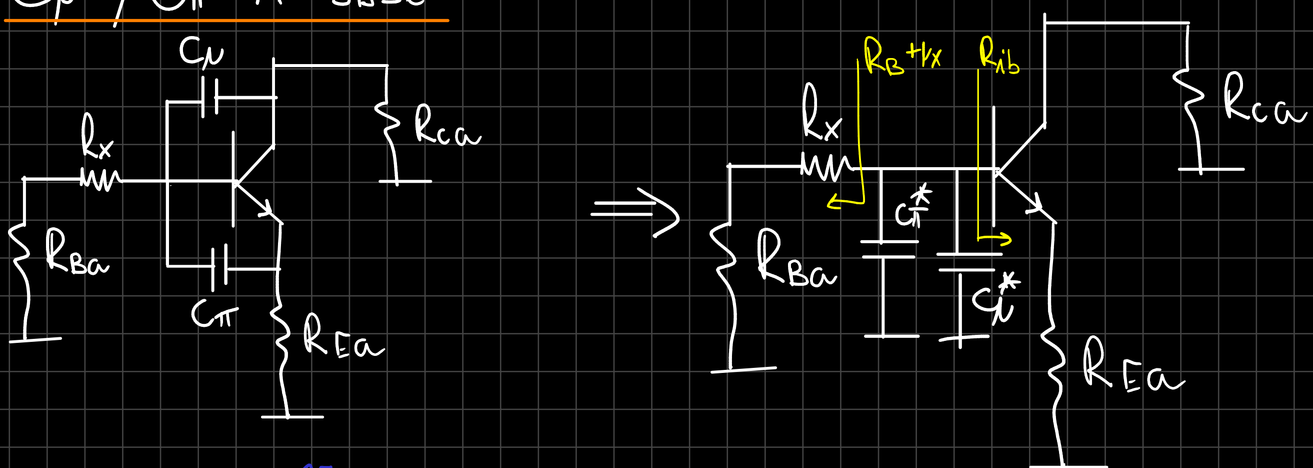
Para TBJ

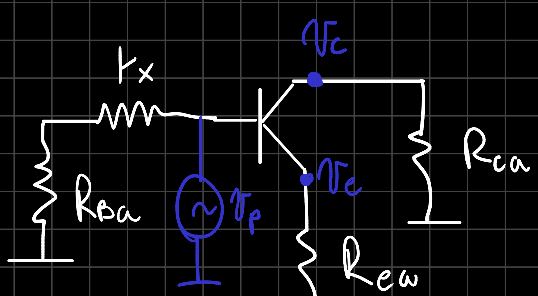
$$\boxed{f_T = \frac{1}{2\pi} \frac{g_m}{C_{gs} + C_{gB} + C_{gD}}}$$

Para Mos.

f_T: Frecuencia de Transición. Máxima frecuencia a la que se puede usar el transistor. Si o si $f_h < f_T$. (si en calculos me da mayor la descarto y uso f_T)

C_μ y C_π a base

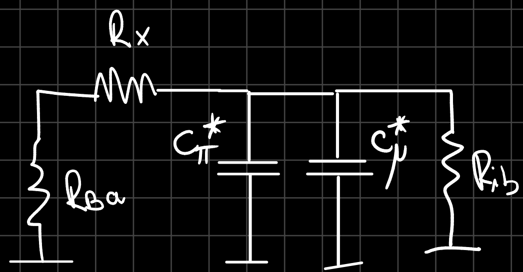




$$\frac{V_e}{V_p} = \frac{g_m \cancel{V_{be}} R_{ea}}{\cancel{V_{be}} + g_m \cancel{V_{be}} R_{ea}} = \frac{g_m R_{ea}}{1 + g_m R_{ea}}$$

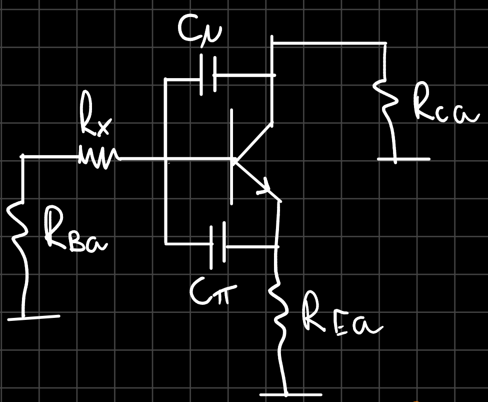
$$\frac{v_c}{v_p} = \frac{-g_m v_{be} R_{Ca}}{v_{be} + g_m v_{be} R_{Ea}} = \frac{-R_{Ca}}{\frac{1}{g_m} + R_{Ea}}$$

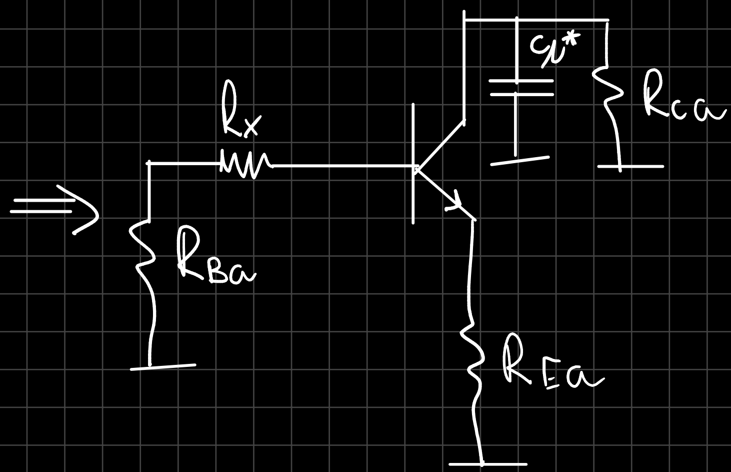
$$\begin{cases} C_\mu^* = C_\mu\left(1 + \dfrac{R_{Ca}}{\frac{1}{g_m} + R_{Ea}}\right) \\ C_\pi^* = C_\pi\left(1 - \dfrac{g_m R_{Ea}}{1 + g_m R_{Ea}}\right) \end{cases}$$

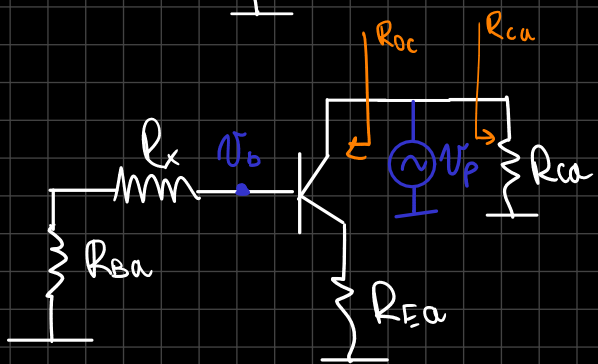


$$\tau_B = (R_{Ba} + R_x) // (r_\pi + \beta R_E) \cdot (C_\pi^* + C_\mu^*)$$

C_μ Al Colector

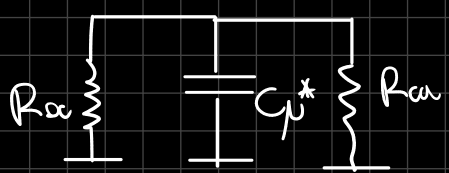






$\frac{v_b}{v_p} = 0$, El TBJ no está diseñado para entrar por colector

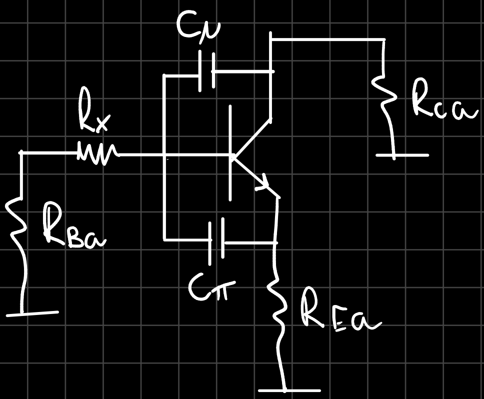
$$C_\mu^* = C_\mu$$



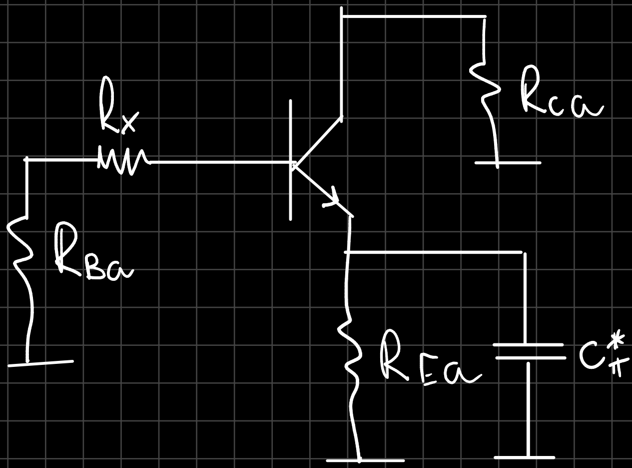
$$R_{oc} = r_o(1 + g_m R_{Ea})$$

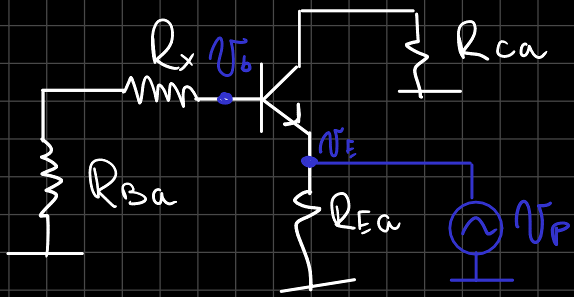
$$\tau_C = r_o(1 + g_m R_{Ea}) // R_{Ca} \cdot C_\mu$$

C_π Al emisor



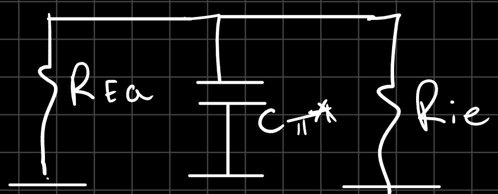
$\Longrightarrow$





$$\frac{v_b}{v_e} = \frac{R_x + R_{Ba}}{r_\pi + R_x + R_{Ba}} < 1$$

$$C_\pi^* = C_\pi\left(1 - \frac{R_x + R_{Ba}}{r_\pi + R_x + R_{Ba}}\right)$$



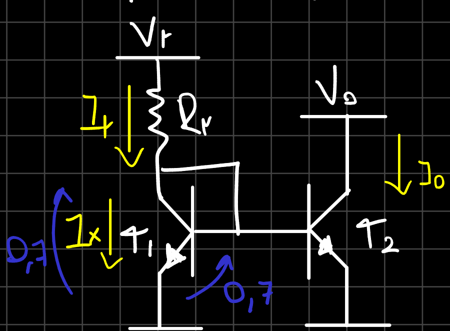
$$\tau_e = C_\pi\left(1 - \frac{R_x + R_{Ba}}{r_\pi + R_x + R_{Ba}}\right) \cdot R_{Ea} // \left(\frac{1}{g_m} + \frac{R_x + R_{Ba}}{\beta}\right)$$

$$R_{ie} = \frac{1}{g_m} + \frac{R_x + R_{Ba}}{\beta}$$

$f_e = \frac{1}{\tau_e}$ queda del orden de f_T, por lo que nunca va a ser dominante.

Fuentes de Corriente

fuente espejo simple



$$\boxed{I_r = \frac{V_r - 0{,}7}{R_r}}$$

$V_{ce} > 0{,}7V$ para mantener MAD

$$\boxed{V_o > 0{,}7V}$$

$$I_x \approx I_o$$

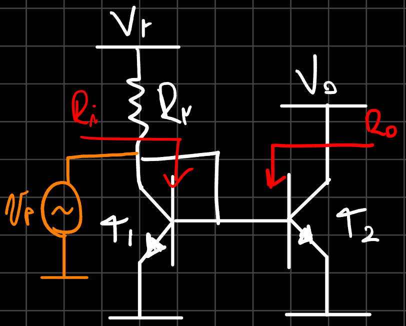
$$I_x = I_r - 2\frac{I_x}{\beta}$$

$$I_o\left(1 + \frac{2}{\beta}\right) = I_r$$

$$\frac{I_o}{I_r} = \boxed{\frac{1}{1 + \frac{2}{\beta}}}$$

$\beta = 100$

$= 0{,}98$



$$R_i = r_o // r^*$$

$$R_i = r_o // \frac{1}{g_m}$$

$$\boxed{R_i \approx \frac{1}{g_m}}$$

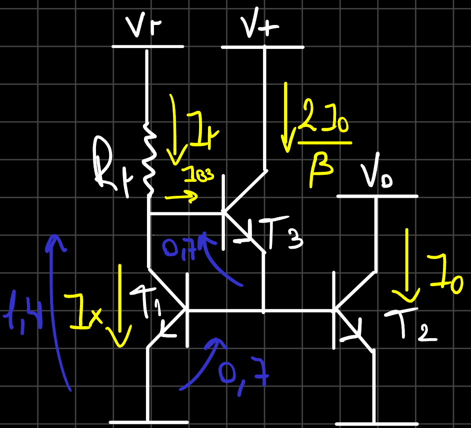
$$\boxed{R_o = R_{o2}}$$

$$r^* = \frac{v_{be}}{g_m v_{be} + \frac{v_{be}}{r_{\pi1} // r_{\pi2}}}$$

$$= \frac{1}{g_m + \frac{1}{r_{\pi1} + r_{\pi2}}} = \frac{1}{g_m + \frac{2}{r_\pi}}$$

$$= \frac{r_\pi}{\beta + 2} \approx \frac{1}{g_m}$$

Fuente espejo con β-Helper



$$\boxed{I_r = \frac{V_r - 1,4}{R_r}}$$

$V_{ce2} > 0,7$

Para mantener MAD

$$\boxed{V_o > 0,7}$$

$$I_r = I_{B3} + I_x$$

$I_x \approx I_o$

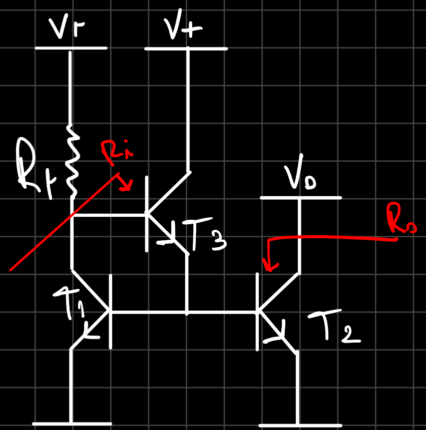
$$I_r = \frac{2I_o}{\beta^2} + I_x$$

$$I_r = I_o\left(\frac{2}{\beta^2} + 1\right)$$

$$\boxed{\frac{I_o}{I_r} = \frac{1}{\frac{2}{\beta^2} + 1}}$$

$\beta = 100$

$= 0,9998$



$$R_i = r_o // \left(r_{\pi3} + \beta \overbrace{\left(r_{\pi1} // r_{\pi2}\right)}^{r_{\pi1}/2}\right)$$

$$R_i = r_o // \left(\frac{\beta}{2} r_{\pi1} + \frac{\beta}{2} r_{\pi1}\right)$$

$$\boxed{\cancel{R_i = r_o // \beta r_{\pi1}}}$$

$$\frac{1}{g_m \beta}$$

$$\boxed{R_o = r_{o3}}$$

$$r_{\pi3} = \frac{\beta}{g_{m3}}$$

$$g_{m3} = \frac{2I_o}{\beta V_T}$$

$$r_{\pi3} = \frac{\beta^2 V_T}{2I_o}$$

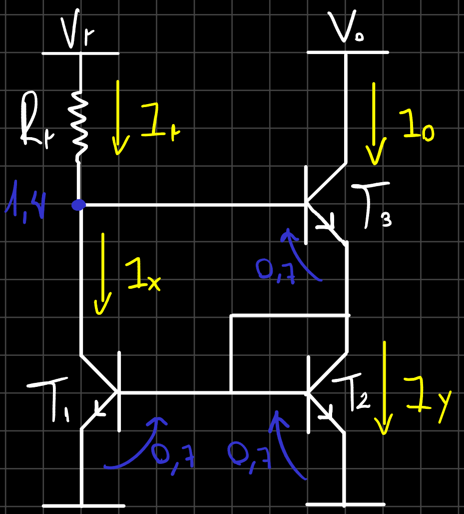
$$r_{\pi1,2} = \frac{\beta}{g_{m1,2}}$$

$$g_{m1,2} = \frac{I_o}{V_T}$$

$$r_{\pi1,2} = \frac{\beta V_T}{I_o}$$

$$r_{\pi3} = \frac{\beta}{2} r_{\pi1}$$

Fuente Wilson



$$\boxed{I_r = \frac{V_r - 1,4}{R_r}}$$

Por copia de corriente.

$$I_r = I_x + \frac{I_o}{\beta} \qquad I_x = I_y$$

$$I_y = I_o\left(1+\frac{1}{\beta}\right) - 2\frac{I_y}{\beta}$$

$$I_y + 2\frac{I_y}{\beta} = I_o\left(1+\frac{1}{\beta}\right)$$

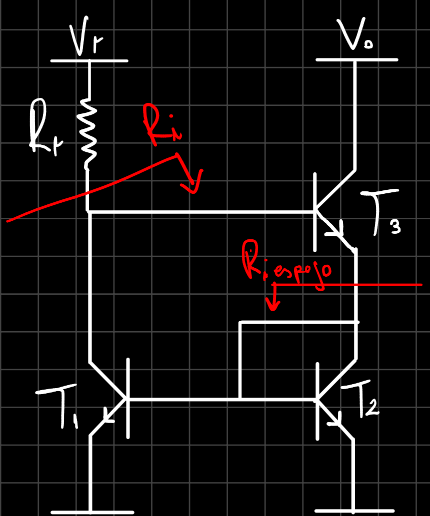
$$I_y\left(1-\frac{2}{\beta}\right) = I_o\left(1+\frac{1}{\beta}\right)$$

$$I_y = I_o\frac{\left(1+1/\beta\right)}{\left(1+\frac{2}{\beta}\right)} \Rightarrow I_r = I_o\left(\frac{\beta+1}{\beta+2}+\frac{1}{\beta}\right)$$

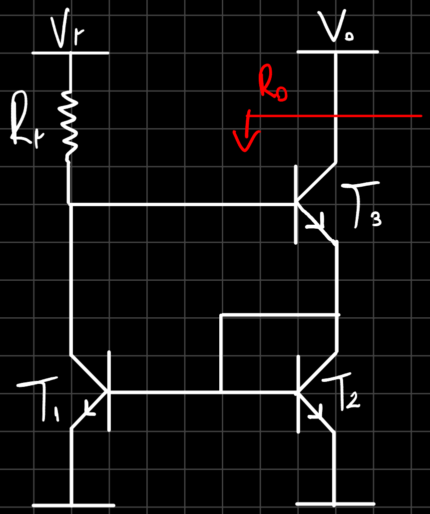
Las V_{CE} de T_1 y T_2 están fijas, la de T_3 tiene que ser mayor a 0,7, lo que pasa cuando $\boxed{V_o > 1,4V}$

$$\Rightarrow I_r = I_o\left(\frac{\beta+2+\beta(\beta+1)}{\beta(\beta+2)}\right) = I_o\left(1+\frac{2}{\beta(\beta+2)}\right)$$

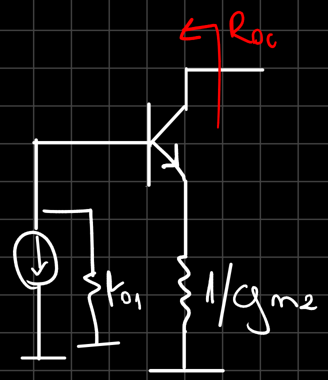
$$\boxed{\frac{I_o}{I_r} = \frac{1}{1+\frac{2}{\beta(\beta+2)}}} \quad \beta = 100 \quad = 0,9998$$



$$R_i = r_{o1} \,\|\, \left(\overbrace{r_{\pi3}}^{r_{\pi2}} + \overbrace{\frac{\beta}{g_{m2}}}^{r_{\pi2}}\right) \simeq \boxed{2r_{\pi2} = R_i}$$

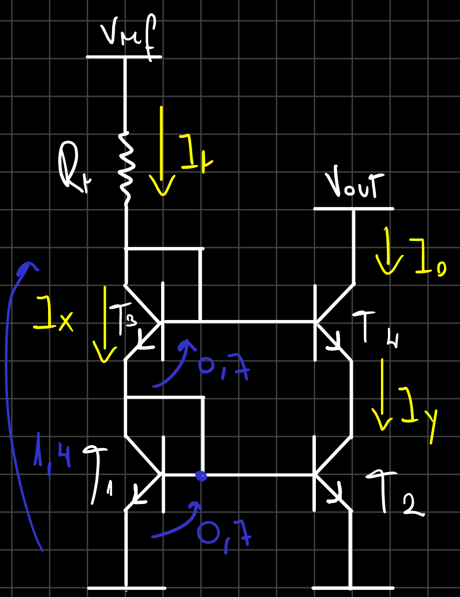


$\equiv$



$$R_{oc} = r_{o3}\left(1 + \frac{\beta}{2}\right) = \boxed{\frac{\beta r_{o3}}{2}}$$

Fuente Cascode



$$\boxed{I_r = \frac{V_{ref} - 1{,}4}{R_r}}$$

V_{ce} de T_1, T_2, T_3 y T_4 es fijo, y el de T_4 debe ser mayor a 0,7, por lo que

$$\boxed{V_o > 1{,}4\,V}$$

$$I_y = \frac{1}{1 + 2/\beta} I_x = I_o(1 + 1/\beta)$$

$$I_x = I_o\left(1 + \frac{1}{\beta}\right)(1 + 2/\beta)$$

$$I_x = I_r - \frac{2I_o}{\beta} = I_o\left(1 + \frac{1}{\beta}\right)(1 + 2/\beta)$$

$$I_r = I_o\left(\frac{2}{\beta} + (1 + 1/\beta)(1 + 2/\beta)\right)$$

$$\frac{I_o}{I_r} = \frac{1}{\left(\frac{2}{\beta} + 1 + \frac{2}{\beta} + \frac{1}{\beta} + \frac{2}{\beta^2}\right)} = \boxed{\frac{\beta^2}{\beta^2 + 5\beta + 2}}$$

Me da paja dividir polinomios

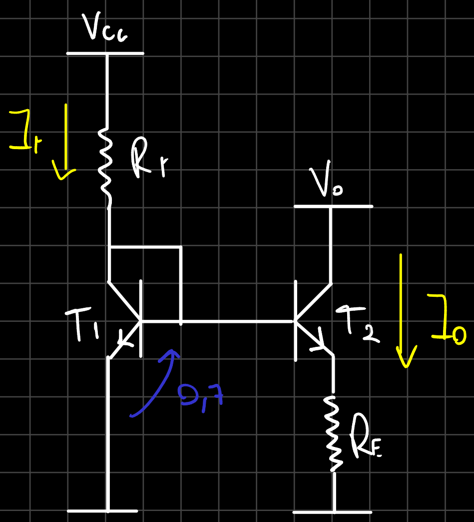
Para $\beta = 100$, $\frac{I_o}{I_r} = 0{,}9522$

$$R_i = \frac{v_i}{i_i} \approx \frac{v_{be1} + v_{be3}}{g_{m3} v_{be3}} = \frac{2}{g_{m3}}$$ $\Rightarrow$ Random, pero son las 23:17 del dia antes de mi cumple y elijo confiar en Ebern.

$R_o \approx r_{o4}(1 + g_m r_{o2}) \Rightarrow$ Idem con R_i (Igual esto se me ocurre xq) (Roc Realimentado)

---

fuente widlar



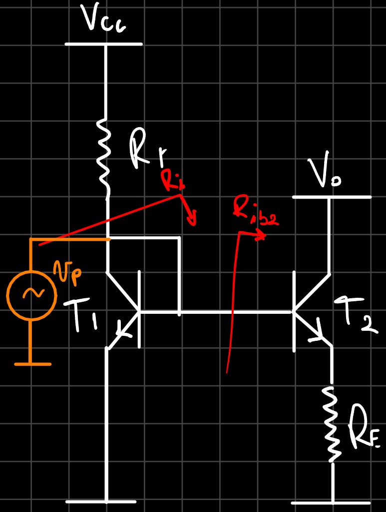
$$v_{be1} - v_{be2} - I_o R_E = 0$$

$$\ln\left(\frac{I_r}{I_s}\right) - \ln\left(\frac{I_o}{I_2}\right) - I_o R_E = 0$$

$$\ln\left(\frac{I_r}{I_o}\right) - I_o R_E = 0$$

Se Itera Sobre esto.

$$I_r = \frac{V_{cc} - 0,7}{R_r}$$



$$R_i = \left(r_{\pi 2} + \beta R_E\right) // \frac{1}{g_{m1}} \approx \frac{1}{g_{m1}}$$

$$R_o = r_o\left(1 + g_{m2} R_E\right)$$