ECE 3050A – Fall 2002

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 $g_m$, $r_\pi$, 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.) $g_m = \frac{I_C}{V_T} = \frac{0.5\text{mA}}{25\text{mV}} = 20\text{mS}$

$r_\pi = \beta_o \frac{V_T}{I_C} = \frac{100}{20\text{mS}} = 5k\Omega$

$r_o = \frac{V_A + V_{CE}}{I_C} = \frac{102}{0.5\text{mA}} = 204k\Omega$

(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,

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

$= 5k\Omega + (101)1k\Omega = 106k\Omega$

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

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

$\frac{v_{out}}{v_{in}} = \left(\frac{v_{out}}{i_b}\right)\left(\frac{i_b}{v_{in}}\right) = (-\beta_oR_C)\left(\frac{1}{R_{in}}\right) = \frac{-100\cdot10k\Omega}{106k\Omega} = 9.434 \text{ V/V}$