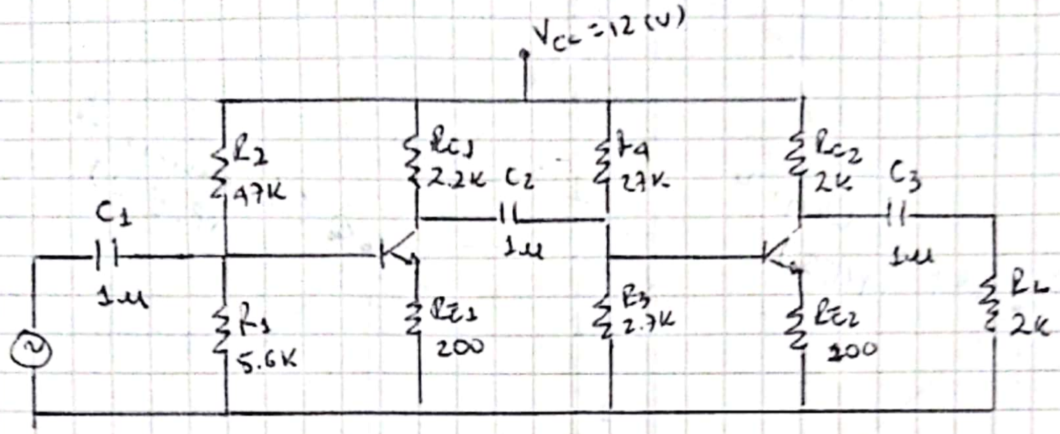
Parcial 2B.

1.



$\beta_1=\beta_2=100$

$f_T=500MHz$

$C_{bc}=10pF$

C_π: despreciable.

Análisis D.C

Etapa 1:

$R_{B1}=R_1 // R_2 \simeq 5K\Omega$

$V_{BB1}=\dfrac{V_{cc}R_1}{R_1+R_2}\simeq 1.28(V)$

L.V.K malla de entrada

$V_{BB1}=\dfrac{I_{CQ1}R_{B1}}{\beta}+V_{BE}+I_{CQ1}R_{E1}$

$\Rightarrow I_{CQ1}=\dfrac{V_{BB1}-V_{BE}}{\frac{R_{B1}}{\beta}+R_{E1}}=2.32mA$

L.V.K malla de salida:

$V_{cc}=I_{CQ1}R_{C1}+V_{CE1}+I_{CQ1}R_{E1}$

$\Rightarrow V_{CE1}=V_{cc}-I_{CQ1}(R_{C1}+R_{E1})$

$\Rightarrow V_{CE1}=6.43(V)$

$I_{Cmax}(V_{CE1}=0)=\dfrac{V_{cc}}{R_{E1}+R_{C1}}=5mA$

$V_{CEmax_1}(I_{C1}=0)=V_{cc}=12(V)$.

Etapa 2:

$R_{B2}=R_3 // R_4=2.45K\Omega$.

$V_{BB2}=\dfrac{V_{cc}R_3}{R_3+R_4}=1.09(V)$

L.V.K malla de entrada:

$V_{BB2}=\dfrac{I_{CQ2}R_{B2}}{\beta}+V_{BE}+I_{CQ2}R_{E2}$

$\Rightarrow I_{CQ2}=\dfrac{V_{BB2}-V_{BE}}{\frac{R_{B2}}{\beta}+R_{E2}}=3.1mA$

L.V.K malla de salida:

$V_{cc}=I_{CQ2}R_{C2}+V_{CE2}+I_{CQ2}R_{E2}$

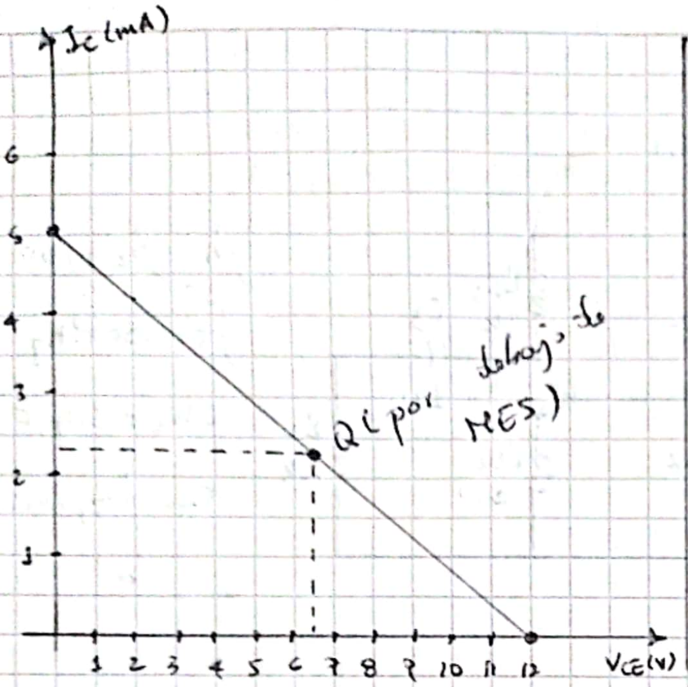
$\Rightarrow V_{CE2}=V_{cc}-I_{CQ2}(R_{C2}+R_{E2})$

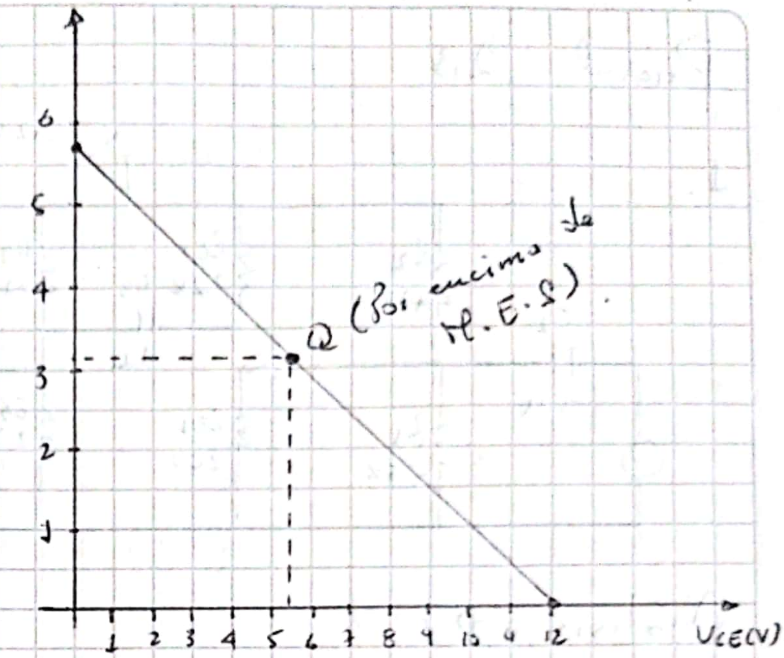
$\Rightarrow V_{CE2}=5.49(V)$

$I_{Cmax_2}(V_{CE2}=0)=\dfrac{V_{cc}}{R_{E2}+R_{C2}}=5.71mA$

$V_{CEmax_2}(I_{C2}=0)=V_{cc}=12(V)$

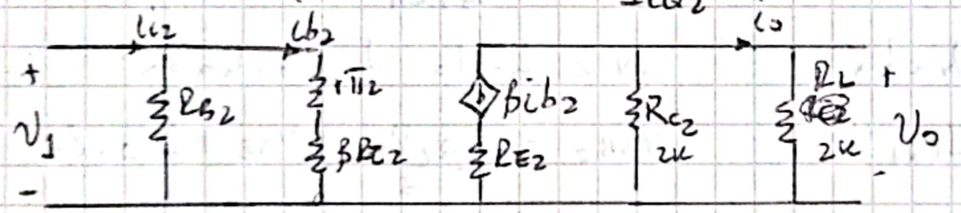
Escaneado con CamScanner





Análisis AC (Frecuencias medias).

Etapa 2 $\Rightarrow$ $r_{\pi 2} = \dfrac{\beta\, 26mV}{I_{CQ2}} = 838.7\,\Omega$; $R_{B2} = 2.45k\Omega$.



$A_{v2} = \dfrac{V_o}{V_i}$

$V_o = -\beta i_{b2}\, R_{C2}||R_L$; $V_i = i_{b2}(r_{\pi 2} + \beta R_{E2})$

$\Rightarrow A_{v2} = \dfrac{V_o}{V_i} = \dfrac{-\beta \cancel{i_{b2}}\, R_{C2}||R_L}{\cancel{i_{b2}}(r_{\pi 2} + \beta R_{E2})} = -\beta\, \dfrac{R_{C2}||R_L}{(r_{\pi 2} + \beta R_{E2})} = -9.23$

$A_{i2} = \dfrac{i_o}{i_{i2}}$; $i_o = -\dfrac{\beta i_{b2} R_{C2}}{R_{C2} + R_L}$, pero $i_{b2} = \dfrac{i_{i2}\, R_{B2}}{R_{B2} + r_{\pi 2} + \beta R_{E2}}$

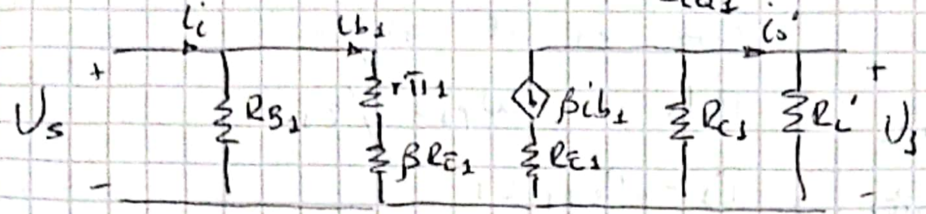
$\Rightarrow \dfrac{i_o}{i_{i2}} = A_{i2} = \dfrac{-\beta R_{C2} R_{B2}}{(R_{C2}+R_L)(R_{B2} + r_{\pi 2} + \beta R_{E2})} = -9.22$

$Z_{out2} = Z_{out} = R_{C2} = 2k\Omega$

$Z_{in2} = R_L' = (\beta R_{E2} + r_{\pi 2})||R_{B2} \approx 2.0k\Omega$

Etapa 1. $\Rightarrow r\pi_1 = \frac{\beta 26mV}{I_{CQ1}} = 1.1k\Omega$; $R_{B1} = 5k\Omega$

$R_L' = \cancel{2.4k\Omega}$. $2.0k\Omega$



$A_{v1} = \frac{V_1}{V_s}$

$V_1 = -\beta i b_1 (R_{C1} // R_L')$; $V_s = i b_1 (r\pi_1 + \beta R_{E1})$

$\Rightarrow A_{v1} = \frac{V_1}{V_s} = \frac{-\beta \cancel{ib_1}(R_{C1}//R_L')}{\cancel{ib_1}(r\pi_1 + \beta R_{E1})} = \cancel{5.48}\ -5.05$

$A_{i1} = \frac{i_o'}{i_i}$; $i_o = -\frac{\beta i b_1 R_{C1}}{R_{C1} + R_L'}$; pero $i b_1 = \frac{i_i R_{B1}}{R_{B1} + r\pi_1 + \beta R_{E1}}$

$\Rightarrow \frac{i_o'}{i_i} = A_{i1} = \frac{-\beta R_{C1} R_{B1}}{(R_{C1} + R_L')(R_{B1} + r\pi_1 + \beta R_{E1})} \approx -10$

$Z_{in1} = Z_{i1} = (r\pi_1 + \beta R_{E1}) // R_{B1} \approx 4.04\,k\Omega$.

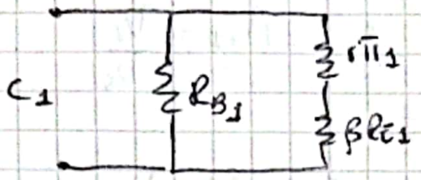
$A_{vT} = A_{v1} \times A_{v2} = (-9.23)(-5.05) = 46.6$

$A_{iT} = A_{i1} \times A_{i2} = (-9.22)(-10) = 92.2$

Escaneado con CamScanner

Análisis AC (frecuencias bajas).

Para C_1:



Cero en el origen

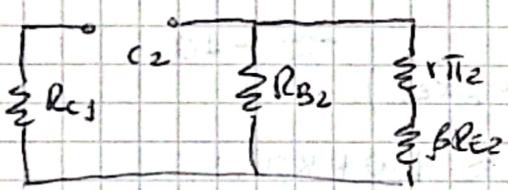
Polo en $\omega_{p1} = 1/\tau_1$

$\tau_1 = R_{eq_1} C_1$

$R_{eq_1} = (r\pi_1 + \beta R_{E1}) // R_{B1} = 4k\Omega$

$\Rightarrow \omega_{p1} = \dfrac{1}{4k\Omega \times 1\mu} = 250\ rad/s.$

Para C_2:



Cero en el origen

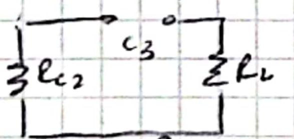
Polo en $\omega_{p2} = 1/\tau_2$

$\tau_2 = R_{eq_2} C_2$

$R_{eq_2} = [(r\pi_2 + \beta R_{E2}) // R_{B2}] + R_{C1}$

$R_{eq_2} = 4.2k\Omega \Rightarrow \omega_{p2} = \dfrac{1}{4.2k \times 1\mu} = 238\ rad/s.$

Para C_3:

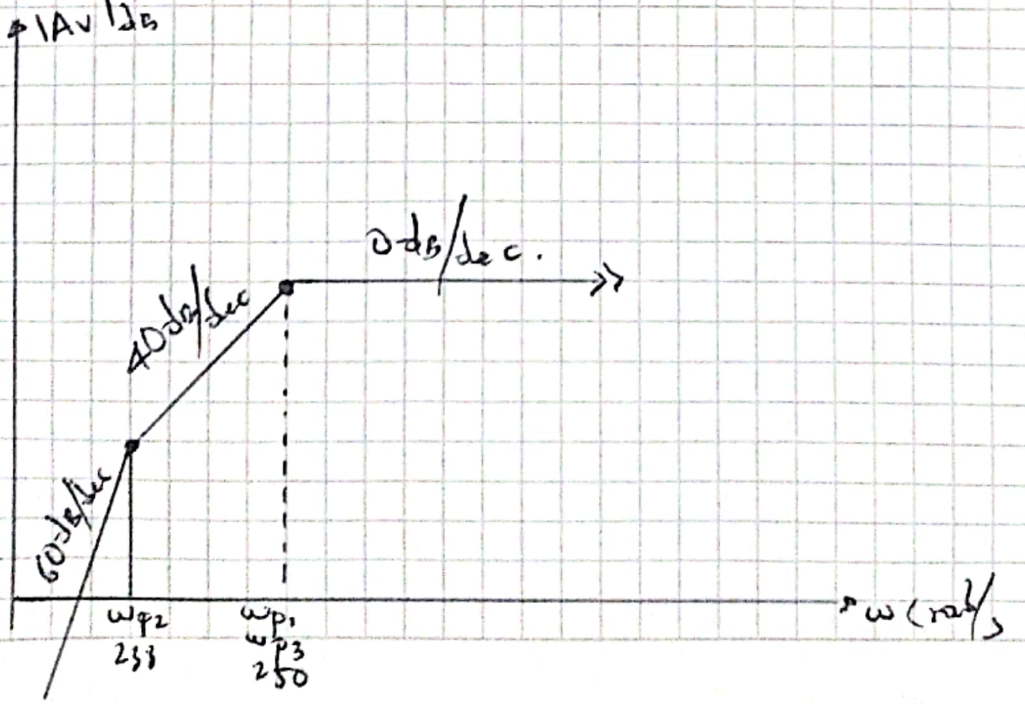


$R_{eq_3} = R_{C2} + R_L$

Cero en el origen

Polo en $\omega_{p3} = \dfrac{1}{R_{eq_3} C_3} = 250\ rad/s.$

$\Rightarrow \omega_L = \sqrt{\omega_{p1}^2 + \omega_{p2}^2 + \omega_{p3}^2} = 426.2\ rad/s.$



Análisis A-C para altas frecuencias

$C_{bc1} = C_{bc2} = 10pF$ $\omega_T = 2\pi \times 500MHz$

$C_{be1} = \frac{g_{m1}}{\omega_T}$; $g_{m1} = \frac{1}{r_{e1}}$ $\Rightarrow g_{m1} = \frac{1}{26mV/I_{CQ1}} = 0.089$

$\Rightarrow C_{be1} = \frac{0.089}{2\pi \times 500MHz} = 28pF$

$C_{be2} = \frac{g_{m2}}{\omega_T}$; $g_{m2} = \frac{1}{r_{e2}}$ $\Rightarrow g_{m2} = \frac{1}{26mV/I_{CQ2}} = 0.12$

$\Rightarrow C_{be2} = \frac{0.12}{2\pi \times 500MHz} = 38pF$

Aplicamos teorema de Miller para C_{bc1} y C_{bc2}

Para C_{bc1}:

$C_{M1} = C_{bc1}(1 - A_{v1}) = 10pF(1 - (-5.05)) = 60.5pF$

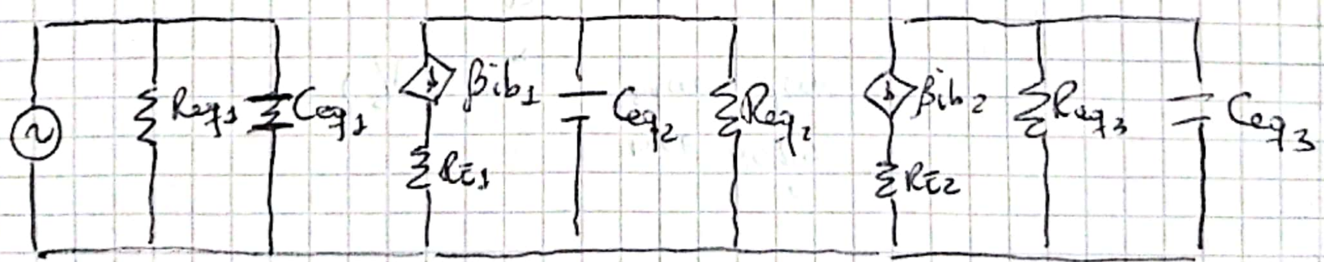
$C_{M2} = C_{bc1}(1 - (1/A_{v1})) = 10pF(1 - (-1/5.05)) \approx 12pF$

Para C_{bc2}:

$C_{M3} = C_{bc2}(1 - A_{v2}) = 10pF(1 - (-9.23)) = 102pF$

$C_{M4} = C_{bc2}(1 - 1/(A_{v2})) = 10pF(1 - (-1/9.23)) \approx 11pF$

Reduciendo los paralelos, se obtiene:



Polo para C_{eq_1} $\Rightarrow$ $C_{eq_1} = C_{be_1} + C_{M_1} = 88.5\,pF$

Pero $R_{eq_1} \,//\,$ Corto $= 0$ $\Rightarrow$ $\omega_{p_1} = \frac{1}{0} \approx \infty$ (No hay polo).

Polo para C_{eq_2} $\Rightarrow$ $C_{eq_2} = C_{M_2} + C_{be_2} + C_{M_3} = 12pF + 38pF + 102pF$

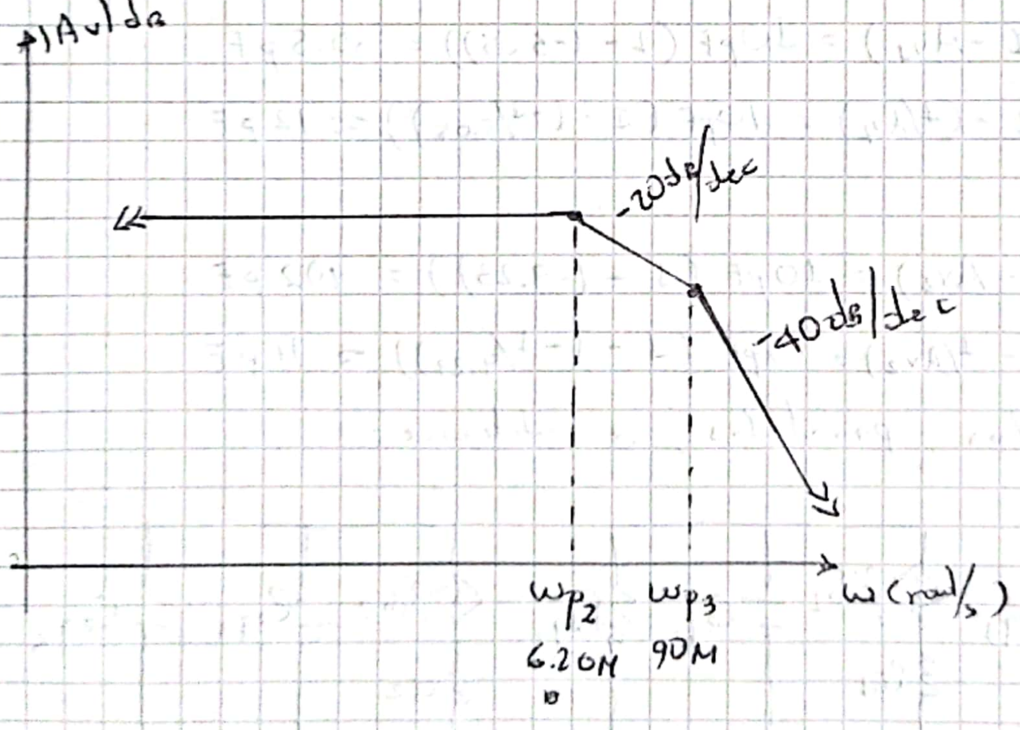
$R_{eq_2} = R_{C_1} \,//\, R_{B_2} \,//\, (r_{\pi_2} + \beta R_{E_2})$ $\quad C_{eq_2} = 152\,pF$

$R_{eq_2} = 1.05\,k\Omega$ $\Rightarrow$ $\omega_{p_2} = \frac{1}{1.05k\Omega \times 152pF} = 6.26\,Mrad/s$

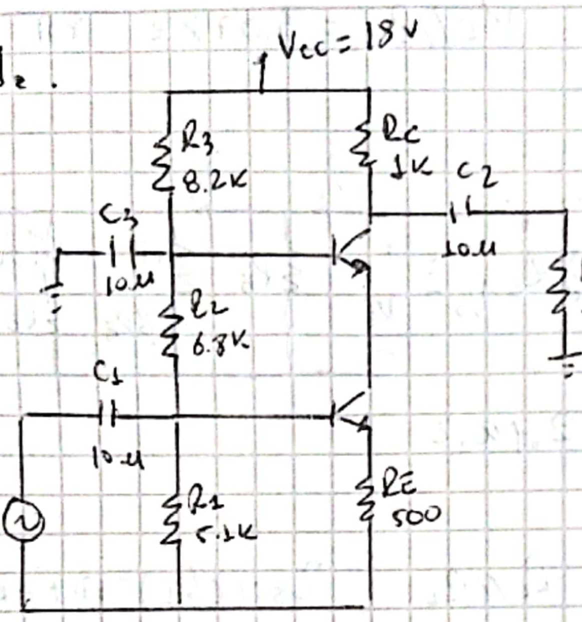
Polo para C_{eq_3} $\Rightarrow$ $C_{eq_3} = C_{M_4} = 11\,pF$; $R_{eq_3} = R_{C_2} \,//\, R_L = 1k\Omega$

$\Rightarrow \omega_{p_3} = \frac{1}{1k\Omega \times 11pF} = 90\,Mrad/s.$

$\therefore \omega_H = \omega_{p_2} = 6.26\,Mrad/s.$

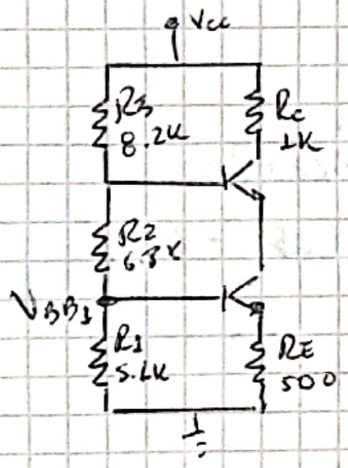


2. Cascode.



$\beta = 100$

Análisis D.C



$$V_{BB_1} = \frac{V_{CC} R_1}{R_1+R_2+R_3} = 4.57\ (V)$$

L.V.K en Malla de entrada:

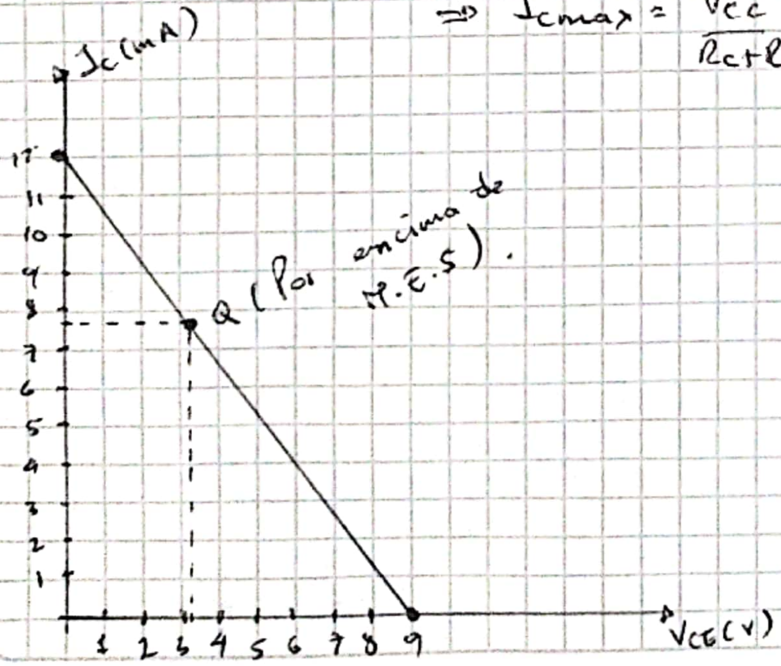
$$V_{BB_1} = V_{BE} + I_{CQ} R_E \Rightarrow I_{CQ} = \frac{V_{BB_1} - V_{BE}}{R_E} = 7.74\,mA$$

L.V.K en Malla de salida:

$$V_{CC} = 2V_{CEQ} + I_{CQ}(R_C + R_E) \Rightarrow V_{CEQ} = \frac{V_{CC} - I_{CQ}(R_C+R_E)}{2}$$

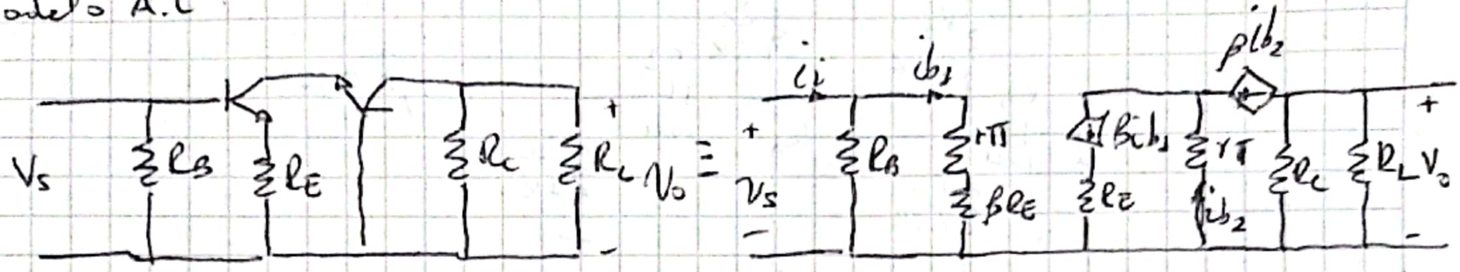
$$\Rightarrow V_{CEQ} = 3.2\ (V) \quad \Rightarrow V_{CEmax} = \frac{V_{CC}}{2} = \frac{18(V)}{2} = 9$$

$$\Rightarrow I_{Cmax} = \frac{V_{CC}}{R_C + R_E} = 12\,mA$$



Análisis A.C : $R_B = R_1 // R_2 = 3.07 k\Omega$ $r\pi = \frac{\beta 26mv}{I_{CQ}} \approx 338\Omega$

Modelo A.C :



$Zin = (r\pi + \beta R_E) // R_B \approx 2.9 k\Omega$

$Zout = R_C = 1k\Omega$,

$Av = \frac{V_o}{V_s}$; $V_o = -\beta ib_1 R_C // R_L$; $V_s = (ib_1)(r\pi + \beta R_E)$

$\Rightarrow A_v = \frac{v_o}{v_s} = \frac{-\beta \cancel{ib_1} (R_C // R_L)}{\cancel{ib_1}(r\pi + \beta R_E)} = 0.993$

$Ai = \frac{i_o}{i_i}$, $i_o = \frac{-\beta ib_1 R_C}{R_C + R_L}$; $ib_1 = \frac{i_i R_B}{r\pi + \beta R_E + R_B}$

$\Rightarrow \frac{i_o}{i_i} = Ai = -\frac{\beta R_C R_B}{(R_C + R_L)(r\pi + \beta R_E + R_B)} =$ [illegible] -2.87