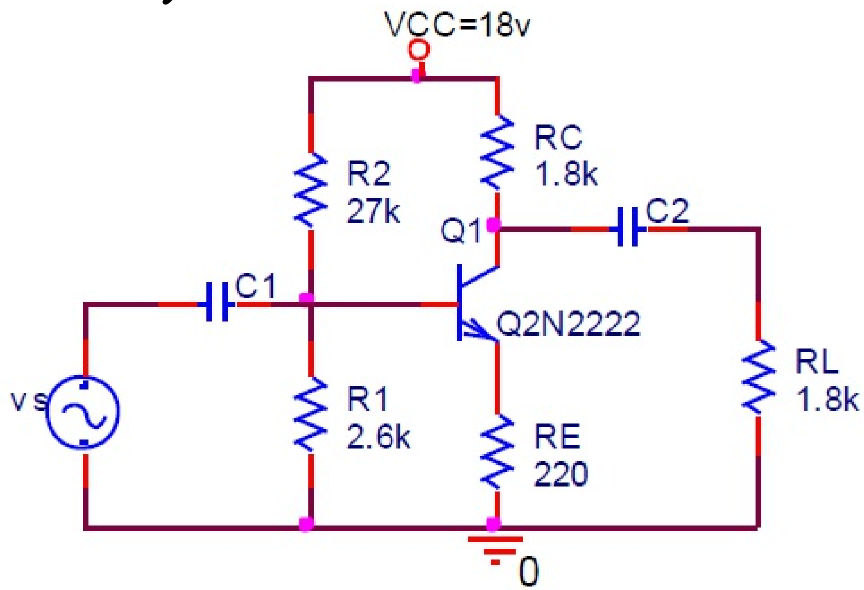
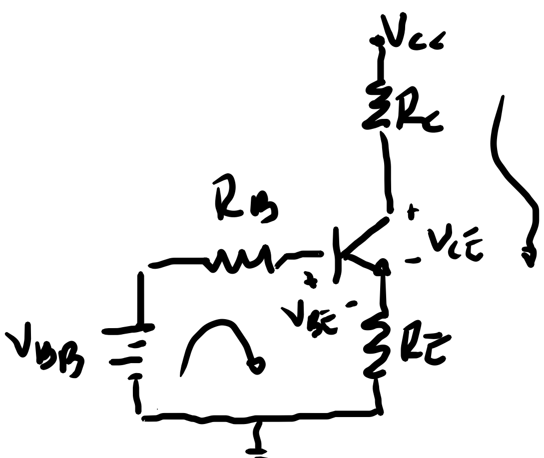
Parcial 1A - Solución

1. Analizar el siguiente amplificador:



$\beta = 100$

Análisis DC:



$R_B = R_1 \parallel R_2 = 2.37\,k\Omega$ $\quad V_{BB} = \dfrac{V_{CC} R_1}{R_1 + R_2} = 1.58\,(V)$

L.V.K en malla de entrada:

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

$I_{CQ} = 3.6\,mA$

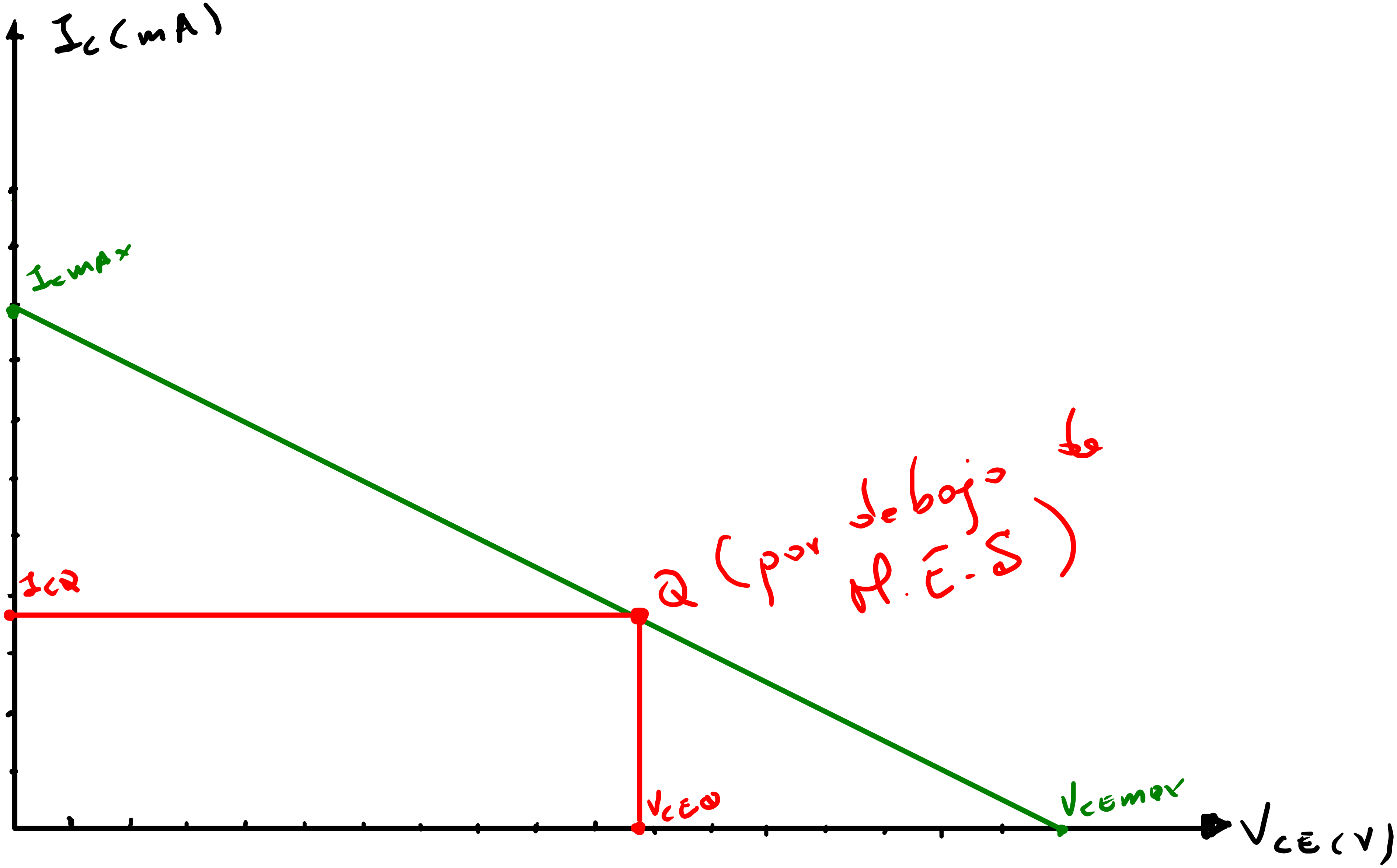
L.V.K en malla de salida:

$$V_{CC} = I_C R_C + V_{CE} + I_C R_E$$

$\Rightarrow V_{CEQ} = V_{CC} - I_{CQ}(R_C + R_E) = 10.7\ V$

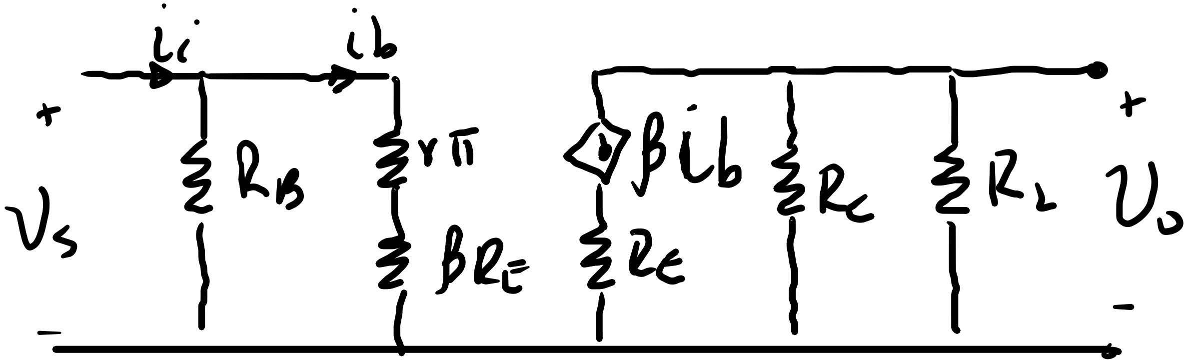
$I_{Cmax}(V_{CE}=0) = \dfrac{V_{CC}}{R_E + R_C} = 8.91\ mA$; $V_{CEmax}(I_C = 0) = V_{CC} = 18(V)$

Recta DC:



Análisis A.C: $r\pi = \beta \frac{26\,mV}{I_{CQ}} = \frac{100(26)}{3.6} = 722.2\,\Omega$

Modelo híbrido:



$R_B = R_1 \parallel R_2 = 2.37\,K\Omega$

Ganancia de voltaje $A_v = \frac{V_o}{V_s}$:

$V_o = -\beta i_b\, R_c \parallel R_L$; $V_s = i_b(r\pi + \beta R_E) \Rightarrow A_v = \frac{V_o}{V_s} = -\frac{\beta(R_c \parallel R_L)\cancel{i_b}}{(r\pi + \beta R_E)\cancel{i_b}}$

$\Rightarrow A_v = -3.96$

Ganancia de corriente $A_i = \frac{i_o}{i_i}$:

$i_o = -\frac{\beta i_b R_c}{R_c + R_L}$; $i_b = \frac{i_i R_B}{R_B + r\pi + \beta R_E}$ $\Rightarrow$ Reemplazando i_b:

$\frac{i_o}{i_i} = A_i = -\frac{\beta R_c R_B}{(R_c + R_L)(R_B + r\pi + \beta R_E)} = -4.72$

$Z_{in} = (r\pi + \beta R_E) \parallel R_B = 2.14\,K\Omega$

$Z_{out} = R_c = 1.8\,K\Omega$

$V_{omax} = ?$ Punto Q por debajo de M.E.S

$\Rightarrow \dot{i}_{cmax} = I_{CQ}$; además $\dot{i}_{omax} = \dfrac{\dot{i}_{cmax} R_C}{R_C + R_L}$

$$V_{omax} = \dot{i}_{omax} R_L = \dot{i}_{cmax} (R_C \| R_L)$$

$$V_{omax} = I_{CQ} (R_C \| R_L) = 3.24 (V)$$

$$v_{imax} = \frac{V_{omax}}{|A_V|} = \frac{3.24}{3.96} = 0.81 (V)$$

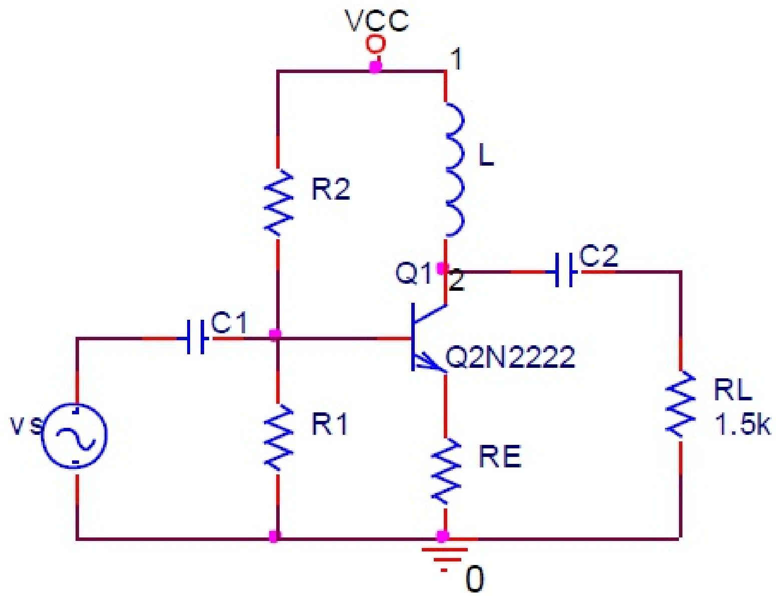
Potencia en la carga y eficiencia:

$$P_L = \frac{V_{omax}^2}{2R_L} = \frac{(3.24)^2}{2(1.8k)} = 2.91\,mW$$

$$P_{DC} = V_{CC} I_{CQ} = (18V)(3.6mA) = 64.8\,mW$$

$$\eta\% = \frac{P_L}{P_{DC}} \times 100\% = \frac{2.91}{64.8} \times 100\% = 4.5\%$$

2. Diseñar para $P_L = 1W$; $R_L = 1.5K\Omega$; $Z_{in} = 2K\Omega$, $\beta = 100$
Considera M.E.S



$R_E \le 0.1 R_L \Rightarrow R_E = 0.1 R_L = 150\Omega$

$i_o = I_{CQ}$; Además

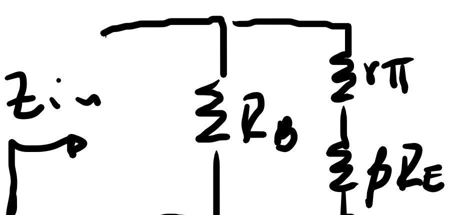
$$P_L = \frac{i_o^2 R_L}{2} = \frac{I_{CQ}^2 R_L}{2}$$

$$\Rightarrow I_{CQ} = \sqrt{\frac{2P_L}{R_L}} = 36.5mA$$; Para M.E.S $\Rightarrow I_{CQ} = \dfrac{V_{CC}}{R_{DC}+R_{AC}}$

$R_{DC} = R_E = 150$; $R_{AC} = R_E + R_L = 1.65K$

$$\Rightarrow V_{CC} = I_{CQ}(R_{DC} + R_{AC}) = 36.5mA(150 + 1.65K) = 65.7 (V)$$

Para R_B necesitamos Z_{in}, del modelo AC:



$$Z_{in} = \frac{R_B(r\pi + \beta R_E)}{R_B + r\pi + \beta R_E}$$

$$r\pi = \frac{\beta 26mV}{I_{CQ}} = 71\Omega$$

Se puede omitir r_π porque $\beta R_E >>> r_\pi$

$$\Rightarrow Z_{in} = R_B \parallel \beta R_E = \frac{\beta R_E R_B}{\beta R_E + R_B} = 2K\Omega$$

$$\Rightarrow \frac{\beta R_E R_B}{2K} = \beta R_E + R_B \Rightarrow \frac{\beta R_E R_B}{2K} - R_B = \beta R_E$$

$$\Rightarrow R_B = \frac{\beta R_E}{\frac{\beta R_E}{2K} - 1} = 2.3K\Omega$$

De la malla de entrada en DC:

$$V_{BB} = \frac{I_{CQ}}{\beta} R_B + V_{BE} + I_{CQ} R_E = 7.01 (V)$$

Finalmente:

$$R_1 = \frac{R_B}{1 - \frac{V_{BB}}{V_{CC}}} = 2.57 K\Omega \quad ; \quad R_2 = \frac{R_B V_{CC}}{V_{BB}} = 21.56 K\Omega .$$