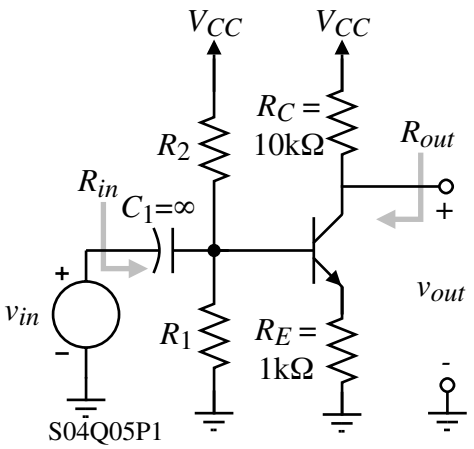
QUIZ NO. 5

(Average score = 7.5/10 for those taking the quiz.)

An NPN BJT common-emitter inverting amplifier is shown. Assume the parameters of the transistor are $\beta_o = 100$, $V_T = 25\text{mV}$, and $V_A = 100\text{V}$. (a.) If $I_C = 0.5\text{mA}$ and $V_{CE} = 3\text{V}$, find the small signal model parameter values for g_m, r_π, and r_o. (b.) Find the numerical value for the small signal voltage gain, v_{out}/v_{in}, the input resistance, R_{in}, and the output resistance, R_{out}. Assume $r_o = \infty$ in this part of the problem.

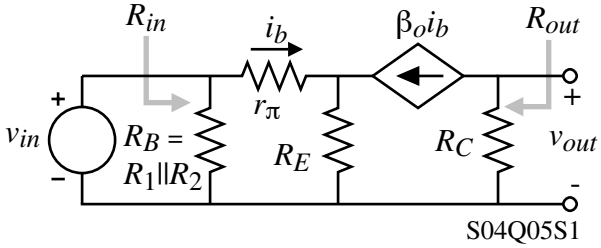


Solution

(a.) $$g_m = \frac{I_C}{V_T} = \frac{0.5\text{mA}}{25\text{mV}} = \underline{\underline{20\text{mS}}}$$

$$r_\pi = \beta_F \frac{V_T}{I_C} = \frac{100}{20\text{mS}} = \underline{\underline{5\text{k}\Omega}} \qquad r_o = \frac{V_A + V_{CE}}{I_C} = \frac{102}{0.5\text{mA}} = \underline{\underline{204\text{k}\Omega}}$$

(b.) The small signal model for this problem is shown (note a current controlled generator has been chosen for this problem).



Using the BE impedance reflection principle we get,

$$R_{in} = r_\pi + (1+\beta_o)R_E$$

$$= 5\text{k}\Omega + (101)1\text{k}\Omega = \underline{\underline{106\text{k}\Omega}}$$

($R_B = R_1 \| R_2$ is not part of this because it is in parallel with v_{in} and is not a part of R_{in}.)

$$R_{out} = R_C = \underline{\underline{10\text{k}\Omega}}$$

$$\frac{v_{out}}{v_{in}} = \left(\frac{v_{out}}{i_b}\right)\left(\frac{i_b}{v_{in}}\right) = (-\beta_o R_C)\left(\frac{1}{R_{in}}\right) = \frac{-100 \cdot 10\text{k}\Omega}{106\text{k}\Omega} = \underline{\underline{-9.434\ \text{V/V}}}$$