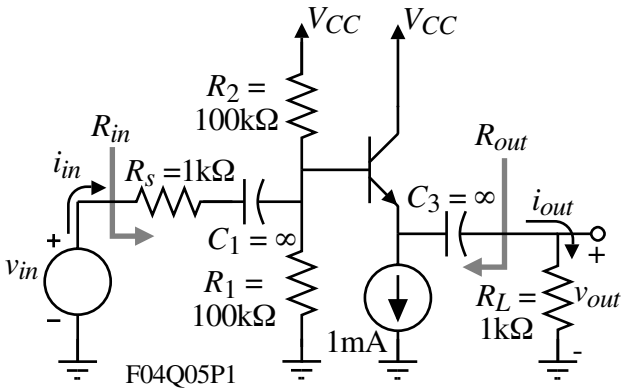
QUIZ NO. 5 - SOLUTION

(Average = 6.6/10 of those taking the quiz)

An NPN BJT common-collector amplifier is shown. Assume the parameters of the transistor are $\beta_F = \beta_o = 100$, $V_T = 25\text{mV}$, and $V_A = \infty$. Find the numerical value for the small signal voltage gain, v_{out}/v_{in}, the input resistance, R_{in}, the output resistance, R_{out}, and the current gain, i_{out}/i_{in}.

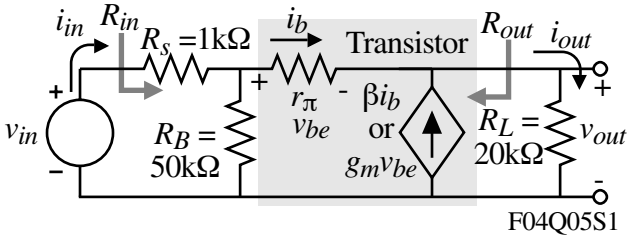


Solution

Find the small-signal parameters first:

$$g_m = \frac{I_C}{V_T} \approx \frac{1\text{mA}}{25\text{mV}} = \frac{1}{25\Omega} \qquad \rightarrow \qquad r_\pi = \frac{\beta_o}{g_m} = 25 \cdot 100 = 2.5\text{k}\Omega$$

The small-signal model is:



$$R_{in} = R_s + R_B \,||\, [r_\pi + (1+\beta_o)R_L] = 1\text{K} + 50\text{K} \,||\, [2.5\text{K} + (101)1\text{K}]$$

$$= 1\text{K} + 33.71\text{K} = \underline{34.71\text{k}\Omega}$$

$$R_{out} = \frac{r_\pi + R_s \,||\, R_B}{1+\beta_o} = \frac{2.5\text{K} + 1\text{K} \,||\, 50\text{K}}{101} = \frac{2.5\text{K} + 0.98\text{K}}{101} = \underline{34.46\Omega}$$

$$\frac{v_{out}}{v_{in}} = \left(\frac{v_{out}}{i_b}\right)\left(\frac{i_b}{i_{in}}\right)\left(\frac{i_{in}}{v_{in}}\right) = [(1+\beta_o)R_L]\left[\frac{R_B}{R_B + r_\pi + (1+\beta_o)R_L}\right]\left[\frac{1}{R_{in}}\right]$$

$$= (101 \cdot 1\text{K})\left[\frac{50\text{K}}{50\text{K} + 2.5\text{K} + 101\text{K}}\right]\left[\frac{1}{34.71\text{K}}\right] = \frac{(101\text{K})(0.326)}{34.7\text{K}} = \underline{0.948\text{V/V}}$$

$$\frac{i_{out}}{i_{in}} = \left(\frac{v_{out}}{R_L}\right)\left(\frac{v_{in}}{R_{in}}\right) = \left(\frac{v_{out}}{v_{in}}\right)\left(\frac{R_{in}}{R_L}\right) = 0.948\left(\frac{34.71}{1}\right) = \underline{32.9\text{A/A}}$$