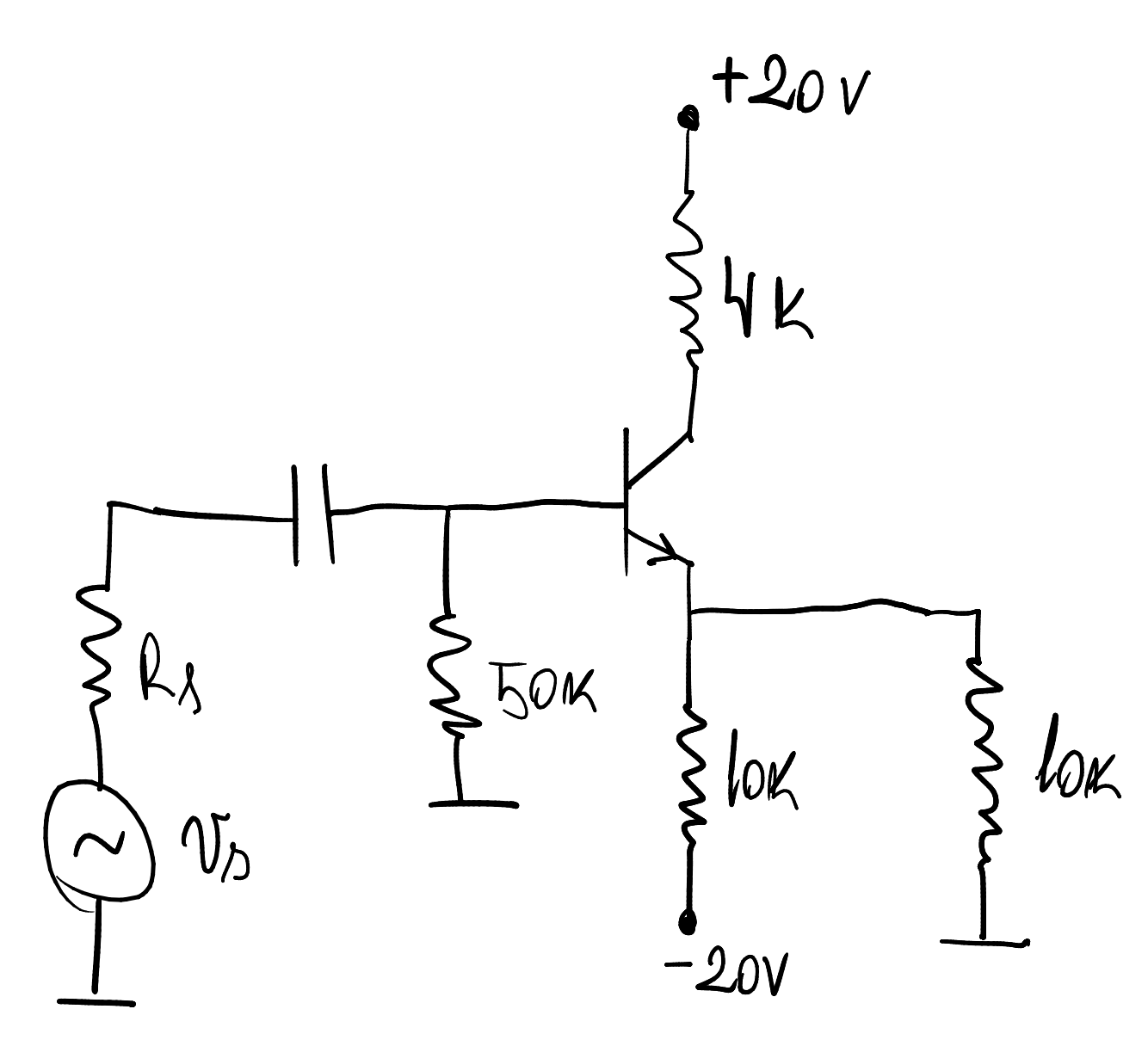
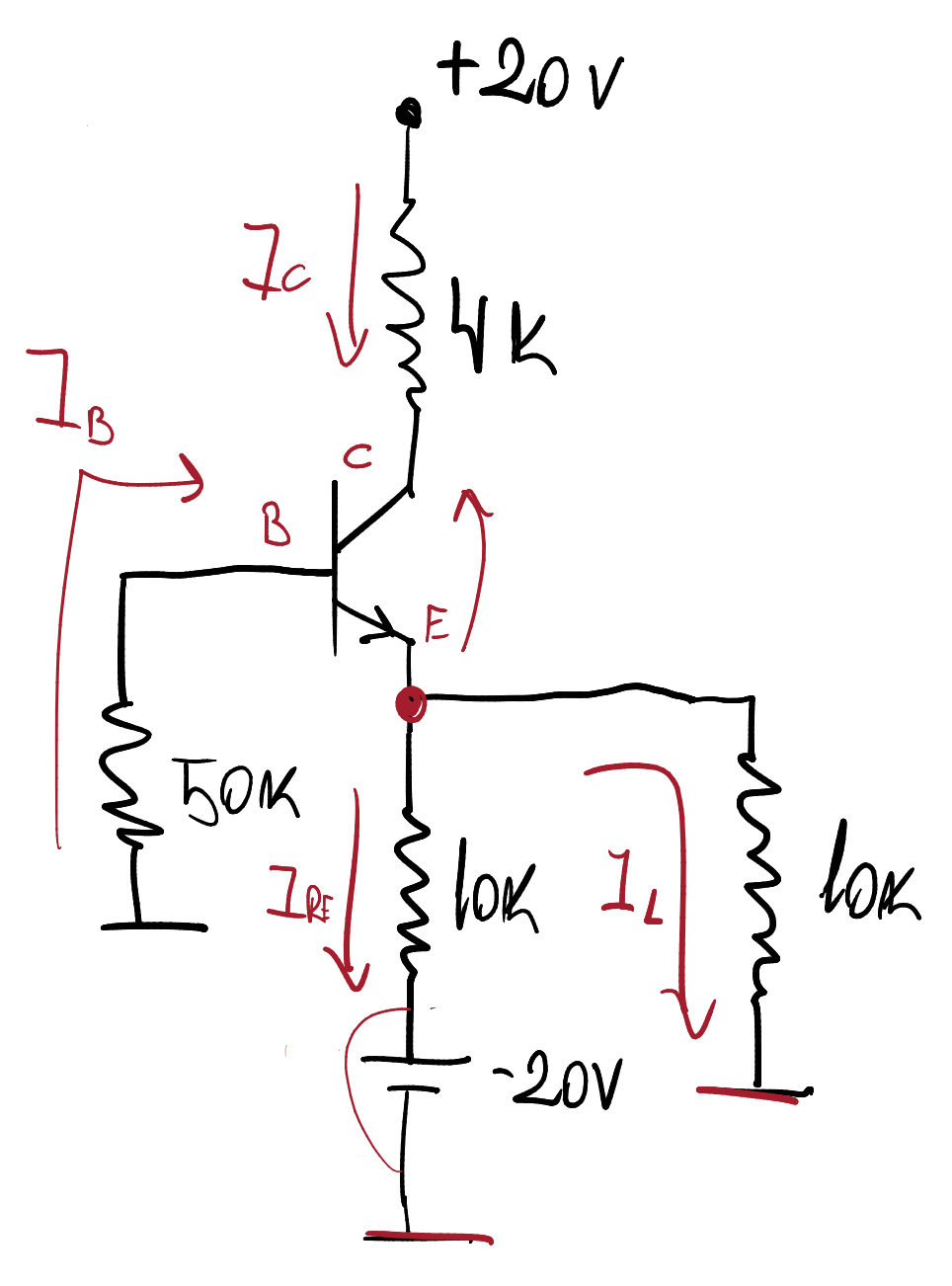


TBJ: BC548B

$R_s = 2K$

a) determinar la ubicación del punto Q indicando las tensiones de los tres electrodos contra común.
b) Dibujar el circuito de señal sin reemplazar el transisitor por su modelo. Determinar las expresiones de Rib; Ri; Roc; Ro; Av y Avs, y calcularlas. Indicar como se las puede obtener por simple inspección.
c) Trazar las rectas de carga estática y dinámica en el plano Ic - Vce. Determinar el valor de Vomax(pico) obtenible sin recorte en ninguno de los dos semiciclos.
NOTA: Tener en cuenta que siempre los calculos de deben ser efectuados con una tolerancia de alrededor de un 10%. Simplificarlos de acuerdo con ello.



$I_E = I_C + I_B$ $\qquad I_E = I_L + I_{RE}$

$20 - I_C 4K - V_{CE} - I_L 10K = 0$

$20 - I_C 4K - V_{CE} - I_{RE} 10K + 20 = 0$

$50K I_B - V_{BE} - I_L 10K$

$50K I_B - V_{BE} - I_{RE} 10K + 20 = 0$

Asumimos MAD

$I_C = \beta I_B$ y $V_{BE} = 0{,}7V$

$20 - \beta I_B 4K - V_{CE} - I_L 10K = 0$

$20 - \beta I_B 4K - V_{CE} - I_{RE} 10K + 20 = 0$

$50K I_B - 0{,}7 - I_L 10K = 0$

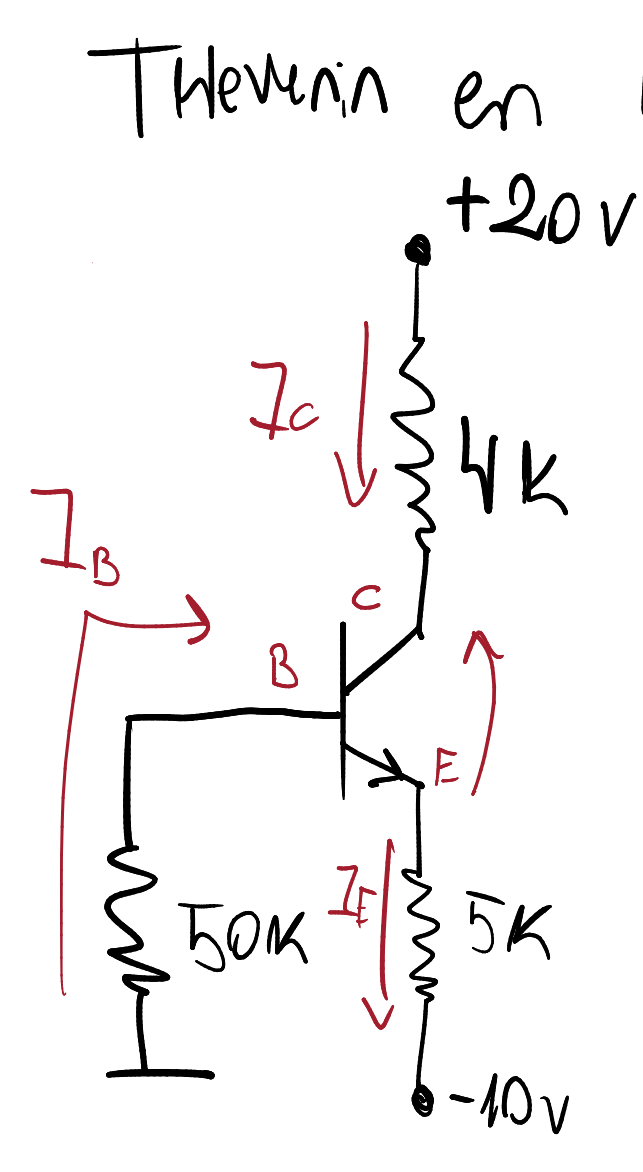
$50K I_B - 0{,}7 - I_{RE} 10K + 20 = 0$

① V_{CE}	② I_B	③ I_L	④ I_{RE}	
$+V_{CE}$	$+\beta I_B 4K$	$+I_L 10K$	$+0$	$=20$
V_{CE}	$+\beta I_B 4K$	$+0$	$+I_{RE}10K$	$=40$
0	$+I_B 50K$	$-I_L 10K$	$+0$	$=0{,}7$
0	$+I_B 50K$	$+0$	$-I_{RE}10K$	$=-19{,}3$

BC546B/547B/548B | | 200 | 290 | 450

Tomando $\beta = 290$

Thevenin en Emisor



$20 - 4K \overbrace{I_C}^{\beta I_B} - V_{CE} - 5K \overbrace{I_E}^{I_B(\beta+1)} + 10 = 0$

$50K I_B - \underbrace{V_{BE}}_{0{,}7} - 5K \overbrace{I_E}^{I_B(\beta+1)} + 10 = 0$

$30 - 4K\beta I_B - V_{CE} - 5K(\beta+1) I_B = 0$

$30 - V_{CE} - I_B\left(4K\beta + 5K(\beta+1)\right) = 0$

$V_{CE} = 30 - I_B\left(4K\beta + 5K(\beta+1)\right)$

$V_{CE} = 12{,}63V$

$V_{CE} > V_{CE(sat)} = 0{,}7$

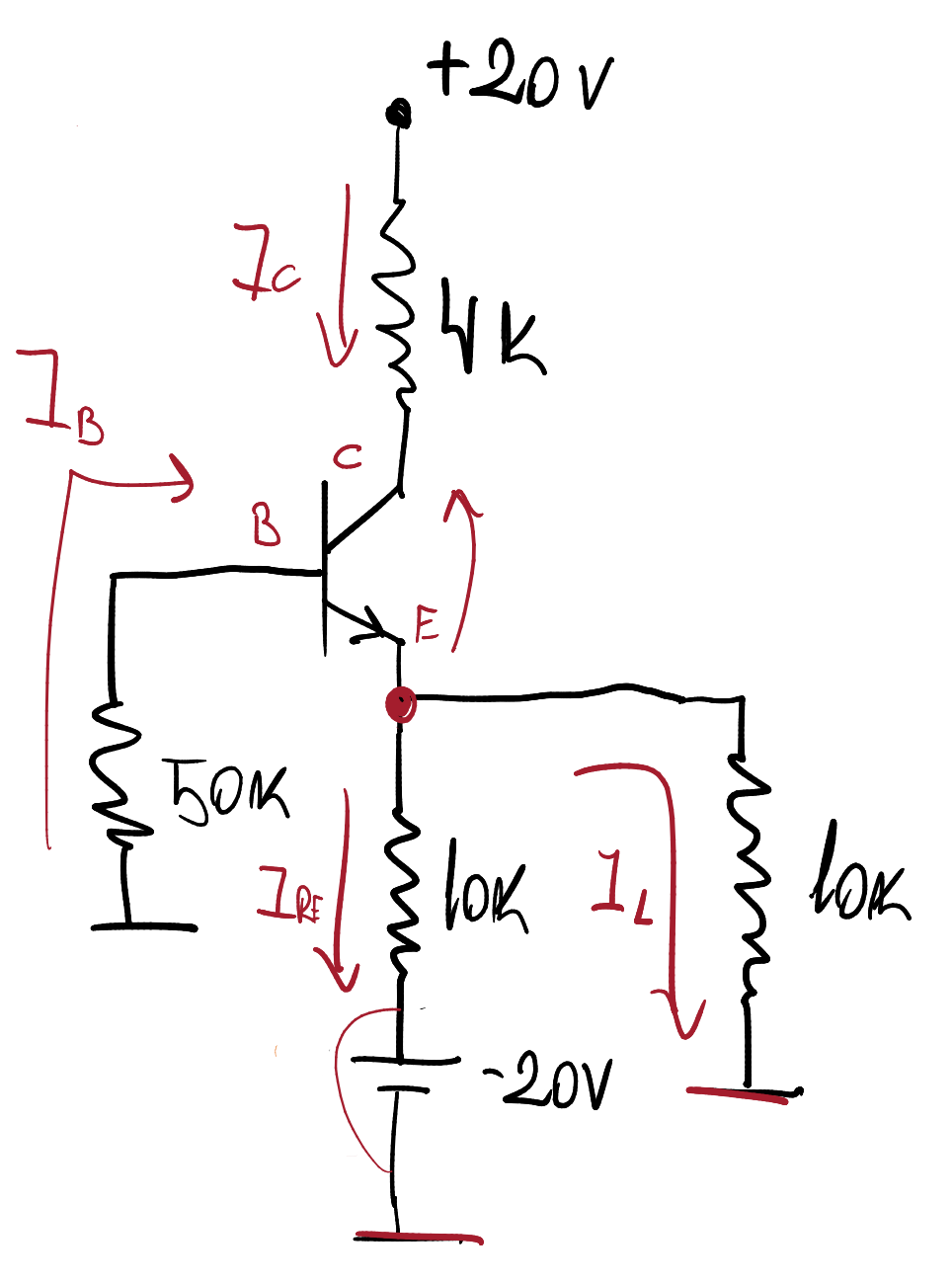
$50K I_B - 5K(\beta+1) I_B + 9{,}3 = 0$

$9{,}3 + I_B\left(50K - 5K(\beta+1)\right) = 0$

$I_B = \frac{-9{,}3}{50K - 5K(\beta+1)} = 6{,}6\mu A$

$I_C = 1{,}9mA$

Volvemos Al circuito sin Simplificar



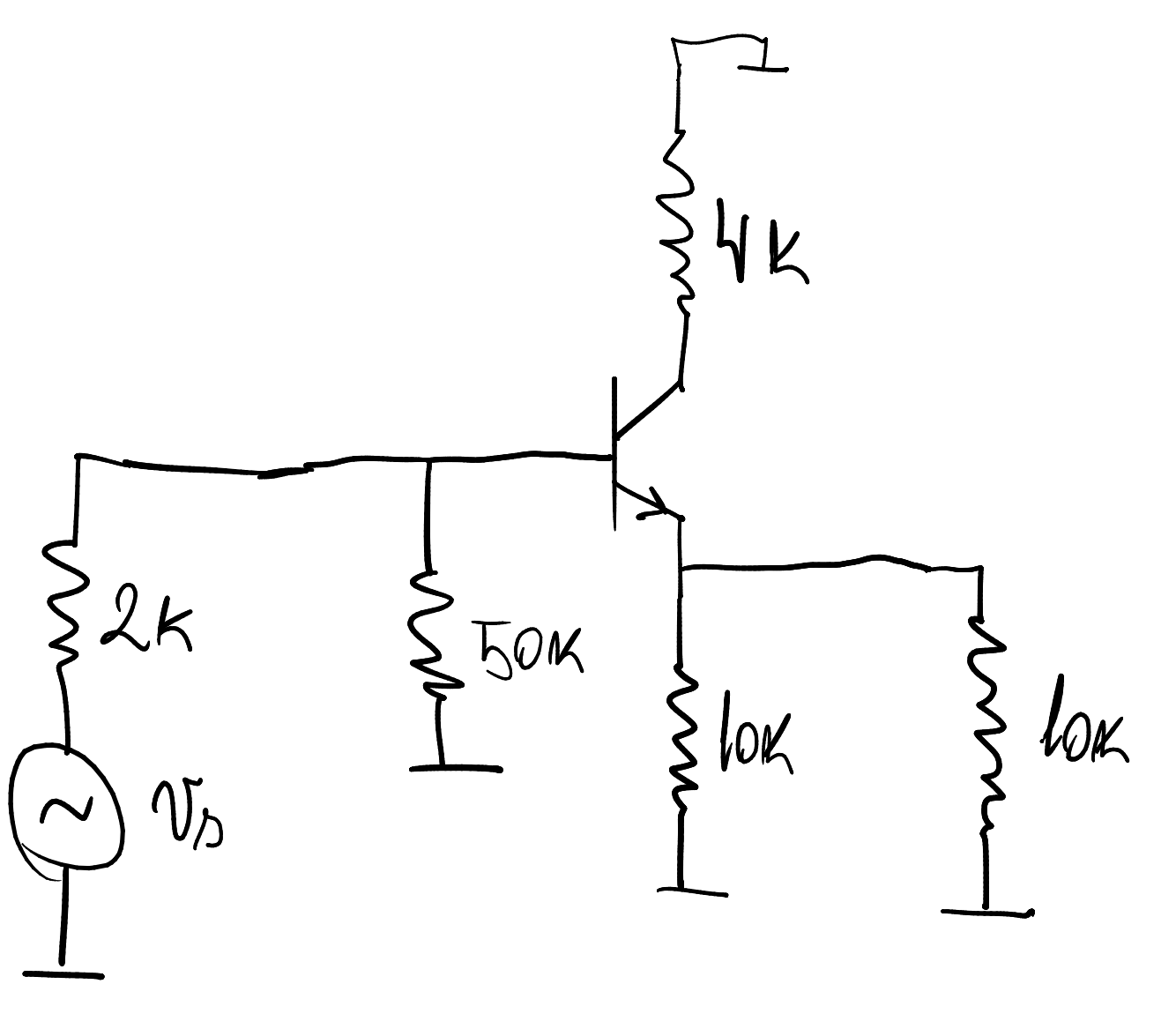
$I_{RE} + I_L = I_E$

$20 - 4K I_C - V_{CE} - 10K I_L = 0$

$I_L = \frac{20 - 4K I_C - V_{CE}}{10K}$

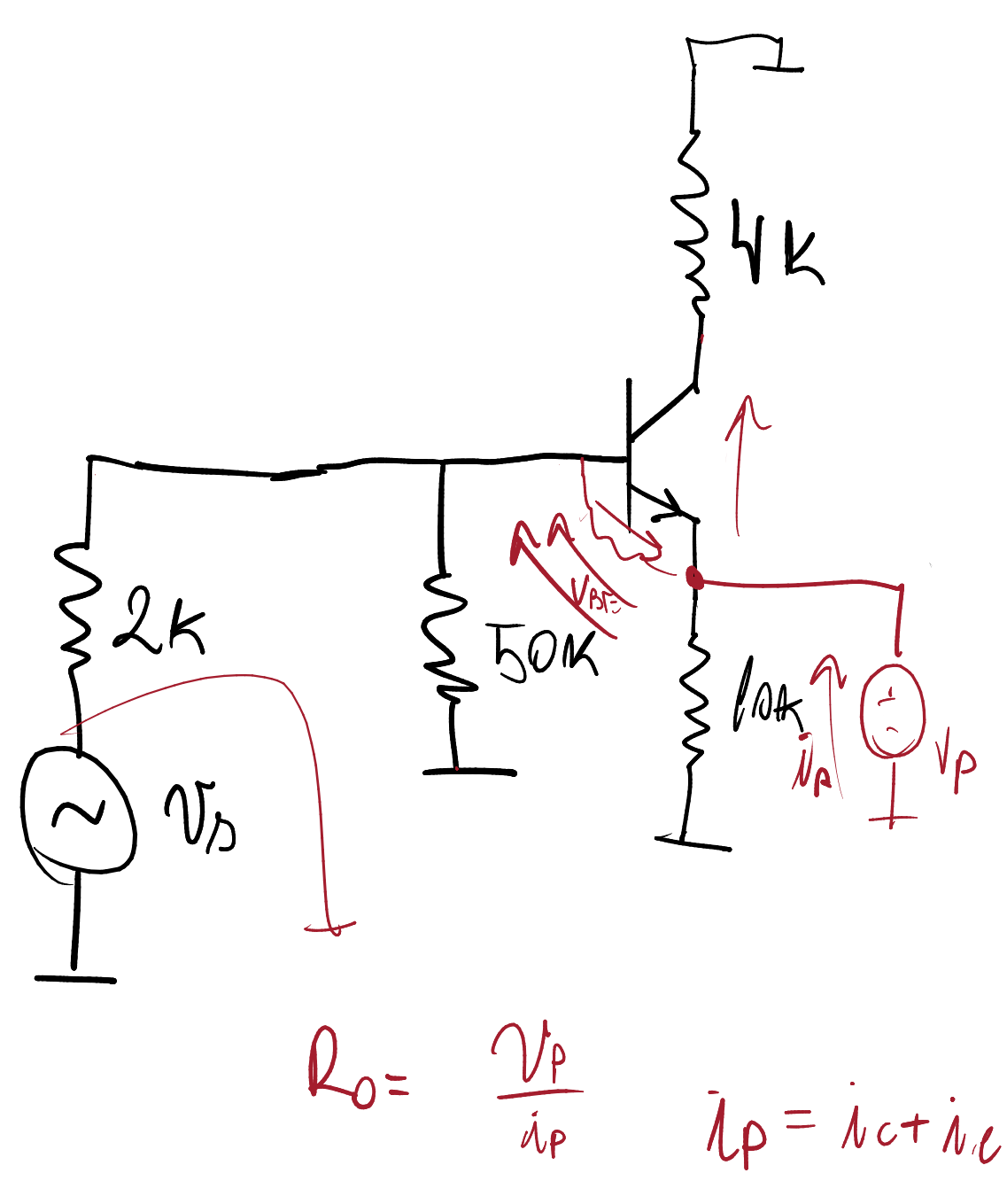
$I_L = -23\mu A$

$I_{RE} = I_E - I_L = 1{,}923mA$



$g_m = 0{,}1$

$r_\pi = 2590$



$R_{IB} = 1{,}3M\Omega$

$R_I = R_B // R_{IB} = 48K\Omega$

$R_{OC} \longrightarrow \infty$ Preguntar A ozcapcito Habia que considerar r_o

$V_{BE} < 0$

$\frac{r_\pi}{r_\pi + 2k} V_p$

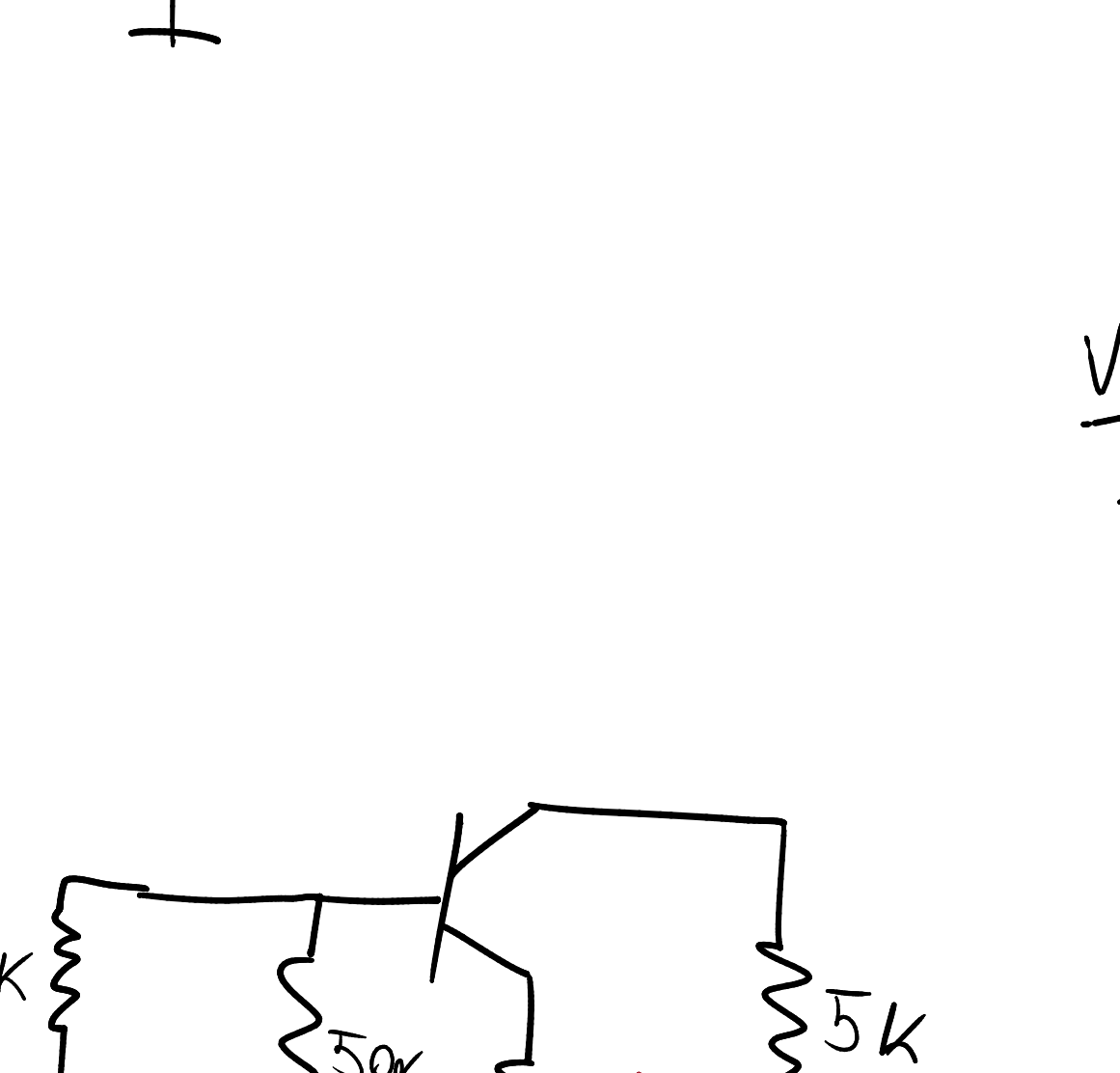
$g_m V_{BE}$

$R_o = \frac{V_p}{i_p}$ $\qquad i_p = i_c + i_e + i_{r\pi}$

$R_o = 17\Omega$

$i_p = \frac{V_p}{10K} + g_m \frac{r_\pi}{r_\pi 2K} V_p + \frac{V_p}{r_\pi + 2K}$

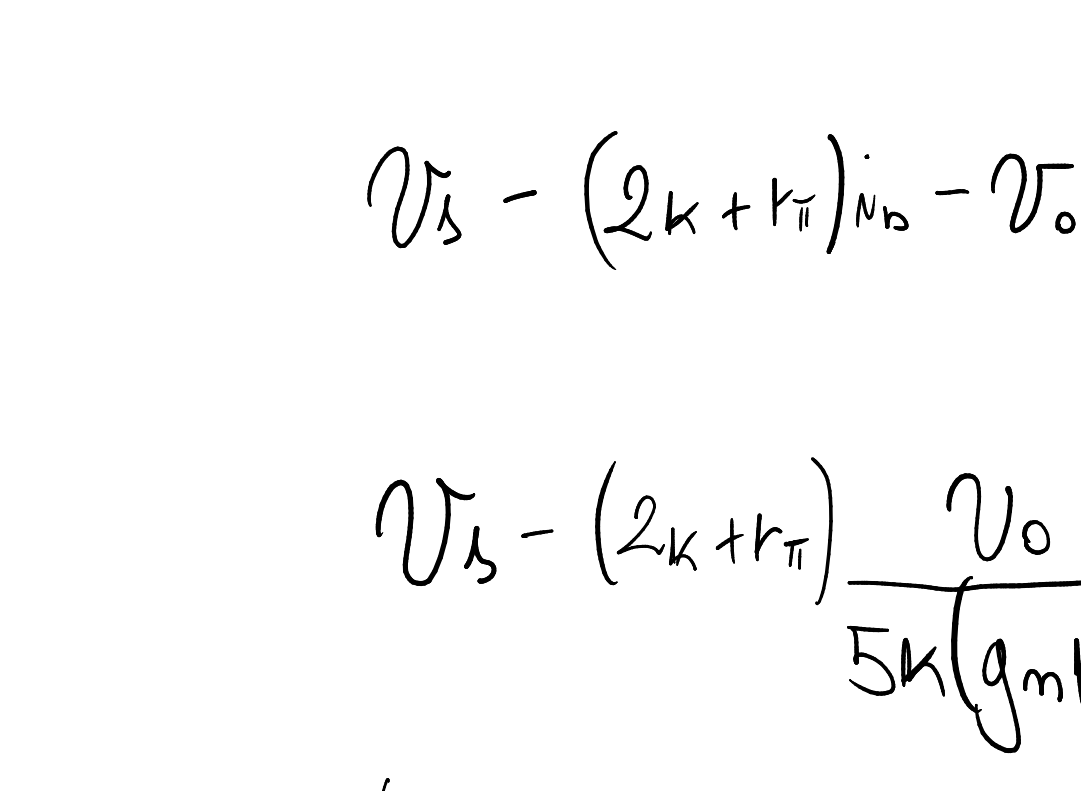
$\left(1/_{10K} + g_m \frac{r_\pi}{r_\pi 2K} + \frac{1}{r_\pi + 2K}\right)^{-1}$



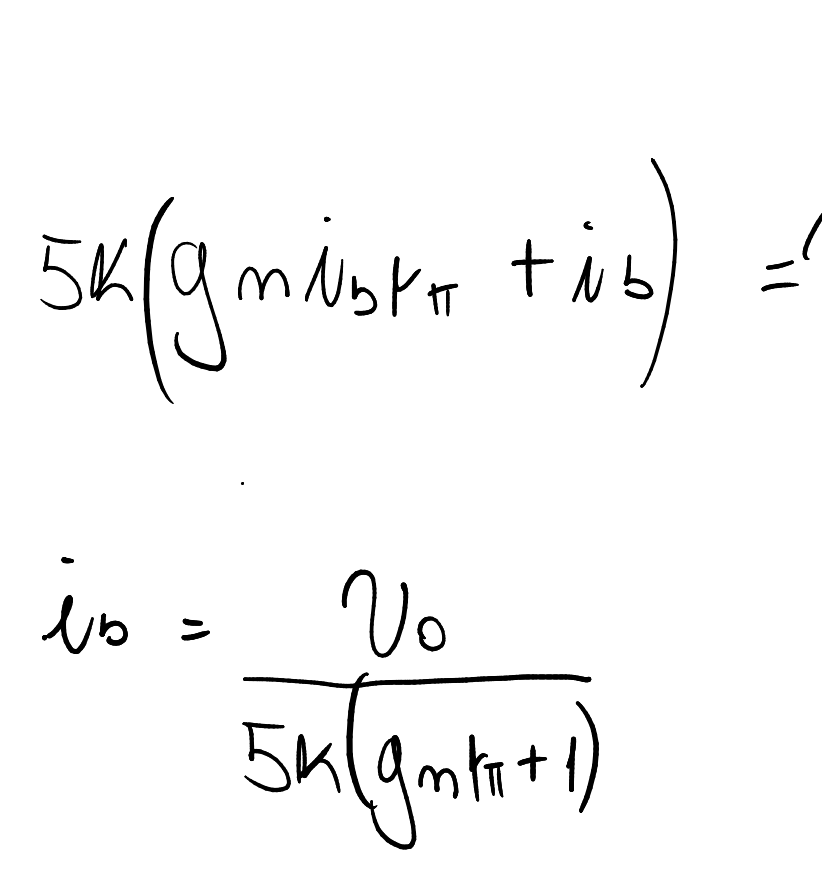
$V_p - I_p r_\pi - I_E 5K = 0$ Está Bien?

$g_m I_p r_\pi + I_p = I_E = I_p(g_m r_\pi + 1) 5K$

$\frac{V_p}{I_p} = (r_\pi + g_m r_\pi 5K + 5K) = 1{,}3M\Omega = r_{ib}$



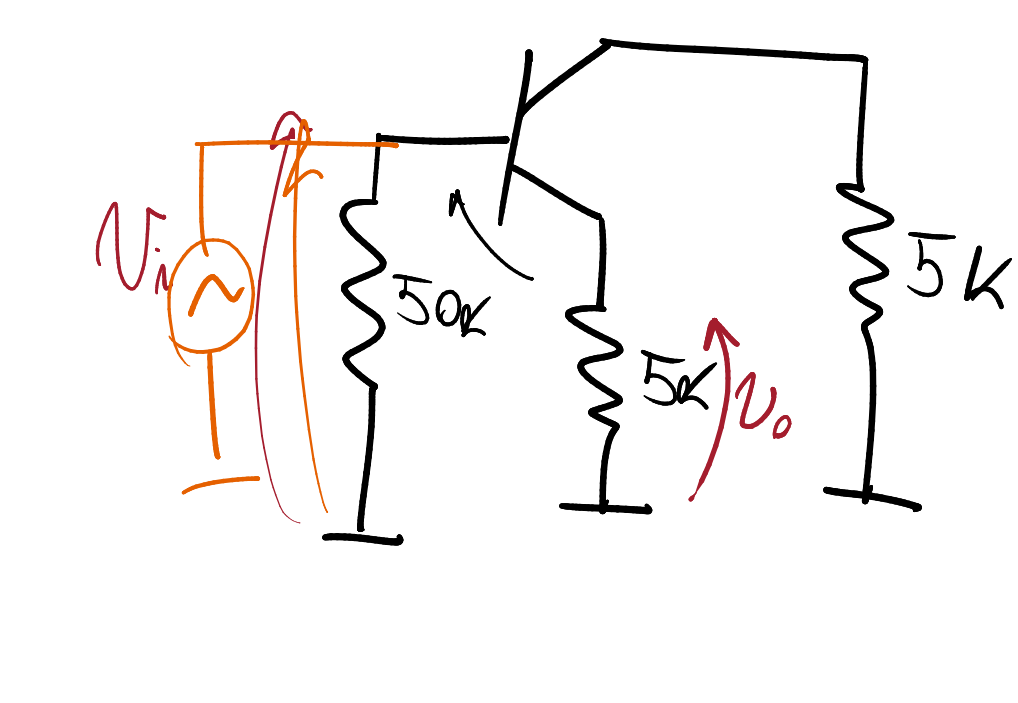
$\equiv$



$V_s - (2K + r_\pi) i_b - V_o = 0$ $\qquad 5K(g_m i_b r_\pi + i_b) = V_o$

$V_s - (2K + r_\pi)\frac{V_o}{5K(g_m r_\pi + 1)} - V_o = 0$ $\qquad i_b = \frac{V_o}{5K(g_m r_\pi + 1)}$

$\frac{V_o}{V_s} = \left(\frac{2K + r_\pi}{5K(g_m r_\pi + 1)} + 1\right)^{-1} = 0{,}996 = AV_s$



$V_i = V_{BE} + V_o$

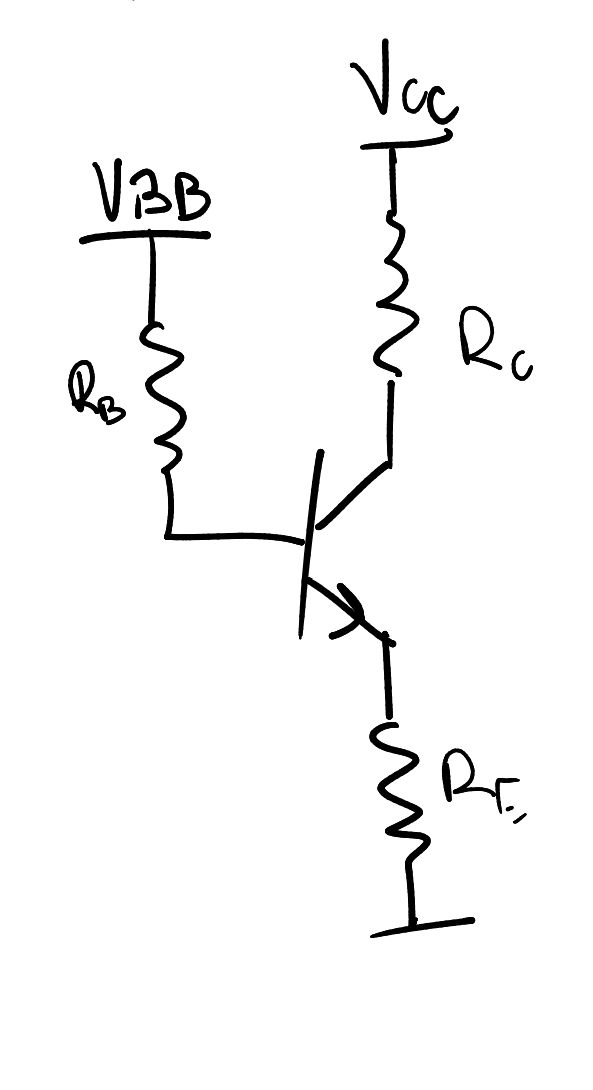
$Av = \frac{V_o}{V_i} = \frac{i_e 5K}{i_b r_\pi + i_e 5K}$

$i_e = (1 + g_m r_\pi) i_b$

$Av = \frac{(1 + g_m r_\pi) 5K}{r_\pi + (1 + g_m r_\pi) 5K} = 0{,}998$

Diseño de nuestro Super Amplificador ($A_V > 20$)

NPN



$i_C = 1mA$

V_A No existe

$\beta i_b = i_c$

$V_{BB} - i_b R_B - \overbrace{V_{BE}}^{0,7} - R_E(i_B + i_C) = 0$

$V_{BB} - i_b R_B - V_{BE} - R_E i_B(1+\beta) = 0$

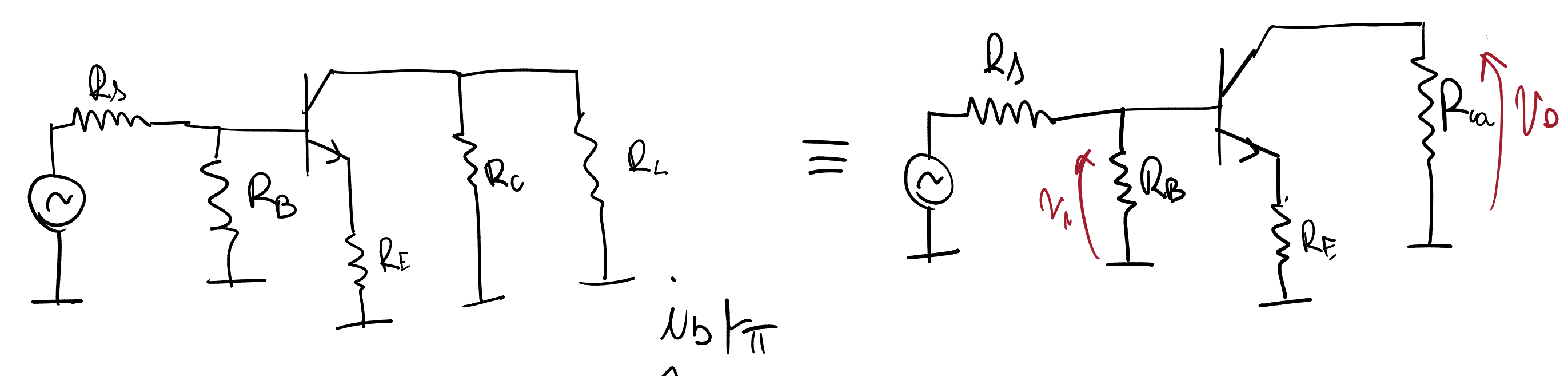
$\dfrac{\overbrace{V_{BB} - 0,7}^{10}}{\underbrace{R_B + R_E(1+\beta)}_{10^7}} = i_b$ (R_B: 10^7; $R_E(1+\beta)$: $10^2 \cdot 10^2 = 10$)

$i_c \approx 1mA$

$r_\pi = \dfrac{\beta}{g_m} \approx 0,039$

$200 < \beta < 450$

$\beta + 125\%$



$A_V = \dfrac{v_o}{v_i} = \dfrac{-g_m \overbrace{v_{be}}^{i_b r_\pi} R_{ca}}{i_E R_E + \underbrace{v_{be}}_{i_b r_\pi}}$

$i_E = i_b + g_m i_b r_\pi$

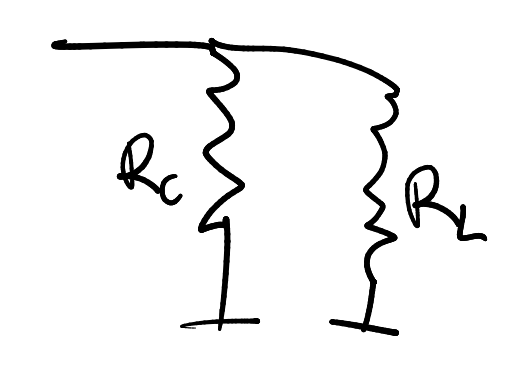
$i_E = i_b(1 + \underbrace{g_m r_\pi}_{\beta})$

$= \dfrac{-i_b g_m r_\pi R_{ca}}{i_b((1+\beta)R_E + r_\pi)} = \dfrac{\overbrace{g_m r_\pi}^{\beta} R_{ca}}{((1+\beta)R_E + r_\pi)} = \dfrac{\beta R_{ca}}{(\beta+1)R_E + r_\pi}$

→ Primero sin carga. $r_\pi = \dfrac{\beta}{g_m}$

$\Rightarrow \dfrac{R_{ca}}{\underbrace{\dfrac{(\beta+1)}{\beta}}_{\approx 1} R_E + \dfrac{r_\pi}{\beta}} \quad \left(\dfrac{r_\pi}{\beta} \to \dfrac{1}{g_m}\right) = \dfrac{R_{ca}}{R_E + 26,3} = \dfrac{R_{ca}}{R_E} = 20 = A_V$

$R_E = 100$ $\qquad R_{ca} = 2K$



$R_C // R_L$ $\qquad R_L = 4K \quad R_C = 4K$

$R_{ceq} = 2K$

$R_E = 100$ $\qquad R_C = 4K$ ⇝ $A_V > 20$ $\quad R_L \geq 4K$

$R_B = ?$ $\qquad V_{BB} = ?$ $\qquad V_{cc} = ?$

$\dfrac{V_{BB} - 0,7}{R_B + R_E(1+\beta)} = i_b \Rightarrow \dfrac{\beta(V_{BB} - 0,7)}{R_B + R_E(1+\beta)} = i_c$

$\Rightarrow \dfrac{(V_{BB} - 0,7)}{\dfrac{R_B}{\beta} + R_E \dfrac{(1+\beta)}{\beta}} \approx \dfrac{\overbrace{(V_{BB} - 0,7)}^{10}}{\dfrac{R_B}{\beta} + R_E} = 1mA$ ($\dfrac{(1+\beta)}{\beta} \to 1$; R_B: 10^6; β: 10^2)

$V_{BB} = 10$ y $R_B = 1M$ $\qquad V_{cc} = 15$

$V_{cc} - \underbrace{I_c R_c}_{4V} - V_{CE} - \underbrace{I_B(\beta+1)R_E}_{0,1V} = 0$