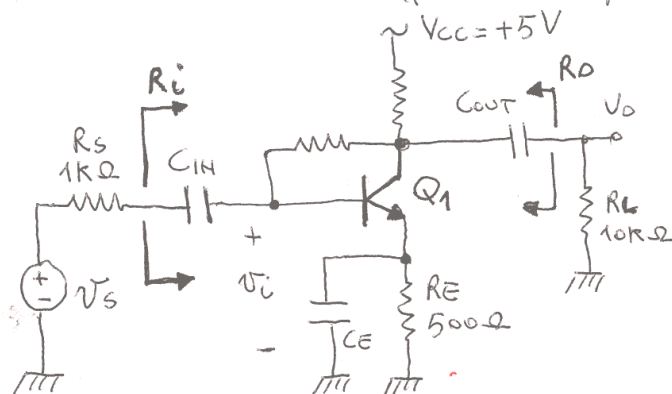


Problema 8.38 (3° Novembre 2004/2005)

1/3

Considerare il seguente amplificatore. Assumere $\beta = 100$, $V_T = 26 \text{ mV}$



e $V_A \rightarrow \infty$.

2) Disegnare il circuito equivalente DC, determinare I_C e I_B .

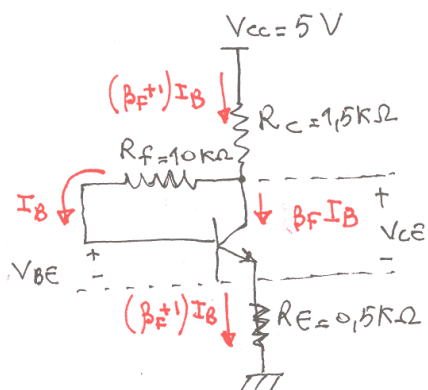
(Assumere $V_{BE} = 0.7 \text{ V}$)

b) Disegnare il circuito ai piccoli segnali a centro bias. Calcolare g_m ed r_{π} ($r_o \rightarrow \infty$).

c) Ottenere l'amplificazione v_o/v_s , R_i ed R_o .

SOLUZIONE

2) POLARIZZAZIONE



$$\begin{cases} (\beta_F + 1) I_B = \frac{V_{CC} - V_{CE}}{R_C + R_E} = \frac{5 - V_{CE}}{2} \\ V_{CE} = R_F I_B + V_{BE} = 10 I_B + 0.7 \end{cases}$$

[NB. Resistenze in $k\Omega$
correnti in mA
tensioni in V]

$$10 I_B = \frac{5 - (10 I_B + 0.7)}{2}$$

$$20 I_B = 5 - 10 I_B - 0.7$$

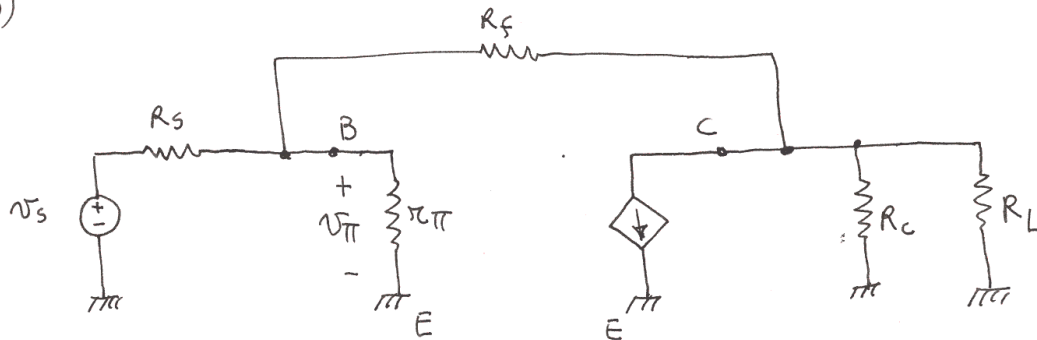
$$I_C = \beta_F I_B = 100 \cdot 20 \mu A = 2 \text{ mA}$$

$$I_B = \frac{4.3}{212} \approx 20 \mu A$$

(segue Problema 8.38)

2/3

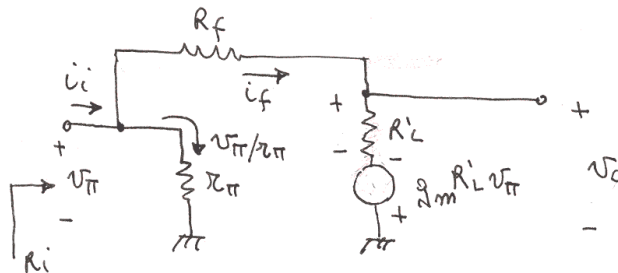
b)



$$g_m = \frac{I_C}{V_T} = \frac{2 \text{ mA}}{26 \text{ mV}} \approx 77 \text{ mA/V}$$

$$r_{\pi} = \frac{V_T}{I_B} = \frac{26 \text{ mV}}{20 \mu\text{A}} = 1,3 \text{ k}\Omega$$

c)



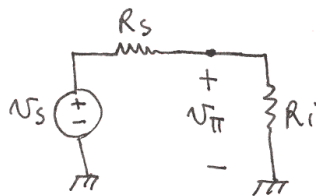
$$R'_L = R_c // R_L = \frac{1}{\frac{1}{1,5 \cdot 10} + \frac{1}{10}} = 1,3 \text{ k}\Omega$$

$$v_o = R'_L i_f - g_m R'_L v_{\pi} = R'_L \frac{v_{\pi} + g_m R'_L v_{\pi}}{R_f + R'_L} - g_m R'_L v_{\pi}$$

$$\frac{v_o}{v_{\pi}} = R'_L \frac{1 + g_m R'_L}{R_f + R'_L} - g_m R'_L = \frac{R'_L}{R_f + R'_L} + g_m R'_L \left(\frac{R'_L}{R_f + R'_L} - 1 \right)$$

$$\frac{v_o}{v_{\pi}} = \frac{R'_L}{R_f + R'_L} (1 - g_m R_f)$$

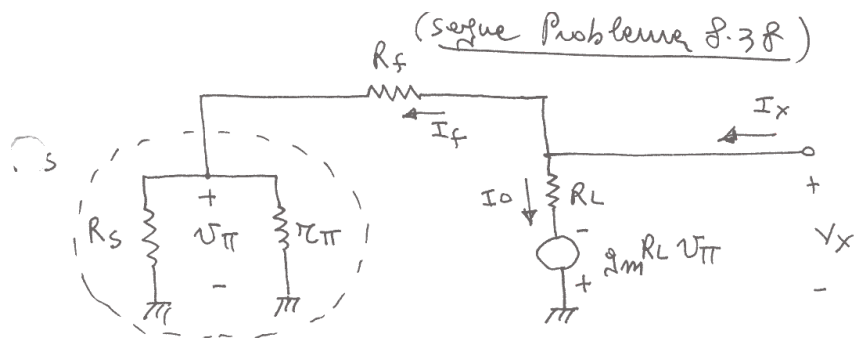
$$R_i = \frac{v_{\pi}}{i_i} = \frac{v_{\pi}}{\frac{v_{\pi}}{r_{\pi}} + \frac{v_{\pi} + g_m R'_L v_{\pi}}{R_f + R'_L}} = \frac{1}{\frac{1}{r_{\pi}} + \frac{1 + g_m R'_L}{R_f + R'_L}} = \frac{1}{\frac{1}{1,3} + \frac{1 + 77 \cdot 1,3}{10 + 1,3}} = 102,9 \Omega$$



$$v_{\pi} = \frac{R_i}{R_i + R_s} v_s$$

$$\frac{v_o}{v_s} = \frac{v_o}{v_{\pi}} \cdot \frac{v_{\pi}}{v_s} = \frac{R_i}{(R_i + R_s)} \cdot \frac{R'_L}{(R_f + R'_L)} \cdot (1 - g_m R_f)$$

$$= \frac{102,9}{102,9 + 1000} \cdot \frac{1,3 \text{ k}}{10 \text{ k} + 1,3 \text{ k}} \cdot (1 - 77 \cdot 10) = -8,254$$



3/3

$$R'_s = R_s // r_{\pi}$$

$$= \frac{1.1,3}{1+1,3} \approx 0,565k$$

$$V_{\pi} = V_x \cdot \frac{R'_s}{R'_s + R_f}$$

$$\begin{aligned} R_o &= \frac{V_x}{I_x} = \frac{\frac{R'_s + R_f}{R'_s} V_{\pi}}{I_o + I_f} = \frac{\frac{R'_s + R_f}{R'_s} V_{\pi}}{\frac{V_x + g_m R_L V_{\pi}}{R_L} + \frac{V_{\pi}}{R'_s}} \\ &= \frac{\frac{R'_s + R_f}{R'_s} \cancel{V_{\pi}}}{\frac{\frac{R'_s + R_f}{R'_s} \cancel{V_{\pi}} + g_m R_L \cancel{V_{\pi}}}{R_L} + \frac{\cancel{V_{\pi}}}{R'_s}} = \frac{R'_s + R_f}{\frac{R'_s + R_f}{R_L} + g_m R'_s + 1} \\ &= \frac{0,565 + 10}{\frac{0,565 + 10}{1,5} + 77 \cdot 0,565 + 1} = \boxed{204,95 \Omega} \end{aligned}$$