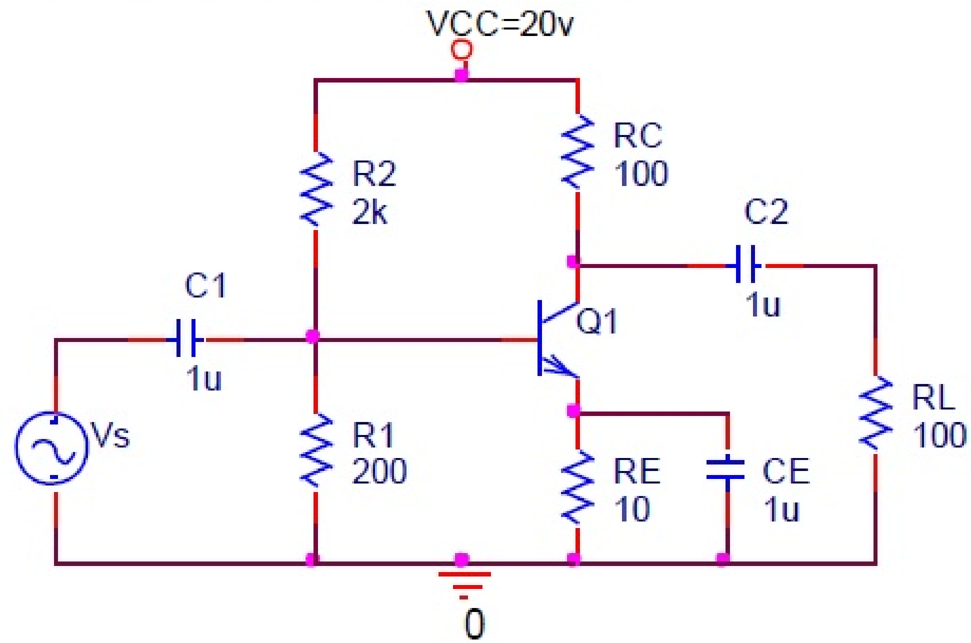
Parcial N° 1 . Electrónica Análoga

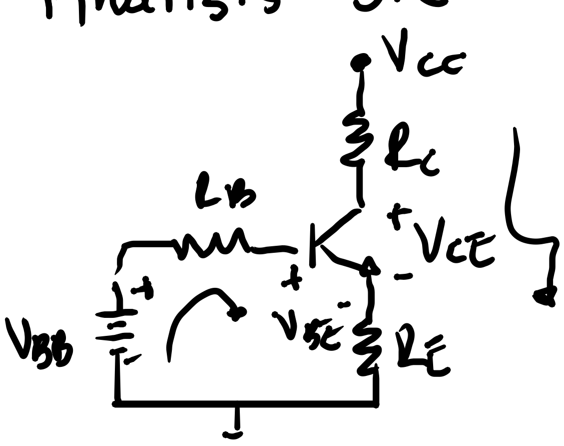
1. Para el siguiente amplificador (Valor: 2.5 unidades):



β=200.

Hallar: recta de carga DC, Av, Ai, Zin, Zout, Vomaxp, Vimaxp, PL, PDC y % de eficiencia del amplificador.

Análisis D.C



$$R_B = R_1 \| R_2 = 181.8\,\Omega$$

$$V_{BB} = \frac{V_{CC} R_1}{R_1 + R_2} = \frac{20(200)}{2k + 200} = 1.81\,(V)$$

L.V.K en malla de entrada:

$$V_{BB} = \frac{I_C}{\beta} R_B + V_{BE} + I_C R_E \Rightarrow I_{CQ} = \frac{V_{BB} - V_{BE}}{R_B/\beta + R_E}$$

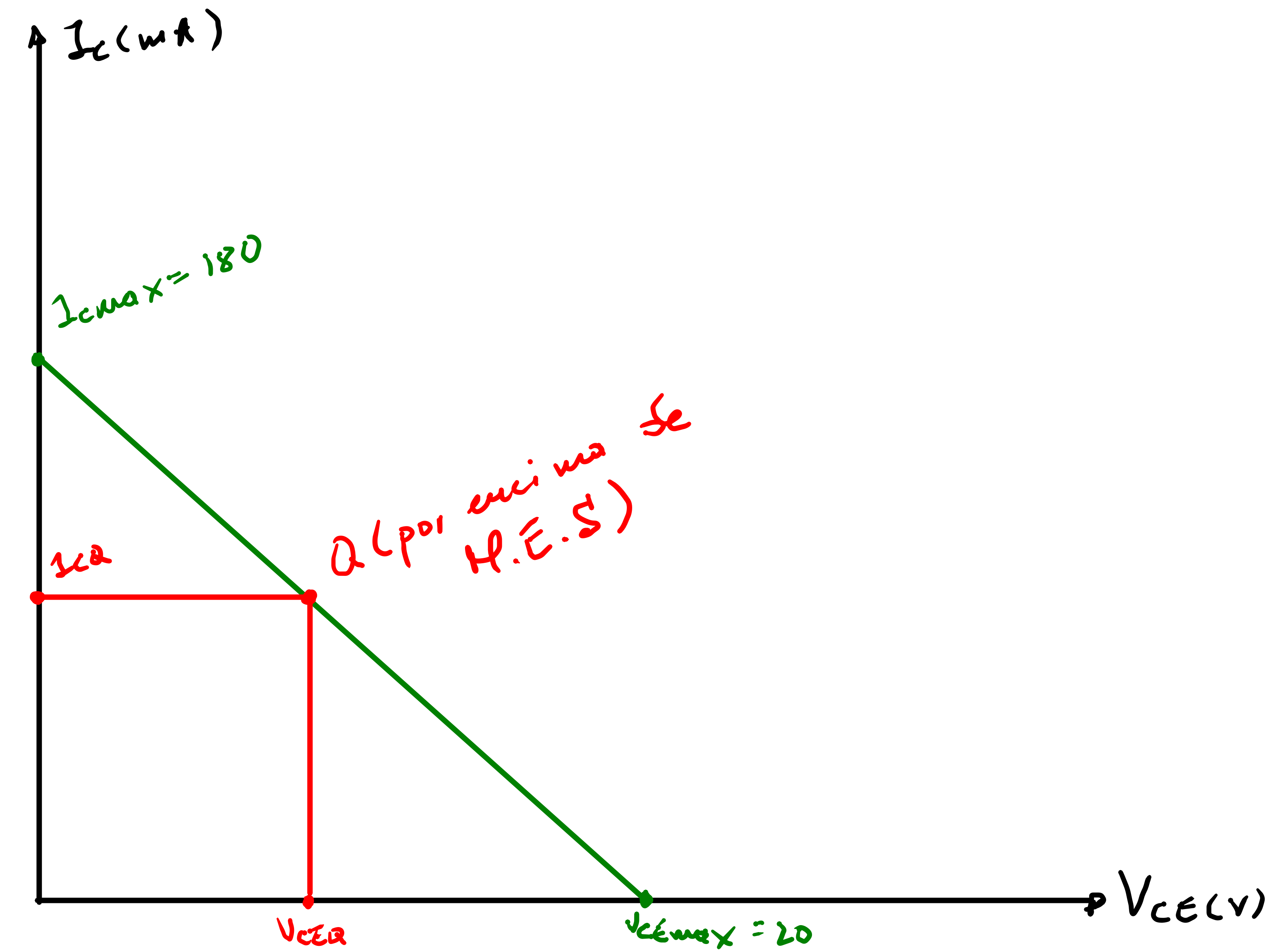
$$I_{CQ} = 101.8\,mA$$

L.V.K en malla de salida:

$V_{cc} = I_c R_c + V_{CE} + I_c R_E \Rightarrow V_{CEQ} = V_{cc} - I_c(R_c + R_E) = 8.9(V)$

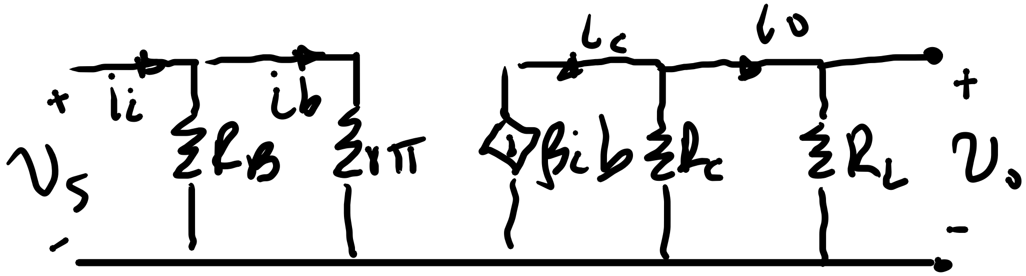
$I_{cmax}(V_{CE}=0) = \dfrac{V_{cc}}{R_c + R_E} = 180\ mA$

$V_{CEmax}(I_c=0) = V_{cc} = 20(V)$



Análisis A.C $\rightarrow r\pi = \dfrac{\beta 26mV}{I_{CQ}} = 51.5\,\Omega$ $R_B = 181.8\,\Omega$

Modelo hibrido:



$v_o = -\beta i_b R_c \| R_L$

$v_s = i_b r\pi$

$A_v = \dfrac{v_o}{v_s} = -\dfrac{\beta \cancel{i_b} R_c \| R_L}{\cancel{i_b} r\pi} = -\dfrac{(200)(50)}{51.5} = -194.2$

$i_o = -\dfrac{\beta i_b R_c}{R_c + R_L}$; $i_b = \dfrac{i_i R_B}{r\pi + R_B}$; reemplazo i_b en i_o:

$\dfrac{i_o}{i_i} = A_i = -\dfrac{\beta R_c R_B}{(R_c+R_L)(r\pi + R_B)} = -\dfrac{(200)(100)(181.8)}{(100+100)(181.8+51.5)} = -77.9$

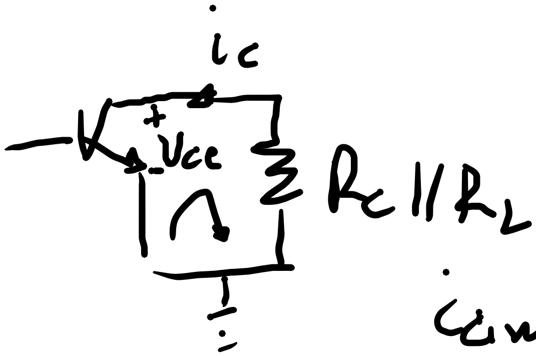
$Z_{in} = R_B \| r\pi = (181.8) \| (51.5) = 40.1\,\Omega$

$Z_{out} = R_c = 100\,\Omega$

$V_{omax} = i_{omax} R_L$; $i_{omax} = \dfrac{i_{cmax} R_c}{R_c + R_L}$

$\Rightarrow V_{omax} = i_{cmax}(R_c \| R_L)$; Caso $\underline{III} \Rightarrow i_{cmax} = i_{c,max} - I_{CQ}$

Para hallar $i_{c,max}$ resuelvo la malla de salida en AC:



$$v_{ce} = -i_c (R_C \| R_L) \; ; \; i_c = i_C - I_{CQ}$$

$$v_{ce} = v_{CE} - V_{CEQ}$$

$$\Rightarrow v_{CE} - V_{CEQ} = -(i_C - I_{CQ})(R_C \| R_L)$$

$$i_{C\,max}(v_{CE} = 0) = \frac{V_{CEQ}}{R_C \| R_L} + I_{CQ}$$

$$\Rightarrow i_{c\,max} = \frac{V_{CEQ}}{R_C \| R_L} = \frac{8.9}{50} = 178\,\text{mA}$$

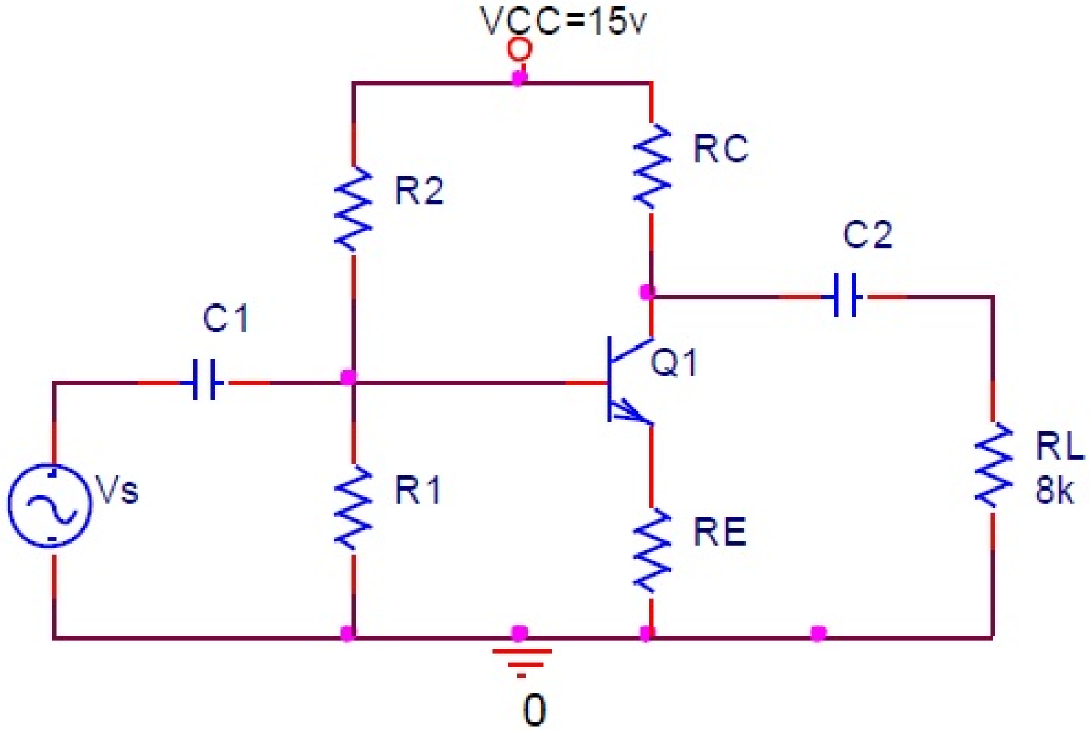
$$\Rightarrow V_{o\,max} = i_{c\,max}(R_C \| R_L) = 178\,\text{mA}\,(50\,\Omega) = 8.9\,(\text{V})$$

$$V_{i\,max} = \frac{V_{o\,max}}{|A_v|} = \frac{8.9}{194.2} = 45.8\,\text{mV}$$

$$P_L = \frac{V_{o\,max}^2}{2R_L} = \frac{(8.9)^2}{2(100)} = 0.396\,\text{W} \; ; \; P_{DC} = V_{CC} I_{CQ} = 2.02\,\text{W}$$

$$\eta\% = \frac{P_L}{P_{DC}} \times 100\% = \frac{0.396}{2.02} \times 100\% = 19.6\%$$

2. Diseñar el siguiente amplificador EC para Av=-100, considerando máxima excursión simétrica (MES) (β=200, valor: 2.5 unidades):



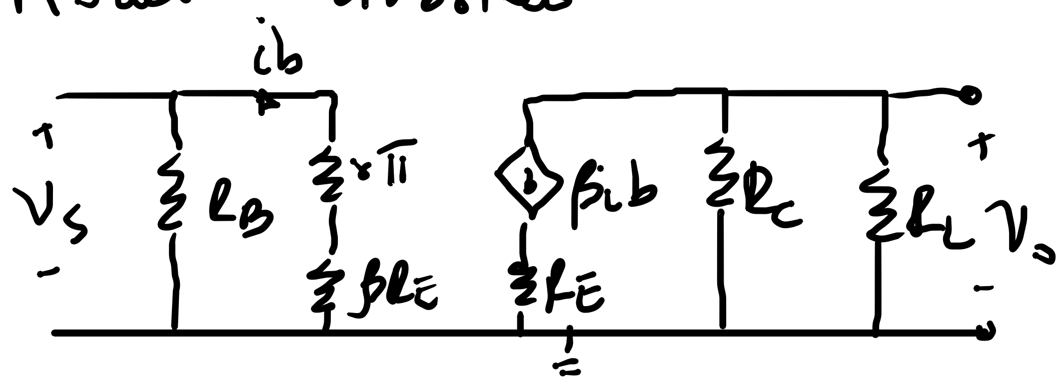
$$R_1 = \frac{R_B}{1 - \frac{V_{BB}}{V_{CC}}}$$

$$R_2 = \frac{R_B V_{CC}}{V_{BB}}$$

Para M.T.P $\Rightarrow$ $R_C = R_L = 8K$

Para hallar R_E, se busca la ganancia de Voltaje

Modelo híbrido:



$$V_o = -\beta i_b R_C \parallel R_L$$

$$V_s = i_b(r_\pi + \beta R_E)$$

$\Rightarrow A_v = \frac{v_o}{v_s} = -\frac{\beta(R_C \parallel R_L)}{r_\pi + \beta R_E}$; Asumimos que $\beta R_E >>> r_\pi$

$\Rightarrow A_v = -100 = -\frac{\cancel{\beta}(R_C \parallel R_L)}{\cancel{\beta} R_E} \Rightarrow R_E = \frac{R_C \parallel R_L}{100} = \frac{4K}{100} = 40\Omega$

Hallamos I_{CQ} para M.E.S :

$I_{CQ} = \frac{V_{CC}}{R_{DC} + R_{AC}}$; $R_{DC} = R_C + R_E = 8K + 40 = 8.04K\Omega$

$R_{AC} = (R_C \parallel R_L) + R_E = 4K + 40 = 4.04 K\Omega$

$I_{CQ} = \frac{15}{8.04K + 4.04K} = 1.24 mA$

$\Rightarrow r_\pi = \frac{\beta\, 26 mV}{I_{CQ}} = \frac{(200)(26)}{1.24} = 4.2K\Omega$

Comprobamos que $\beta R_E >>> r_\pi \Rightarrow (200)(40) >>> 4.2K$??

$8K >>> 4.2K$?? NO !!

$\Rightarrow R_E^* = R_E - \frac{r_\pi}{\beta} = 40 - \frac{4.2K}{200} = 19\Omega$

Hallamos R_B con el criterio de estabilidad:

$R_B = 0.1 \beta R_E^* = 0.1(200)(19\Omega) = 380\Omega$

De la malla de entrada en DC:

$$V_{BB} = \frac{I_{CQ}}{\beta} R_B + V_{BE} + I_{CQ} R_E^{*} = \frac{1.24\,mA}{200}(380) + 0.7 + 1.24\,mA\,(14)$$

$$V_{BB} = 0.725\,(V)$$

Finalmente:

$$R_1 = \frac{R_B}{1 - \frac{V_{BB}}{V_{CC}}} = \frac{380}{1 - \frac{0.725}{15}} \approx 400\,\Omega$$

$$R_2 = \frac{R_B V_{CC}}{V_{BB}} = \frac{380(15)}{0.725} = 7.86K$$