$\beta_F = 150$

$V_A \to \infty$

2) C-7. Dado el circuito de la figura: TBJ: BC558**B** ; $|V_{CEK}| = 0{,}7V$; $I_{C\,mín} = 0{,}2mA$

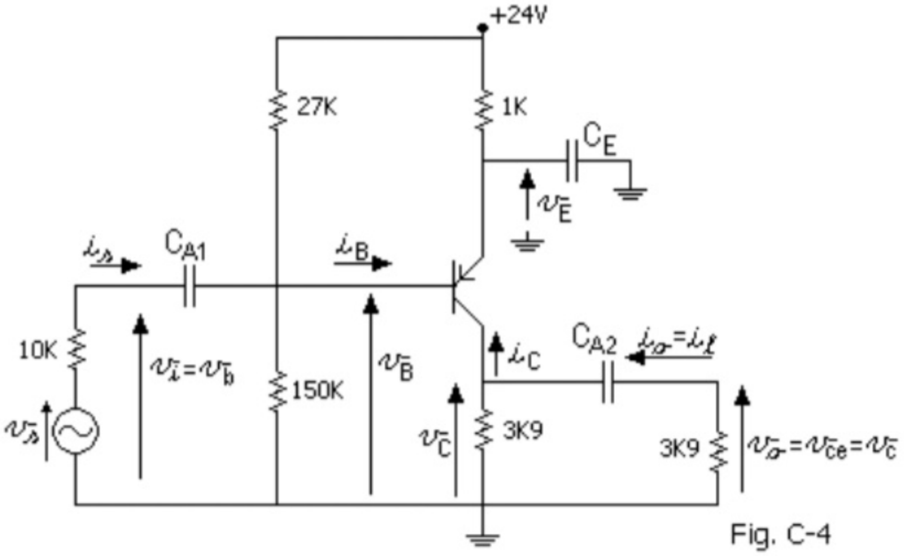
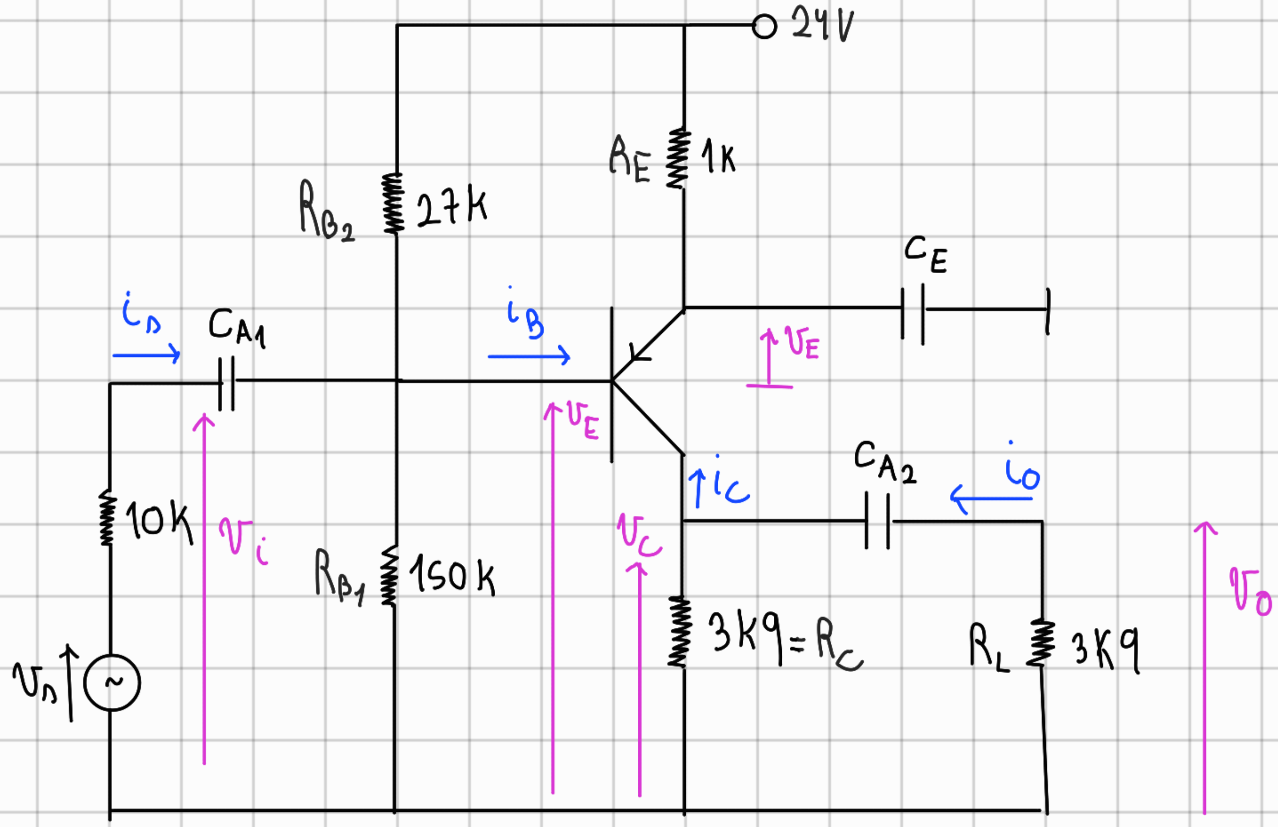


Fig. C-4

a) Determinar el punto Q, indicando las tensiones de los electrodos del transistor contra común.

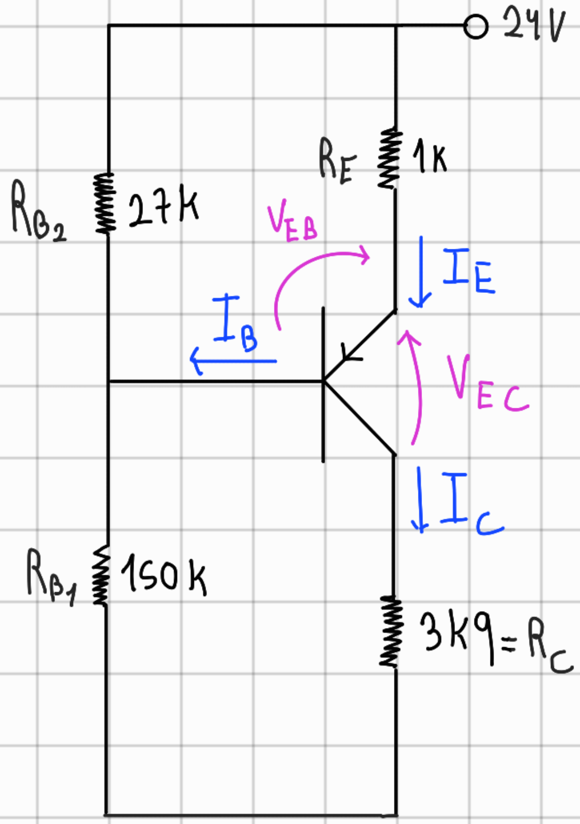
b) Hallar A_v y A_{vs}. Determinar las impedancias de entrada y salida.

c) Hallar la máxima excursión $\hat{V}_{ce_{máx}}$ obtenible y el máximo $\hat{V}_{s_{máx}}$ para que no haya recorte.



2)

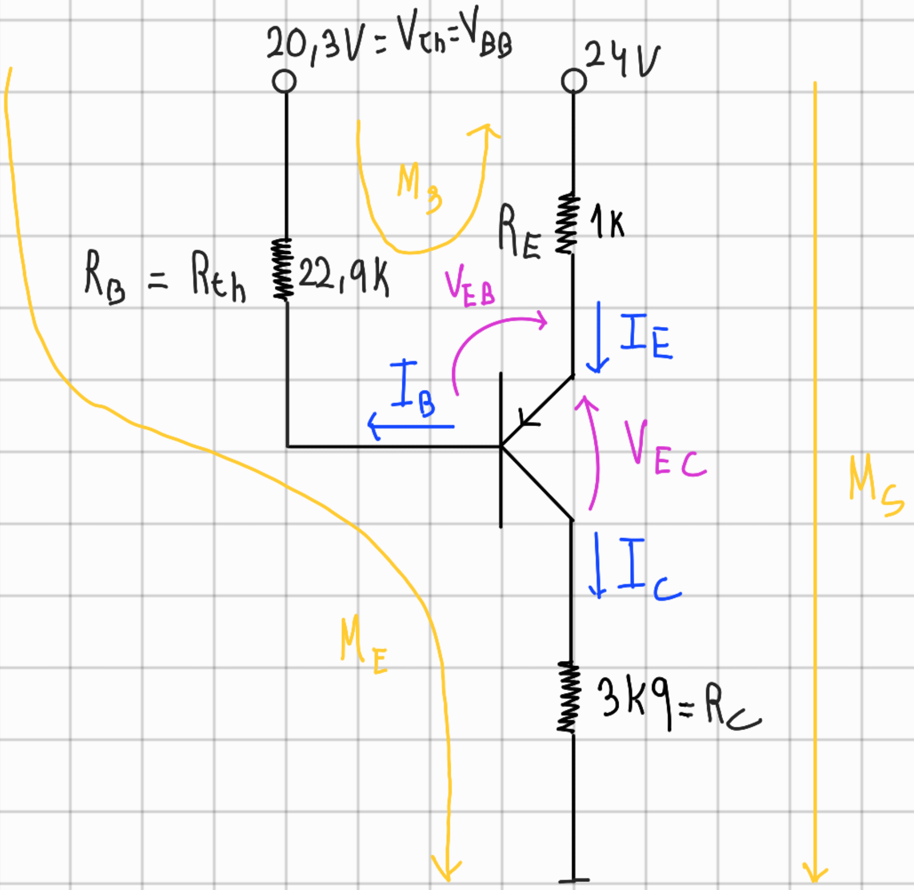
Polarización



Thevenin

$$V_{th} = 24V \cdot \frac{R_{B1}}{R_{B_2}+R_{B_1}} \simeq 20{,}3\,V$$

$$R_{th} = R_{B_1} // R_{B_2} \simeq 22{,}9\,K\Omega$$



$M_E)$ $V_{BB} + R_B . I_B - I_C . R_C = 0$ (1)

$M_S)$ $24 - I_E R_E - V_{EC} - I_C R_C = 0$ (2)

$M_3)$ $V_{BB} + R_B . I_B + V_{EB} + I_E . R_E = 24V$ (3)

Supongo MAD $(V_A \to \infty)$

→ $V_{EB} = 0,7\,V$, $I_E \approx I_C$

→ Desprecio el efecto early : $I_C = \beta_F \cdot I_B$

$\beta_F = 150$

De (3)

$$V_{BB} + R_B \cdot I_B + V_{EB} + I_C \cdot R_E = 24V$$

$$20{,}3V + 22{,}9K\Omega \cdot \frac{I_C}{\beta_F} + 0{,}7V + I_C \cdot 1K = 24V$$

$$I_C = \frac{24V - 20{,}3V - 0{,}7V}{\left(1K\Omega + \frac{22{,}9K\Omega}{150}\right)} = 2{,}6\,mA$$

De (2)

$$24V - I_C \cdot R_E - V_{EC} - I_C \cdot R_C = 0$$

$$V_{EC} = 24V - 2{,}6\,mA \cdot 1K - 2{,}6\,mA \cdot 3{,}9K\Omega = 11{,}26\,V$$

Verifico MAD

$V_{CE} > V_{CE(sat)} = 0{,}7V$ ✓

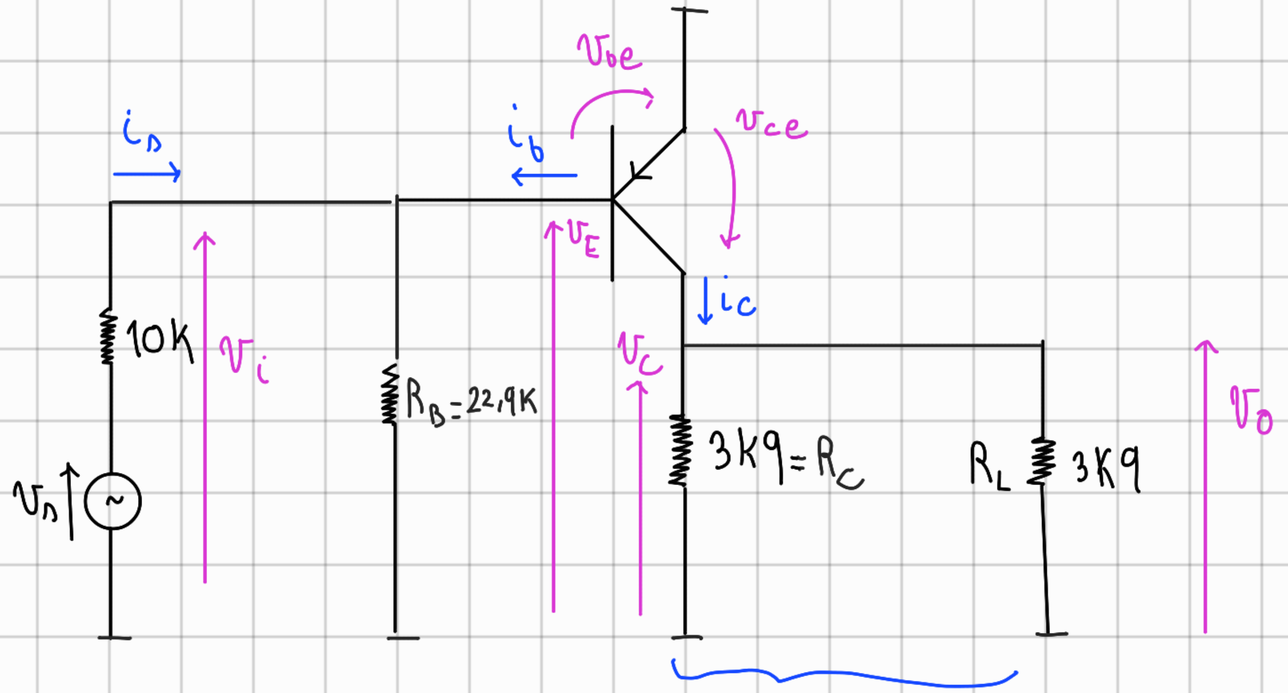
$$\Rightarrow \boxed{(V_{EC}, I_C) = (11{,}26V, 2{,}6\,mA)}$$

b)

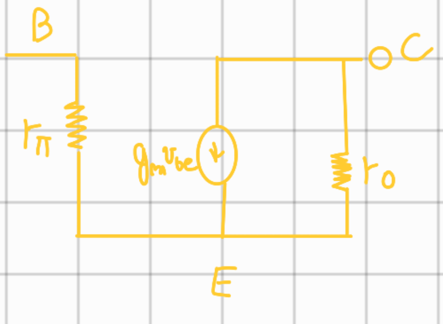
Señal

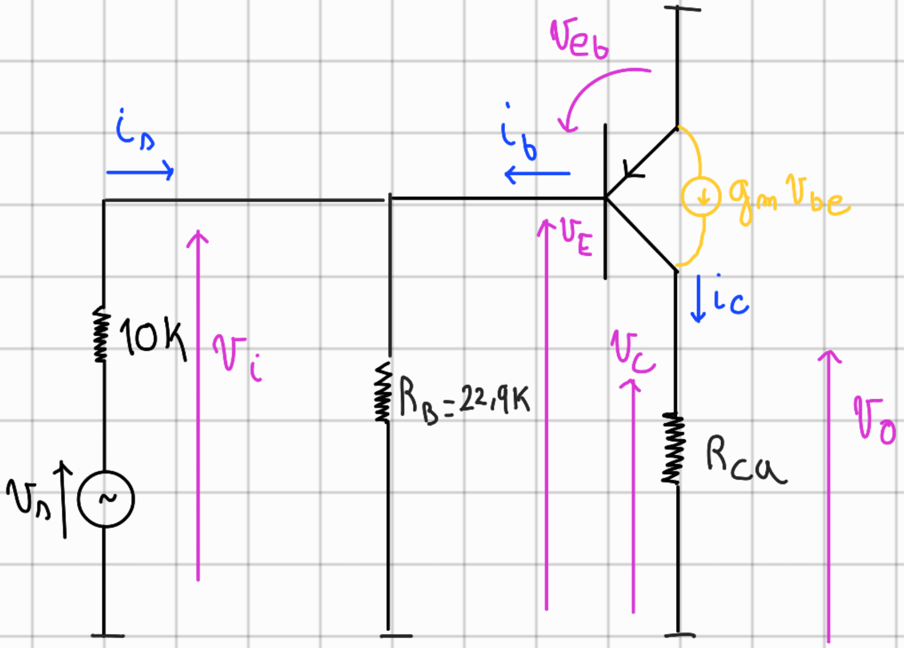
- $r_x = 0$
- $g_m = \left.\dfrac{dI_C}{dV_{EC}}\right|_Q = \left.\dfrac{i_c}{v_{EC}}\right|_Q = \dfrac{I_C}{V_T} = \dfrac{2{,}6\,mA}{25{,}9\,mV} = 100\,\dfrac{mA}{V}$
- $r_\pi = \dfrac{\beta}{g_m} = \dfrac{150}{100\,\frac{mA}{V}} = 1{,}5\,K$
- $r_o \longrightarrow \infty \quad (V_A \longrightarrow \infty)$

Uso punto $Q = (-11{,}26V \,;\, -2{,}6\,mA)$



$R_{ca} = R_C // R_L = 1{,}95\,K$





$$v_i = v_s \,.\, T_i = v_s \frac{R_B}{R_B + R_s} \cong v_s \,.\, 0,7$$

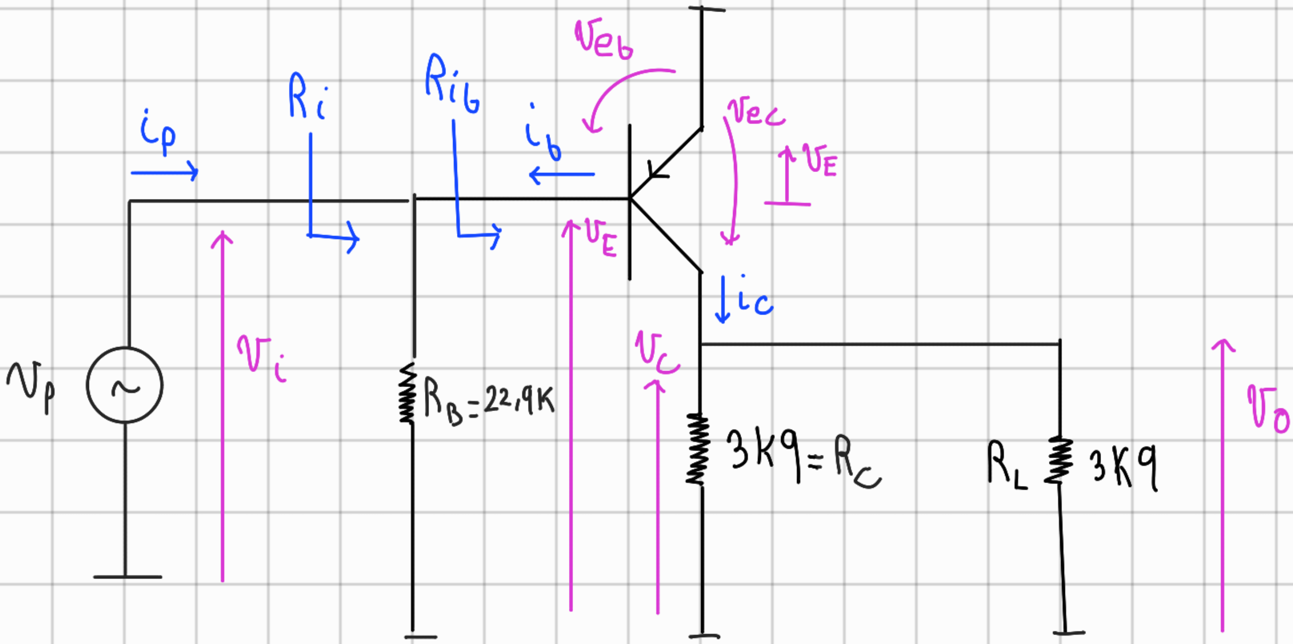
$(R_{ca} // r_o) = R_{ca}$ pues $r_o \to \infty$

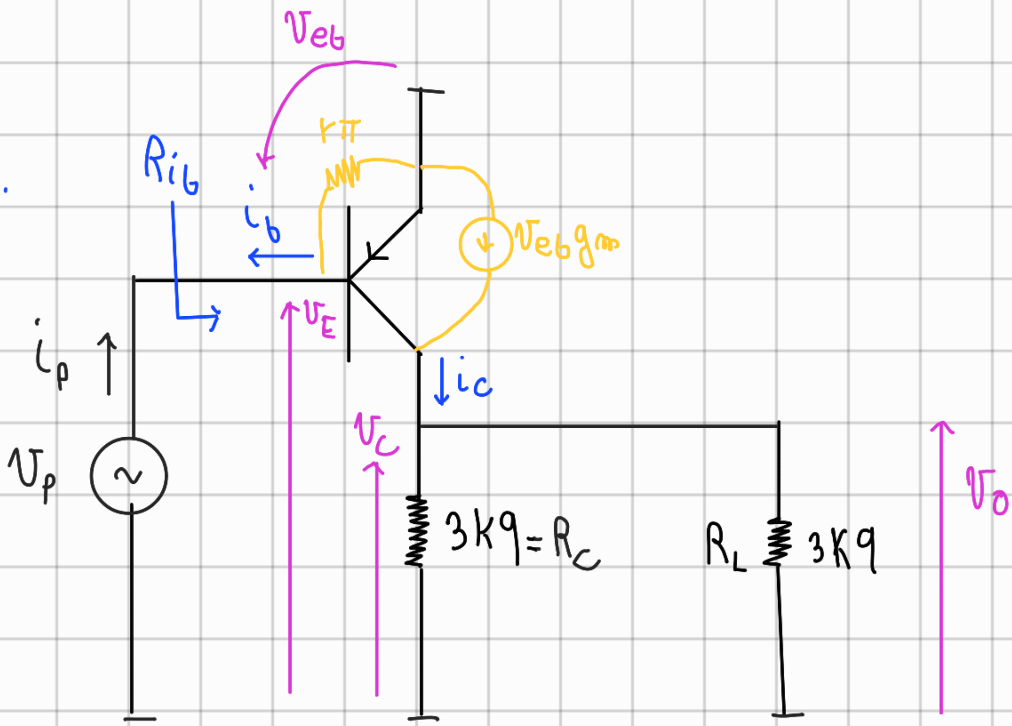
$$A_v = \frac{v_o}{v_i} = \frac{i_c \,.\, R_{ca}}{v_i} = \frac{-g_m v \;.\, R_{ca}}{v} = -g_m R_{ca} = -195$$

$$A_{v_s} = \frac{v_o}{v_s} = \frac{v_o}{\frac{v_i}{T_i}} = -g_m R_{ca} \,.\, T_i = -136,5$$

$$\Rightarrow \boxed{A_v = -195 \,, \quad A_{v_s} = -136,5}$$

Resistencia de entrada R_i

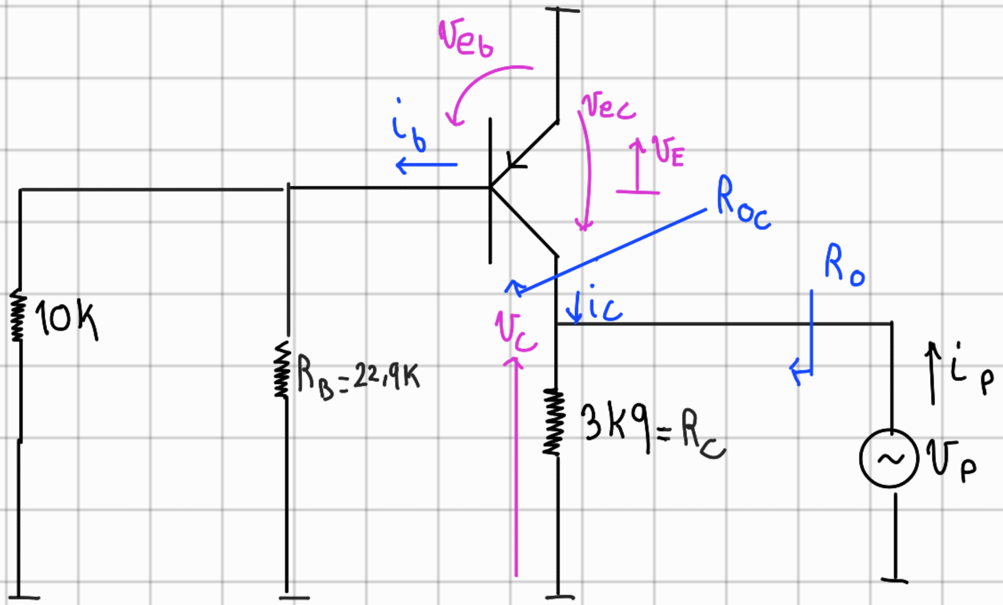


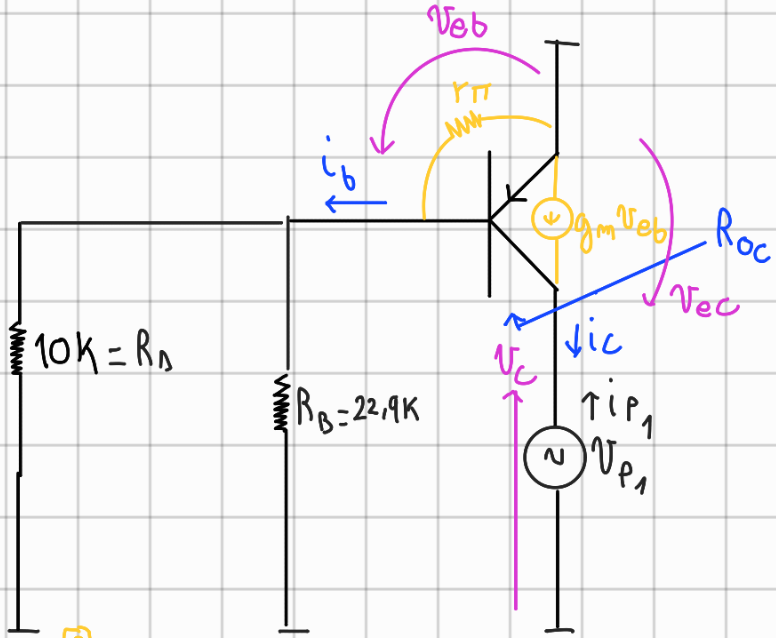


$$R_{ib} = \frac{V_p}{i_p} = \frac{V_{eb}}{i_p} = \frac{i_p \cdot r_\pi}{i_p} = r_\pi = 1{,}5\,K\Omega$$

$$R_i = R_B // R_i = (22{,}9\,K\Omega // 1{,}5\,K\Omega) = 1{,}41\,K\Omega$$

Resistencia de salida (R_o)

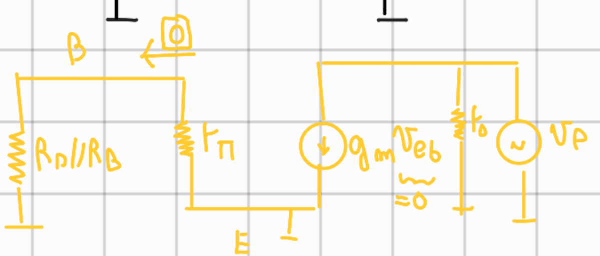




$$v_{ec} = v_p$$

$$i_c = \beta i_b$$

$$\frac{i_c}{v_{ec}} = g_m$$



$$R_{oc} = \frac{v_{p_1}}{i_{p_1}} = r_o \longrightarrow \infty$$

$$R_o = \frac{v_p}{i_p} = R_{oc} // R_C \underset{r_o \to \infty}{=} R_C = 3K9$$

c)

$\hat{V}_{ce_{max}}$ obtenible y $\hat{V}_{s_{max}}$ para que no haya recorte

$$R_{CE}: \quad 24V - I_C . R_E - V_{EC} - I_C . R_C = 0$$

$$24V - V_{EC} = I_C (R_E + R_C)$$

$$I_C = \frac{24V}{R_E + R_C} - \frac{V_{EC}}{R_E + R_C}$$

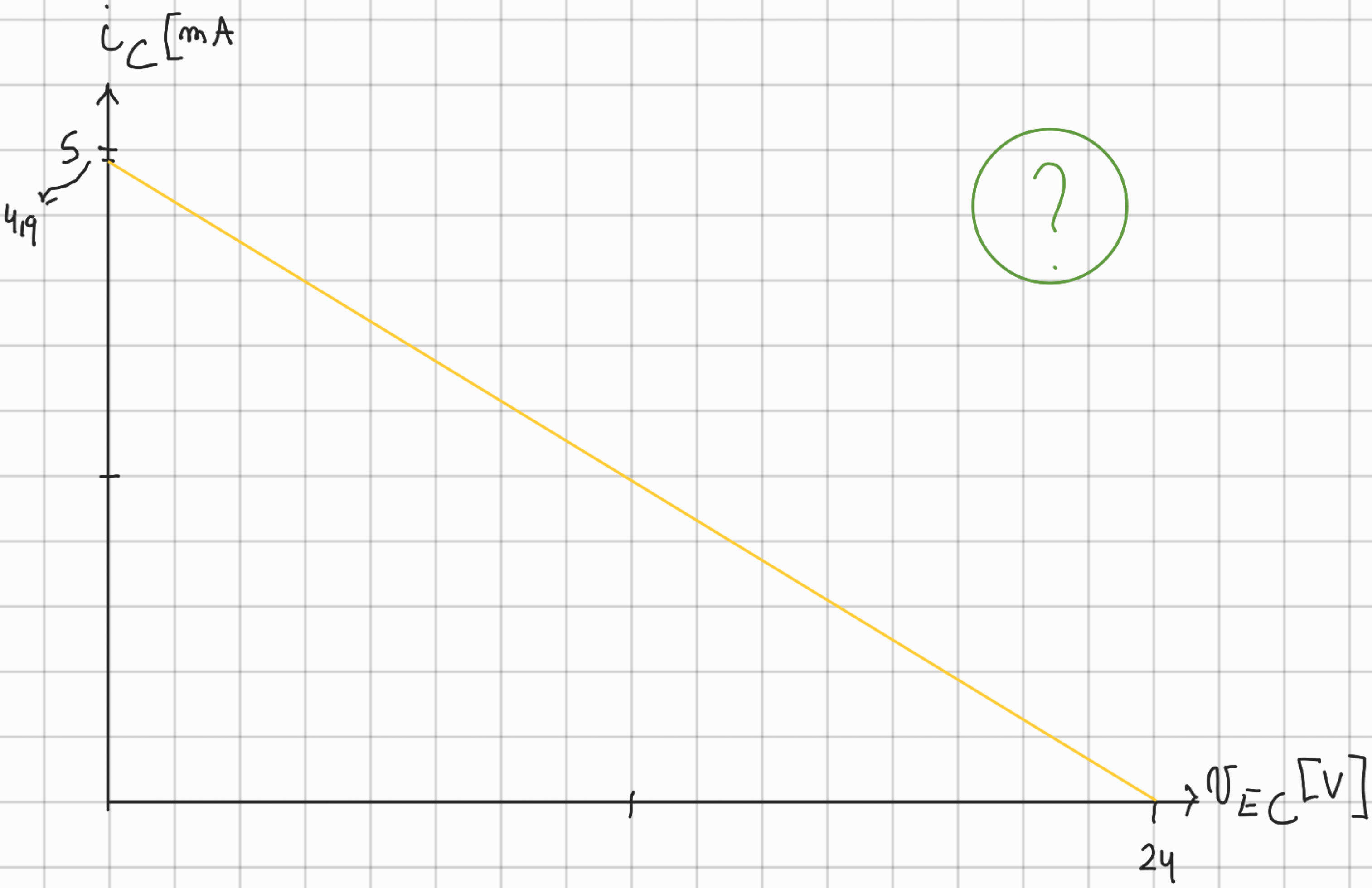
$$\boxed{R_{CE}: \quad I_C = 4{,}9mA - 0{,}204mS\, V_{EC}}$$

$$R_{CD}: \quad v_{ec} - i_c (R_C // R_L) = 0$$

$$(v_{EC} - V_{ECQ}) - (i_C - I_{CQ})\overbrace{(R_C // R_L)}^{1{,}95k} = 0$$

$$\frac{v_{EC}}{1{,}95K\Omega} - \frac{V_{ECQ}}{1{,}95K\Omega} + I_{CQ} = i_C$$

$$\boxed{R_{CD}: \quad i_C = -3{,}17mA + \frac{v_{EC}}{1{,}95K\Omega}}$$



i_C [mA
5
4,9
v_{EC} [V]
24
?