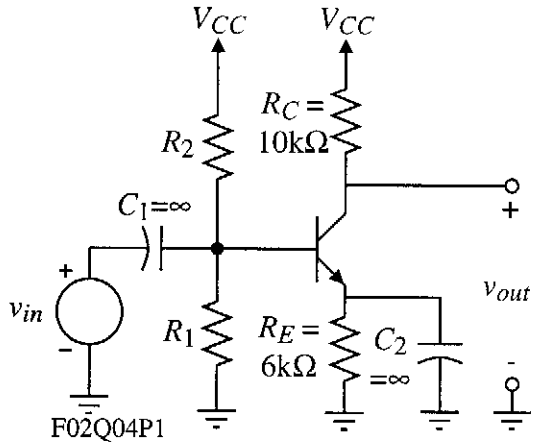
QUIZ NO. 4 - SOLUTION

(Average score = 7.2/10, 5 people did not take the quiz so true average is higher.)

An NPN BJT common-emitter inverting amplifier is shown. Assume the parameters of the transistor are $\beta_F = 100$, $V_T = 25\text{mV}$, 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 an algebraic expression for the small signal voltage gain, v_{out}/v_{in}. (c.) Numerically evaluate the small signal voltage gain, v_{out}/v_{in}.

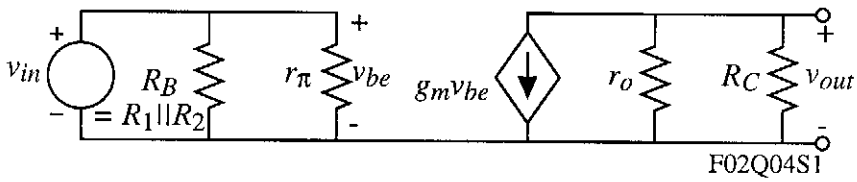


Solution

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

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

(b.) To find the small signal voltage gain, we must first develop a small signal model. This model is given below:



$$\boxed{\frac{v_{out}}{v_{in}} = \frac{v_{out}}{v_{be}} = -g_m(r_o \| R_C)}$$

(c.) The numerical value of this gain is

$$\frac{v_{out}}{v_{in}} = -20\text{mS}(204\text{k}\Omega \| 10\text{k}\Omega) = -20\text{mS}(9.53\text{k}\Omega) = \underline{-190.65\ \text{V/V}}$$