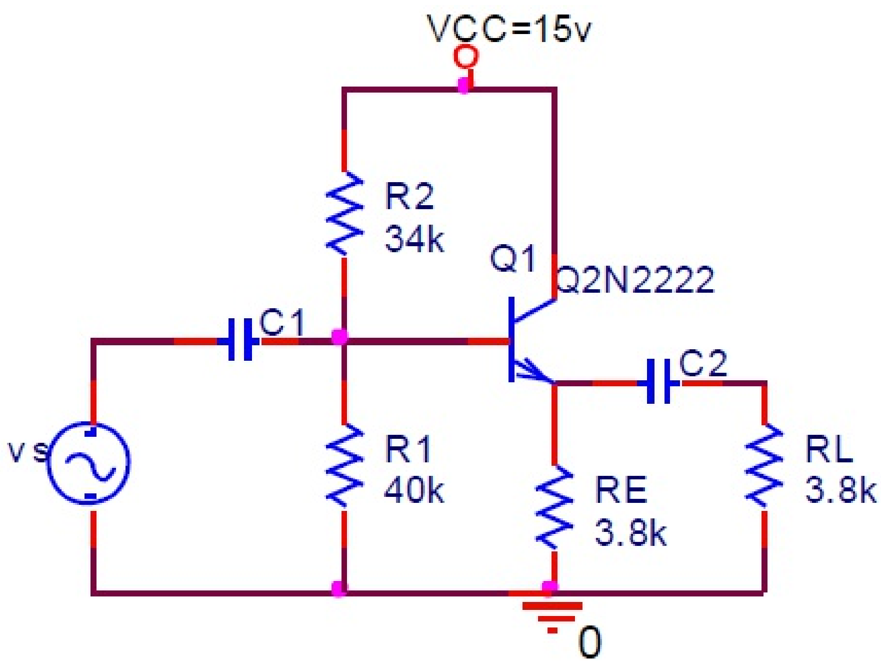
Parcial 1B - Solución

1. Analizar el siguiente amplificador:

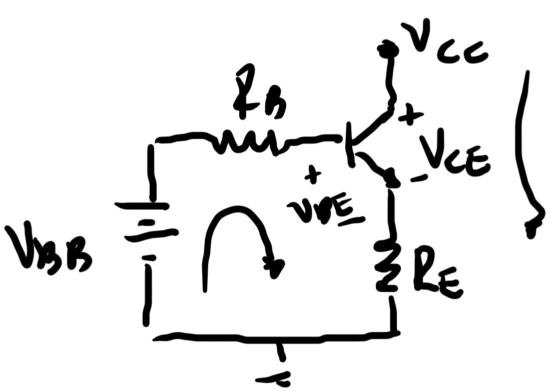


$\beta = 100$

$R_B = R_1 \parallel R_2 = 18.38 K\Omega$

$V_{BB} = \dfrac{V_{CC} R_1}{R_1 + R_2} = 8.1 (V)$

Análisis D.C



L.V.K en malla de entrada:

$V_{BB} = \dfrac{I_{CQ}}{\beta} R_B + V_{BE} + I_{CQ} R_E$

$\Rightarrow I_{CQ} = \dfrac{V_{BB} - V_{BE}}{\frac{R_B}{\beta} + R_E} = 1.85 mA$

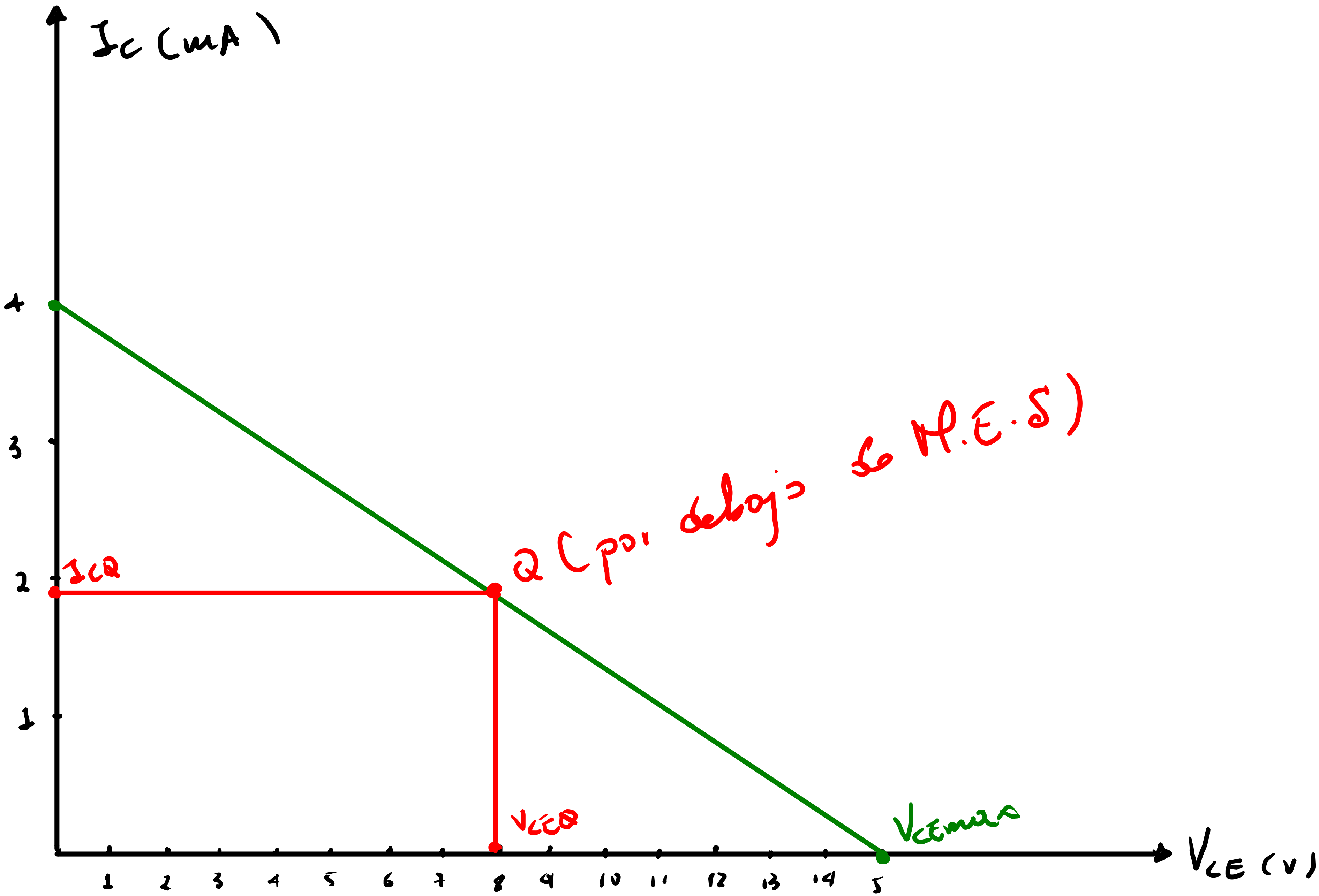
L.V.K en malla de salida:

$V_{cc} = V_{CE} + I_C R_E$

$$\Rightarrow V_{CEQ} = V_{CC} - I_{CQ} R_E \approx 8\,(V)$$

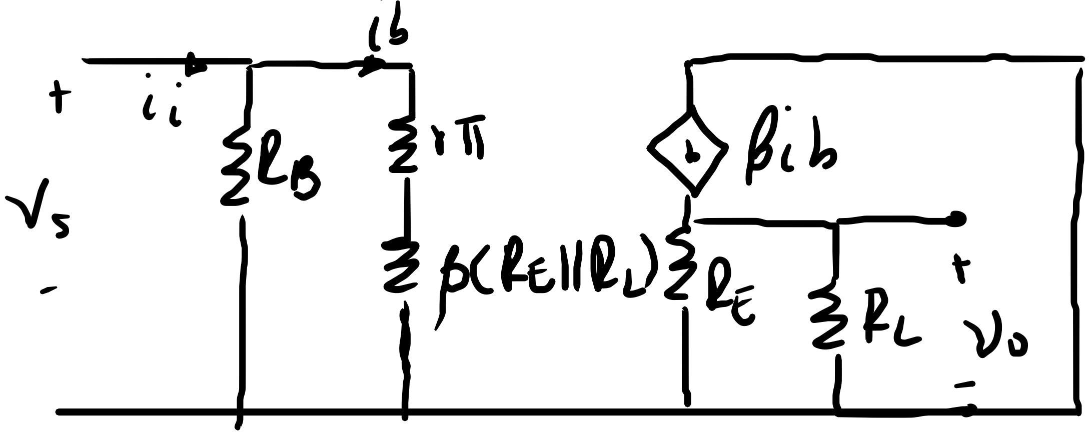
$$I_{Cmax}\,(V_{CE}=0) = \frac{V_{CC}}{R_E} = 3.95\,mA \approx 4\,mA$$

$$V_{CEmax}\,(I_C=0) = V_{CC} = 15\,(V)$$



Análisis AC

Modelo híbrido



$$r\pi = \frac{\beta\, 26mV}{I_{CQ}} = \frac{100(26)}{1.95} = 1.33K$$

$$R_B = R_1 \| R_2 = 18.38 K\Omega .$$

Ganancia de Voltaje $A_v = \dfrac{v_o}{v_s}$:

$v_o = \beta i_b R_E \| R_L$; $v_s = i_b(r\pi + \beta(R_E \| R_L))$

$$\Rightarrow A_v = \frac{v_o}{v_s} = \frac{\beta(R_E // R_L)\cancel{i_b}}{(r\pi + \beta(R_E // R_L))\cancel{i_b}} = 0.993 \approx 1 .$$

Ganancia de Corriente $A_i = \dfrac{i_o}{i_i}$

$i_o = \dfrac{\beta i_b R_E}{R_E + R_L}$; $i_b = \dfrac{i_i R_B}{R_B + r\pi + \beta(R_E \| R_L)}$; Reemplazando i_b :

$$\frac{i_o}{i_i} = A_i = \frac{\beta R_E R_B}{(R_E + R_L)(R_B + r\pi + \beta(R_E \| R_L))} = 4.38$$

$$Z_{in} = R_B \parallel (r_\pi + \beta(R_E \parallel R_L)) = 16.8 K\Omega$$

$$Z_{out} = \frac{r_\pi}{\beta} \parallel R_E \simeq \frac{r_\pi}{\beta} = \frac{1.33K}{100} = 13.3\,\Omega.$$

$V_{omax} = ?$; Punto Q por debajo de M.E.S $\Rightarrow i_{cmax} = I_{CQ}$

Pero $i_{omax} = \dfrac{i_{cmax} R_E}{R_E + R_L}$ y $V_{omax} = i_{omax} R_L$

$$\Rightarrow V_{omax} = i_{cmax}(R_E \parallel R_L) = I_{CQ}(R_E \parallel R_L) = 3.7\,(V)$$

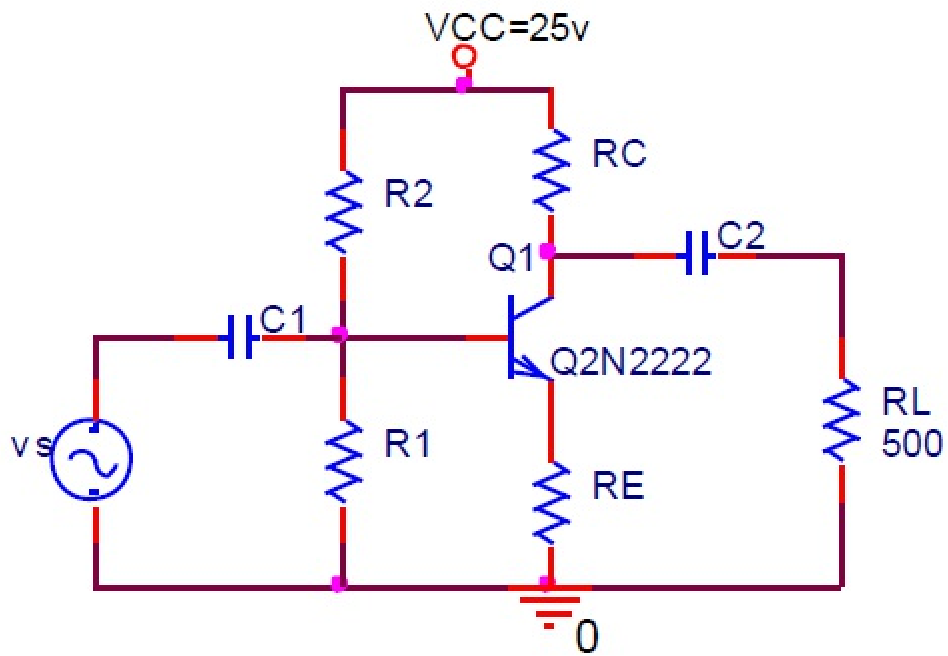
$$V_{imax} = \frac{V_{omax}}{|A_V|} \simeq \frac{V_{omax}}{|1|} \simeq 3.7\,(V)$$

$$P_L = \frac{V_{omax}^2}{2R_L} = \frac{(3.7)^2}{2(3.8k)} = 1.8\,mW$$

$$P_{DC} = V_{CC}\, I_{CQ} = 15(1.95mA) = 29.25\,mW$$

$$\eta\% = \frac{P_L}{P_{DC}} \times 100\% = 6.15\%$$

2. Diseñar para $A_v = -15$; $A_i = -5$; $V_{cc} = 25$; $\beta = 100$
M.E.S



Para M.T.P:

$R_C = R_L = 500$

Asumiendo que $\beta R_E >>> r\pi$, la ganancia de voltaje es:

$A_v \simeq -\dfrac{(R_C // R_L)}{R_E} = -15 \Rightarrow R_E = -\dfrac{(R_C // R_L)}{-15}$

$\Rightarrow R_E = \dfrac{R_C // R_L}{15} = \dfrac{250}{15} = 16.6$

Para M.E.S $I_{CQ} = \dfrac{V_{cc}}{R_{AC} + R_{DC}}$; $R_{DC} = R_C + R_E = 516.6\,\Omega$

$R_{AC} = R_E + (R_C // R_L) = 266.6$

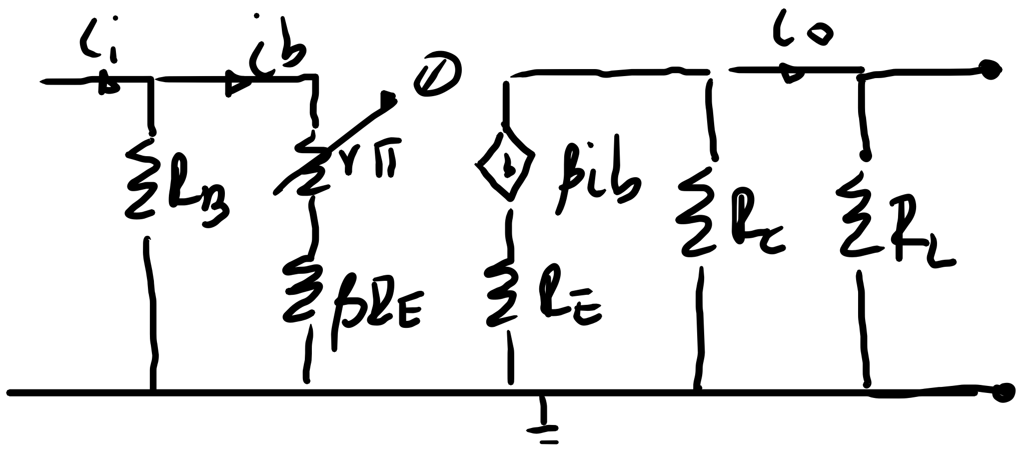
$\Rightarrow I_{CQ} = \dfrac{25}{516.6 + 266.6} = 31.9\,mA$

$$\Rightarrow r_\pi = \frac{\beta\, 26\,mV}{I_{CQ}} = \frac{100(26)}{31.9} = 81.5$$

$$\beta R_E = 100(16.6) = 1.66K >>> 81.5\,\Omega \Rightarrow R_E = 16.6\,\Omega$$

Para hallar R_B usamos la ganancia de corriente A_i:

Modelo AC:



$$i_o = -\frac{\beta i_b R_C}{R_C + R_L}$$

$$i_b = \frac{i_i R_B}{R_B + \beta R_E} \qquad \beta R_E >>> r_\pi$$

$$\Rightarrow \frac{i_o}{i_i} = \frac{-\beta R_B R_C}{(R_C + R_L)(R_B + \beta R_E)} = -5$$

$$\Rightarrow \frac{\beta R_B R_C}{R_C + R_L} = 5R_B + 5\beta R_E \Rightarrow \frac{\beta R_B R_C}{R_C + R_L} - 5R_B = 5\beta R_E$$

$$\Rightarrow R_B\left(\frac{\beta R_C}{R_C + R_L} - 5\right) = 5\beta R_E \Rightarrow R_B = \frac{5\beta R_E}{\left(\frac{\beta R_C}{R_C + R_L} - 5\right)} = 184.4\,\Omega$$

De la malla de entrada en DC:

$$V_{BB} = \frac{I_{CQ}}{\beta} R_B + V_{BE} + I_{CQ} R_E = 1.29\ (V)$$

$$R_1 = \frac{R_B}{1 - \frac{V_{BB}}{V_{CC}}} = 194.4\ \Omega$$

$$R_2 = \frac{R_B V_{CC}}{V_{BB}} = 3.57\ K\Omega\ .$$