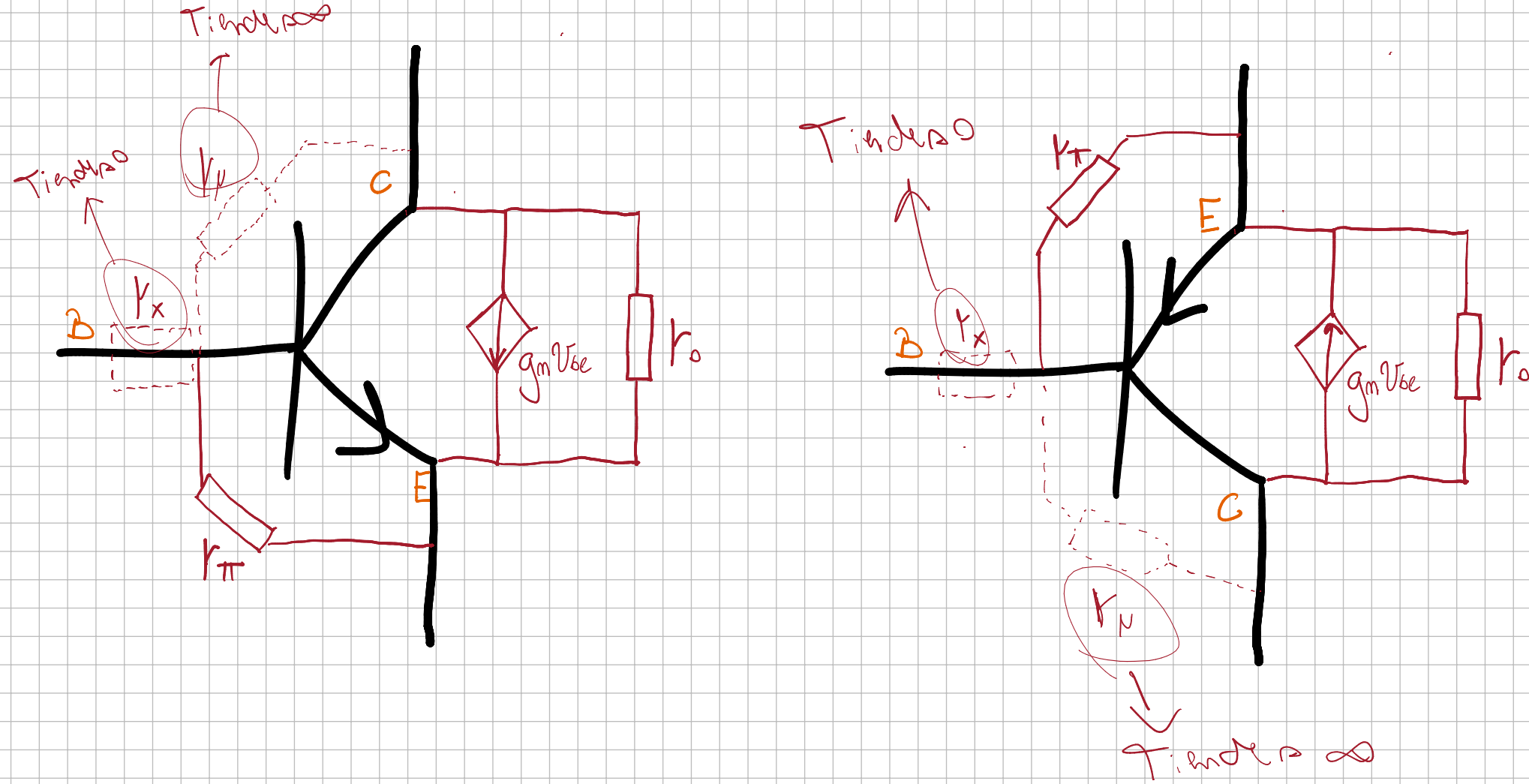


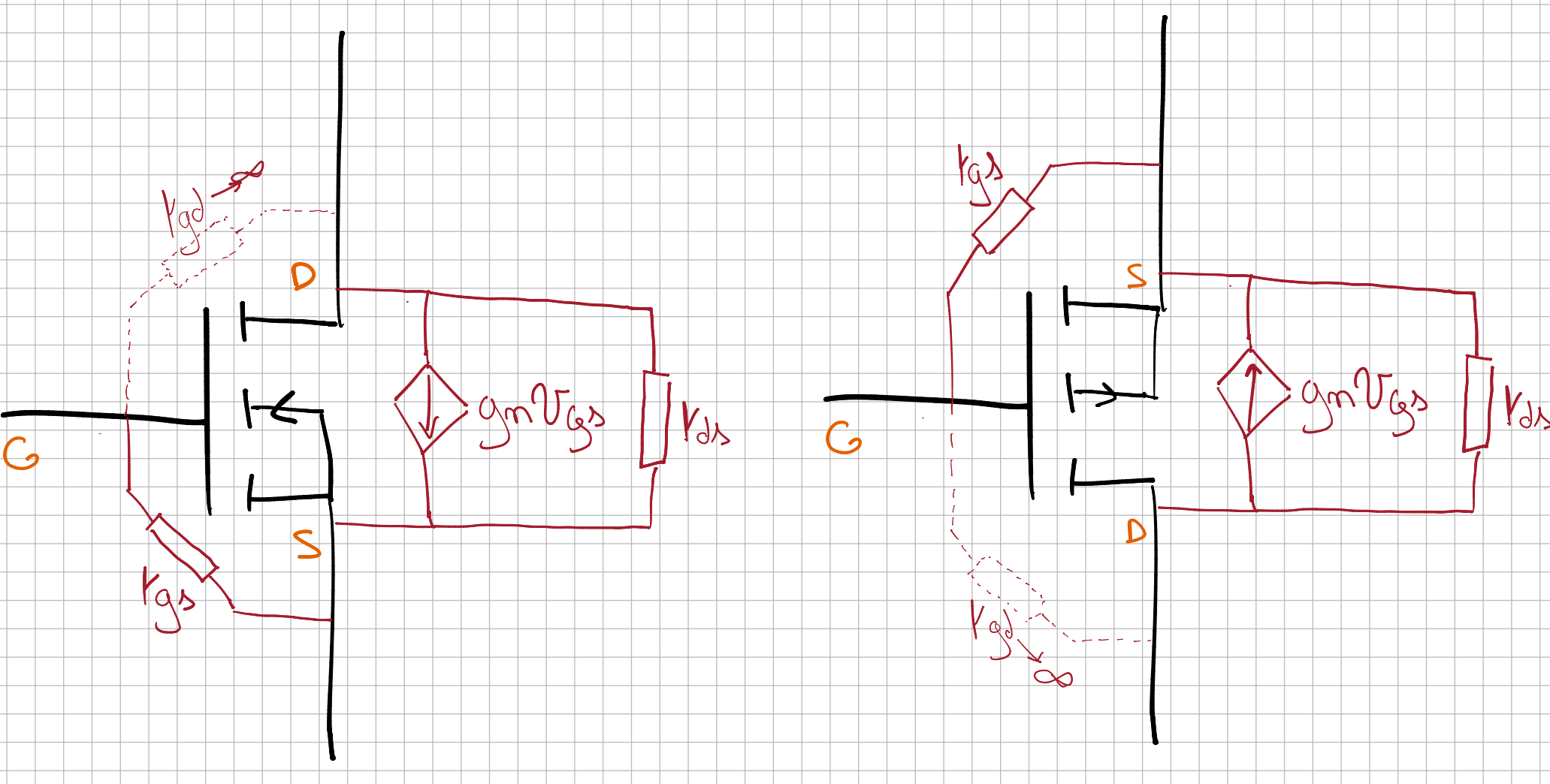
Modulos de pequeña Señal

TBJ (Mad)



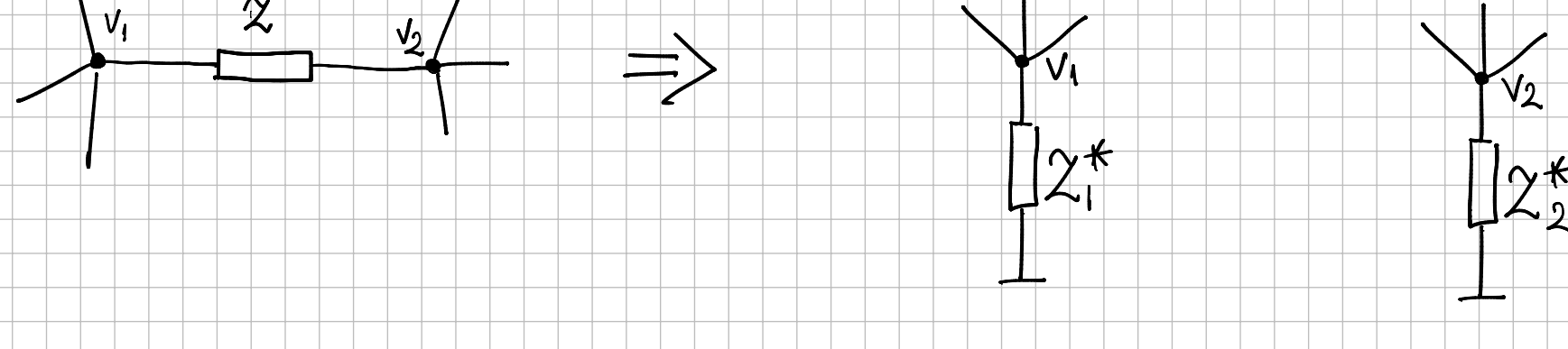
$$g_m = \frac{I_{CQ}}{V_T} \quad r_{\pi} = \frac{\beta}{g_m} \quad r_o = \frac{V_A}{I_{CQ}}$$

Mosfet (SATURACIÓN/Estrangulamiento)



$$g_m = 2 (K \cdot I_{DQ})^{1/2} \quad r_{gs} = \frac{V_{GS}}{I_{DQ}} \quad r_{ds} = \frac{1}{\lambda I_{DQ}}$$

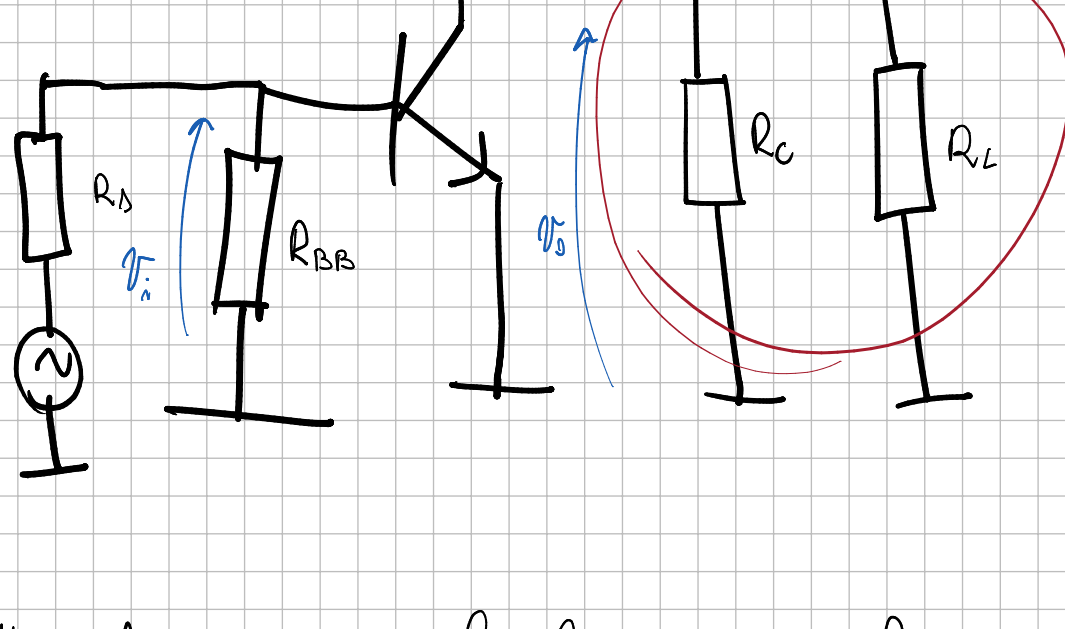
Miller!



$$Z_1 = \frac{Z}{1 - \frac{v_2}{v_1}} \quad Z_2 = \frac{Z}{1 - \frac{v_1}{v_2}}$$

Configuraciones !! (Siempre con TBJ/Mos polarizado bien)
(Y en frecuencias medias)

Emitor Común



$$\frac{v_o}{v_i} = A_v = -\frac{g_m R_{Lc} v_i}{v_i} = -g_m R_{Lc}$$

$$A_{v_s} = \frac{v_o}{v_s} = A_v \frac{R_{BB}}{R_{BB} + R_s}$$

$$v_i = v_s \frac{R_{BB}}{R_{BB} + R_s}$$

$$v_s = \frac{R_{BB} + R_s}{R_{BB}} v_i$$

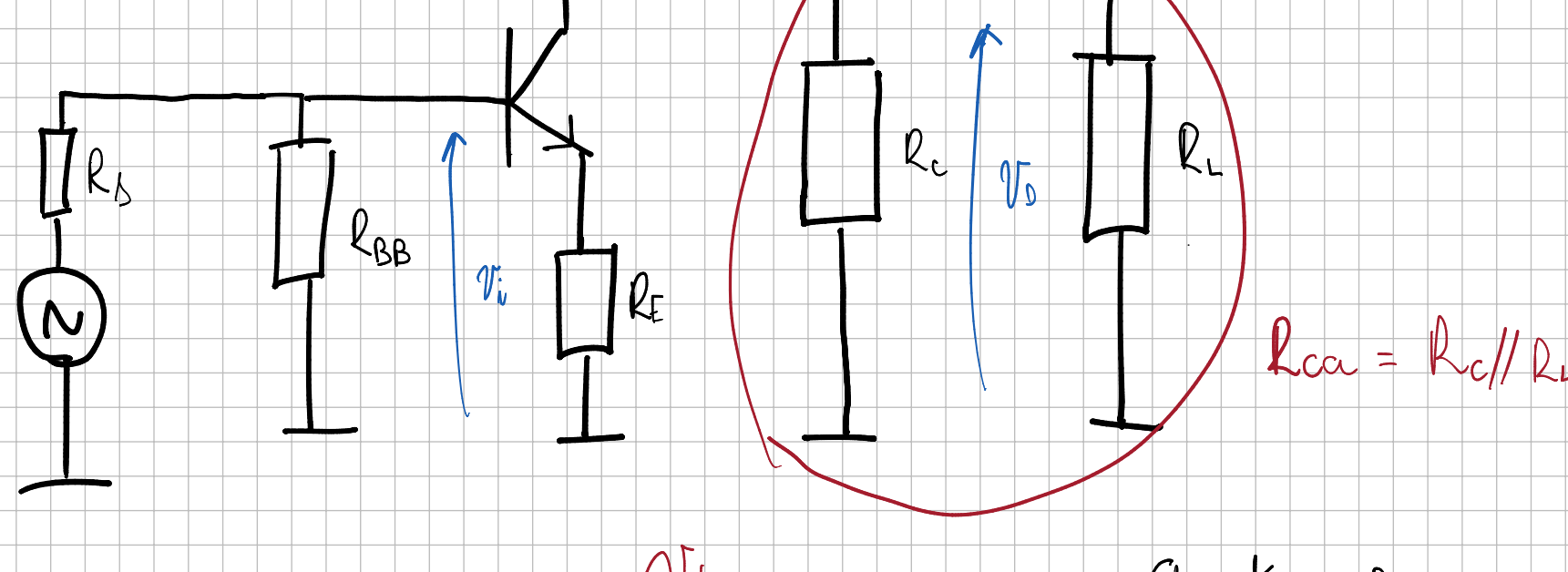
$$R_{oc} = r_o$$

$$R_o = R_{oc} || R_L = r_o || R_L$$

$$R_{ib} = r_{\pi}$$

$$R_i = R_{ib} || R_{BB} = r_{\pi} || R_{BB}$$

Emitor Común (Realimentado por emisor)



$$A_v = \frac{v_o}{v_i} = -\frac{g_m i_b r_{\pi} R_{Lc}}{i_b r_{\pi} + (g_m i_b r_{\pi} + i_o) R_E} = \frac{-\beta R_{Lc}}{r_{\pi} + (\beta + 1) R_E}$$

$$A_v = \frac{-R_{Lc}}{R_E} \quad \left(\frac{1}{g_m} + \frac{\beta r_{\pi}}{\beta} \right) R_E \ll R_E$$

$$A_{v_s} = \frac{A_v R_i}{R_s + R_i}$$

$$R_{ib} = \frac{v_i}{i_b} = i_b r_{\pi} + (i_b + g_m i_b r_{\pi}) R_E$$

$$= r_{\pi} + (1 + \beta) R_E$$

$$R_i = R_{ib} || R_{BB}$$

$$R_o = R_C || R_{Lc}$$

$$v_E = (i_b + i_o) R_E = -i_b (r_{\pi} + R_E || R_L)$$

$$i_b R_E = -i_b (r_{\pi} + R_E || R_L)$$

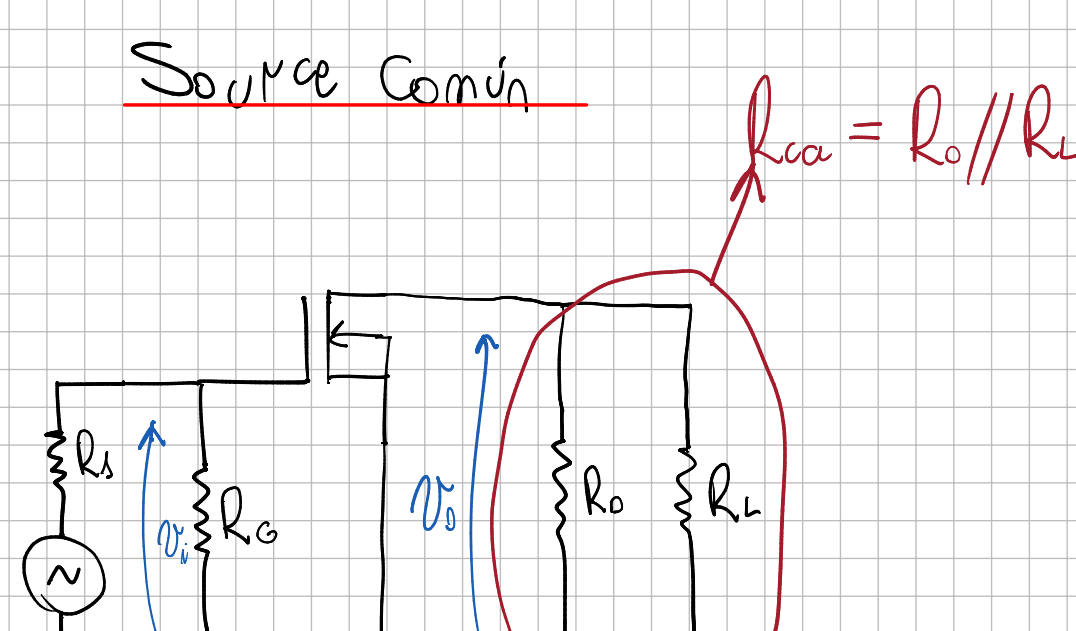
$$i_b = \frac{-i_b R_E}{R_E + r_{\pi} + R_L || R_L}$$

$$v_{oc} = \frac{v_o}{i_p} = \frac{R_E || (r_{\pi} + R_E || R_L)}{i_p} i_p + v_o (i_p - \beta i_b)$$

$$= \frac{R_E || (r_{\pi} + R_E || R_L)}{i_p} + v_o \left(1 + \frac{\beta R_E}{R_E + r_{\pi} + R_L || R_L} \right)$$

Esto es chikito
Comparado con
Lo otro

Source Común



$$A_v = \frac{v_o}{v_i} = -\frac{g_m v_{gs} R_{Lc}}{v_{gs}} = -g_m R_{Lc}$$

$$A_v = -g_m R_{Lc}$$

$$A_{v_s} = A_v \frac{R_i}{R_s + R_i}$$

$$v_{os} = v_{ds}$$

$$v_{ig} = v_{gs}$$

$$v_{os} = v_{ds} || R_o$$

$$v_i = v_{gs} || R_G$$

$$v_o = \frac{v_o}{i_p} = \frac{R_D || (r_{ds} + R_D || R_L)}{i_p} i_p + v_o (i_p - g_m v_{gs})$$

$$= \frac{R_D || (r_{ds} + R_D || R_L)}{i_p} + v_o \left(1 - \frac{g_m R_D || R_L}{1 + g_m R_S} \right)$$

$$R_o = R_{os} || R_o$$

$$v_o = \frac{v_o}{i_p} = \frac{R_D || (r_{ds} + R_D || R_L)}{i_p} i_p + v_o (i_p - g_m v_{gs})$$

$$= \frac{R_D || (r_{ds} + R_D || R_L)}{i_p} + v_o \left(1 - \frac{g_m R_D || R_L}{1 + g_m R_S} \right)$$

$$R_o = R_{os} || R_o$$

$$\frac{v_o}{v_i} = \frac{-g_m v_{gs} R_{Lc}}{v_{gs} + g_m v_{gs} R_S} = \frac{-g_m R_{Lc}}{1 + g_m R_S} = \frac{R_{Lc}}{1/g_m + R_S} = A_v$$

$$A_{v_s} = A_v \frac{R_{in}}{R_s + R_{in}}$$

$$R_{in} = R_{ig} || R_G$$

$$R_{ig} = \frac{v_i}{i_p} = \frac{I_p r_{gs} + g_m I_p r_{gs} R_S}{I_p} = r_{gs} (1 + g_m R_S)$$

$$R_o = R_{os} || R_o$$

$$R_{oo} = \frac{V_E}{i_P} = i_P (R_S // (V_{GS} + R_G // R_D)) + (i_P - g_m V_{GS} i_G) R_D$$

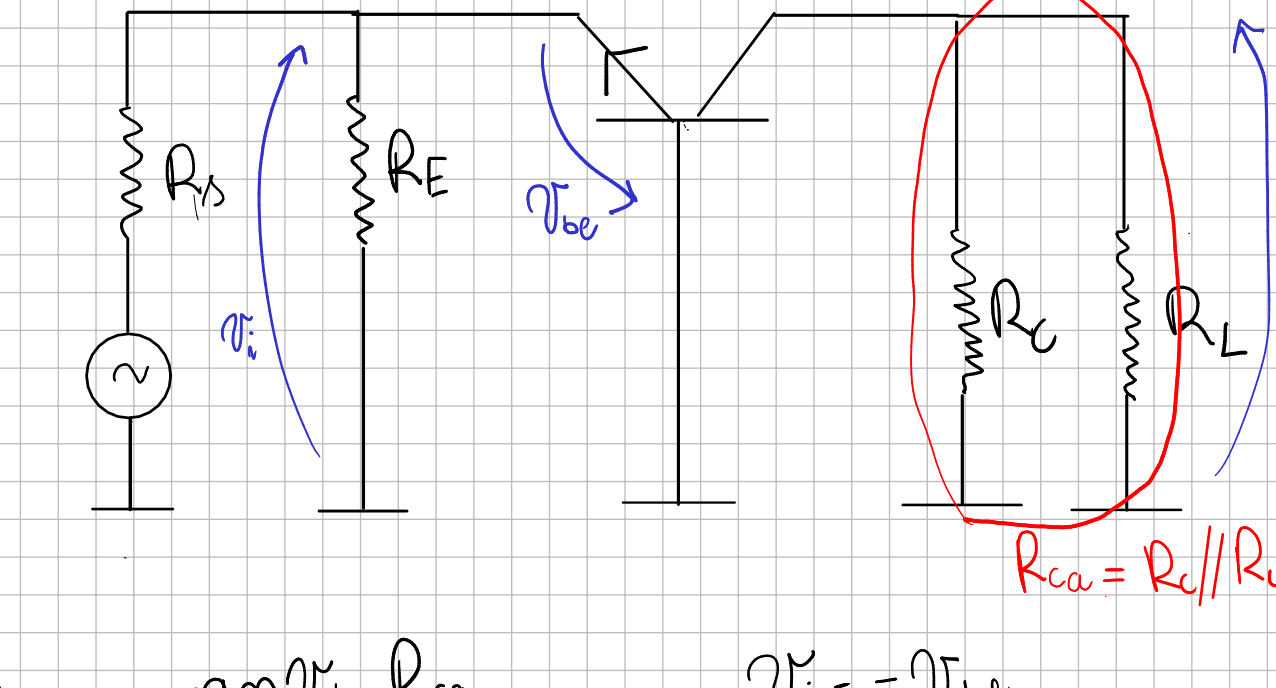
$$R_{oo} = \underbrace{R_S // (V_{GS} + R_G // R_D)}_{\text{OTRO WZ es CHIKITO con respecto al otro}} + \underbrace{R_D \left(1 + \frac{g_m R_S R_D}{V_{GS} + R_G // R_D + R_S} \right)}_{\text{Como } V_{GS} \rightarrow \infty \quad \boxed{V_D (1 + g_m R_D)}}$$

$$R_S (i_P + i_G) = (V_{GS} + R_G // R_D) i_G$$

$$R_S i_P = (V_{GS} + R_G // R_D + R_S) i_G$$

$$i_G = \frac{R_S i_P}{(V_{GS} + R_G // R_D + R_S)}$$

Base Común (Siempre polarizando bonito)



$$A_v = \frac{v_o}{v_i} = \frac{-g_m V_{be} R_{oa}}{V_{be}} \Rightarrow V_{be} = -V_{be}$$

$$A_v = g_m R_{oa} \quad A_v V_s = \frac{A_v R_i}{R_i + R_s} \quad V_{be} = \frac{V_{be}}{\beta} = \frac{1}{g_m} = V_D \quad R_i = R_E // V_{be}$$

$$R_o = R_C // R_L$$

$$R_{oc} = \frac{V_E}{i_P} = \frac{(R_E // V_{be}) i_P + (i_P - \beta i_b) V_D}{i_P}$$

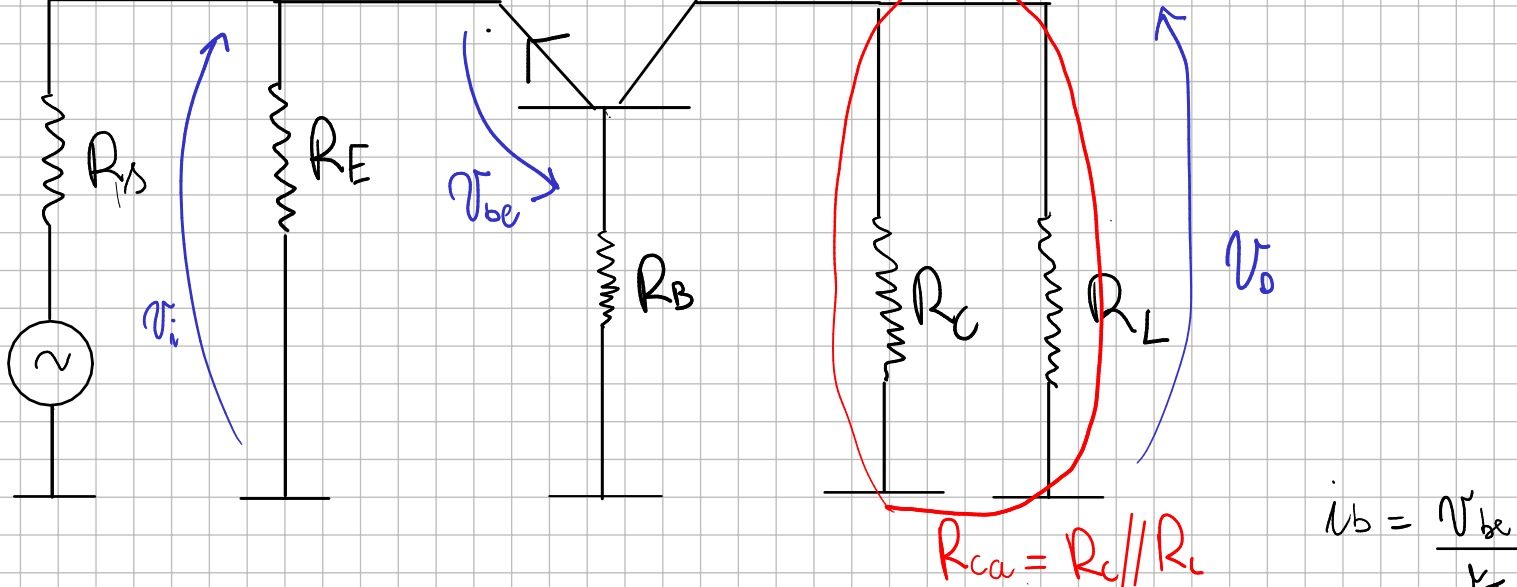
$$R_{oc} = \underbrace{R_E // V_{be}}_{\text{CHIKITO Compende con el otro}} + \boxed{V_D \left(1 + \frac{\beta (R_E // V_{be})}{V_{be} + R_E // R_D} \right)}$$

$$(i_P + i_b) R_E // R_S = -i_b V_{be}$$

$$i_P R_E // R_S = -i_b (V_{be} + R_E // R_D)$$

$$i_b = \frac{-i_P (R_E // R_D)}{V_{be} + R_E // R_D}$$

Base Común (con R_D) (Cmo que esto es Realimentación)



$$A_v = \frac{v_o}{v_i} = \frac{-g_m V_{be} R_{oa}}{-V_{be} - i_b R_D} = \frac{-g_m V_{be} R_{oa}}{-(V_{be} + V_{be} R_D)} = \frac{g_m R_{oa}}{(1 + \frac{R_D}{V_{be}})}$$

$$A_v = \frac{g_m R_{oa}}{g_m (V_{be} + \frac{R_D}{\beta})} = \frac{R_{oa}}{(V_{be} + \frac{R_D}{\beta})} \Rightarrow \text{Confirmamos?} \quad V_{be} = \frac{V_{be}}{\beta} \quad \text{Confirmamos.} \rightarrow \text{ALEX dice que si.}$$

$$R_i = R_{ie} // R_E \quad R_{ie} = \frac{V_E}{i_P} = \frac{i_P (V_{be} + R_D)}{i_P} \quad i_b = i_P / \beta \quad \boxed{R_{ie} = \frac{V_{be} + R_D}{\beta}}$$

$$R_o = R_C // R_L$$

$$R_{oc} = \frac{V_E}{i_P} = \frac{i_P (R_E // R_D) // (V_{be} + R_D) + (i_P - \beta i_b) V_D}{i_P}$$

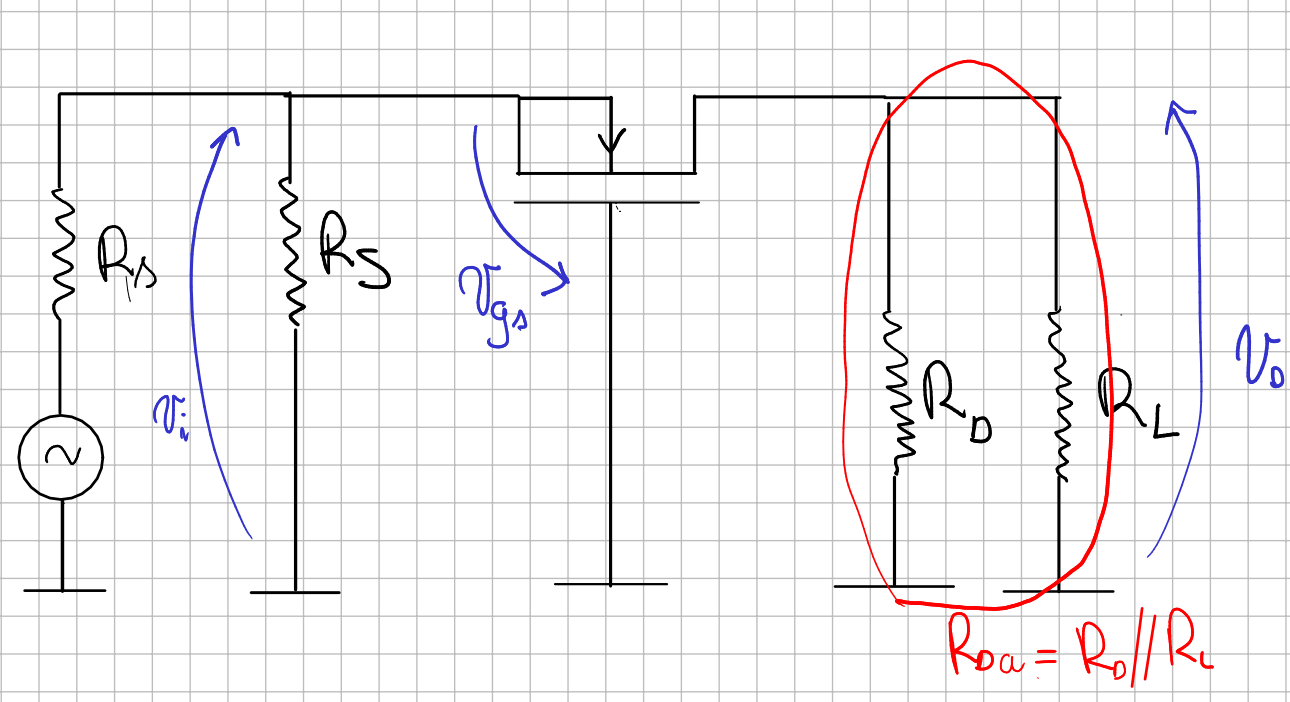
$$R_{oc} = \underbrace{(R_E // R_D) // (V_{be} + R_D)}_{\text{CHIKITO Respecto al otro}} + \boxed{V_D \left(1 + \frac{\beta R_E // R_D}{V_{be} + R_D + R_E // R_D} \right)}$$

$$(i_b + i_P) R_E // R_S = -i_b (V_{be} + R_D)$$

$$i_P R_E // R_S = -i_b (V_{be} + R_D + R_E // R_S)$$

$$i_b = \frac{i_P R_E // R_S}{V_{be} + R_D + R_E // R_S}$$

Gate Común (Sin Realimentación)



$$A_v = \frac{v_o}{v_i} = \frac{-g_m R_{oa}}{-V_{GS}} = \boxed{g_m R_{oa}}$$

$$\beta_{mos} = g_m V_{GS}$$

$$A_v V_s = \frac{A_v R_i}{R_i + R_s} \quad R_i = R_{is} // R_S$$

$$R_{is} = \frac{V_{GS}}{\beta_{mos}} = \frac{V_{GS}}{g_m V_{GS}} = \boxed{\frac{1}{g_m}}$$

$$R_o = R_D // R_L$$

$$R_{oc} = \frac{V_P}{i_P} = \frac{V_{GS} // (R_E // R_S) i_P + (i_P - g_m V_{GS} i_G) V_D}{i_P}$$

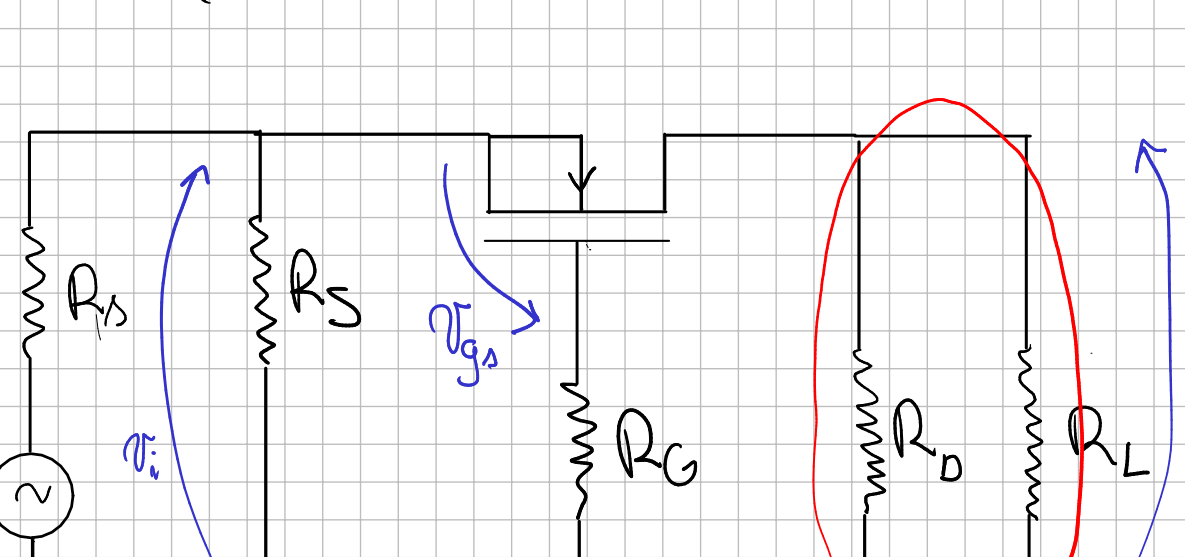
$$(i_P - i_G) R_E // R_S = -i_G V_{GS}$$

$$-i_P R_S // R_S = \frac{-i_G V_{GS}}{V_{GS} + R_S // R_S} = i_G$$

$$= \underbrace{V_{GS} // (R_S // R_S)}_{\text{CHIKITO Respecto A lo otro}} + V_D \left(1 + g_m R_S // R_S \right)$$

$$= \boxed{V_D (1 + g_m R_S // R_S)}$$

Gate Común (Ahora con R_G)



$$A_v = \frac{v_o}{v_i} = \frac{-g_m V_{GS} R_{oa}}{-i_G V_{GS} - i_G R_G} = \frac{-g_m i_G V_{GS} R_{oa}}{-i_G V_{GS} - i_G R_G} = \frac{-g_m V_{GS} R_{oa}}{-V_{GS} - R_G}$$

$$A_v = \frac{R_{oa}}{V_{GS} + \frac{R_G}{\beta}}$$

$$A_v V_s = \frac{A_v R_{in}}{R_{in} + R_s}$$

$$R_{is} = \frac{V_o}{i_P} = \frac{i_P (V_{GS} + R_G)}{i_P} = \frac{1}{g_m} \left(1 + \frac{R_G}{V_{GS}} \right)$$

$$R_{in} = R_{is} // R_S$$

$$R_{oo} = \frac{V_E}{i_P} = i_P \left[\frac{(R_G + V_{GS}) // (R_S // R_S)}{i_P} \right] + (i_P - g_m V_{GS} i_G) V_D$$

$$-i_b R_G = (i_P + i_b) (R_S // R_S + V_{GS})$$

$$i_b = \frac{-i_P R_S // R_S}{R_G + R_S // R_S + V_{GS}}$$

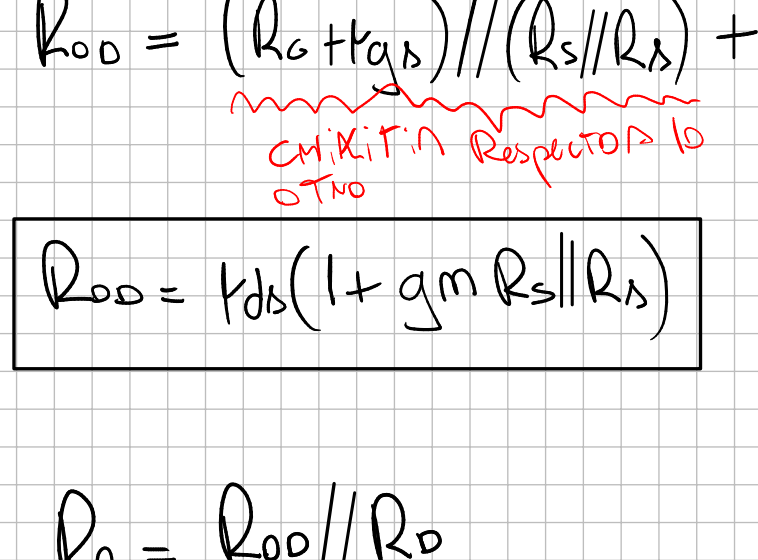
$$R_{oo} = \underbrace{(R_G + V_{GS}) // (R_S // R_S)}_{\text{CHIKITO Respecto al otro}} + V_D \left(1 + g_m R_S // R_S \right)$$

$$\boxed{R_{oo} = V_D (1 + g_m R_S // R_S)}$$

$$R_o = R_{oo} // R_D$$

Collector Común (Este no se como se Realimentar)

(Seguidor por emisor)



$$A_v = \frac{v_o}{v_i} = \frac{g_m V_{be} R_E // R_L}{V_{be} + g_m V_{be} R_E // R_L}$$

$$A_v = \frac{g_m R_E // R_L}{1 + g_m R_E // R_L}$$

$$R_i = R_{ib} // R_B$$

$$A_v V_s = \frac{A_v R_{in}}{R_{in} + R_s}$$

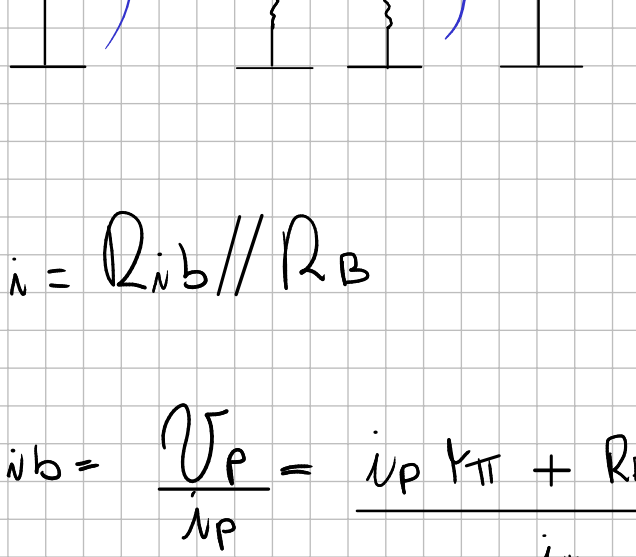
$$R_{ib} = \frac{V_E}{i_P} = \frac{i_P V_{be} + R_E // R_L \beta i_P}{i_P} = V_{be} + R_E // R_L \beta$$

$$R_{oe} = \frac{V_E}{i_P} = \left[i_P V_{be} + i_P \frac{R_E // R_D}{\beta} \right] \cdot \frac{1}{i_P} = \frac{1}{g_m} + \frac{R_E // R_D}{\beta}$$

$$R_o = R_{oe} // R_E$$

Drain Común (Lo mismo que Antes)

(Seguidor por Source?)



$$A_v = \frac{v_o}{v_i} = \frac{g_m V_{GS} R_{sa}}{V_{GS} + g_m V_{GS} R_{sa}}$$

$$A_v = \frac{V_o}{V_i} = \frac{g_m R_{sa}}{1 + g_m R_{sa}}$$

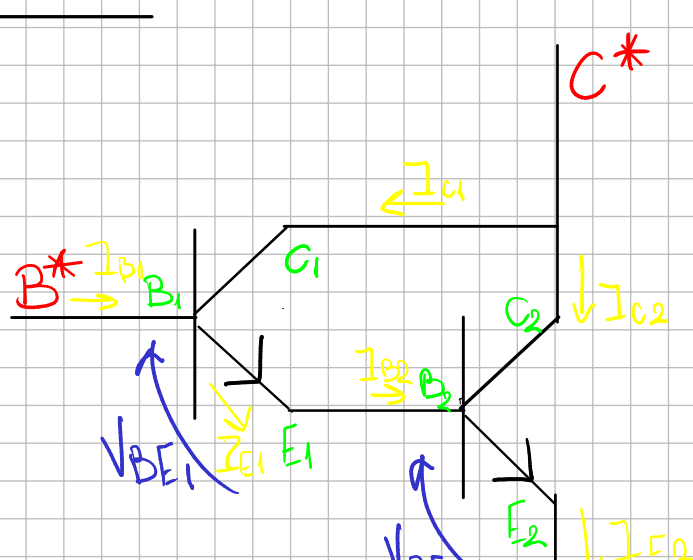
$$R_i = R_{ic} // R_C$$

$$R_{ic} = \frac{V_E}{i_P} = \frac{V_{GS} i_P + g_m R_{sa} i_P}{i_P} = V_{GS} (1 + g_m R_{sa})$$

$$R_o = R_{os} // R_S$$

$$R_{os} = \frac{V_E}{i_P} = \frac{i_P \frac{V_{GS} + R_G // R_S}{V_{GS} g_m}}{i_P} = \frac{V_{GS} + R_G // R_S}{V_{GS} g_m} = \boxed{\frac{1 + R_G // R_S}{g_m \cdot V_{GS} g_m}}$$

Darlington!!



$$I_C^* = I_{C1} + I_{C2} = I_{C2}$$

$$I_E^* = I_{E2}$$

$$I_B^* = I_{B1}$$

$$I_{B2} = I_{E1} \approx I_{C1}$$

$$I_{C2} \approx \beta I_{C1} \Rightarrow I_{C1} + I_{C2} \approx I_{C2}$$

$$\text{Paramod en Ambos Transistors} \Rightarrow V_{BE1} = 0.7V, V_{BE2} = 0.7V$$

$$\Rightarrow V_{BE}^* = 1.4V$$

Paso A Hojas Negras, Bim H. Jode para, lo sé

