QUIZ NO. 4 - SOLUTION

(Average score = 7.9/10 of the students taking the quiz.)

A PNP BJT common-emitter inverting amplifier is shown. Assume the parameters of the transistor are $\beta_F = 50$, $V_T = 25\text{mV}$, and $V_A = 100\text{V}$. (a.) Find the small signal model parameter values for $g_m$, $r_\pi$, and $r_o$ (ignore $V_{EC}$ in the calculation of $r_o$). (b.) Find an algebraic expression for the small signal voltage gain, $v_{out}/v_{in}$, the input resistance, $R_{in}$, and the output resistance, $R_{out}$. (c.) Numerically evaluate the small signal voltage gain, $v_{out}/v_{in}$, the input resistance, $R_{in}$, and the output resistance, $R_{out}$.

Solution

(a.) $I_C = \frac{50}{51} (0.5\text{mA}) = 0.49\text{mA}$

$g_m = \frac{I_C}{V_T} = \frac{0.49\text{mA}}{25\text{mV}} = 19.6mS$

$r_\pi = \beta_F \frac{V_T}{I_C} = \frac{50}{19.6mS} = 2.55k\Omega$

$r_o = \frac{V_A}{I_C} = \frac{100}{0.49\text{mA}} = 204k\Omega$

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

(c.) The numerical value of the above expressions are,

$\frac{v_{out}}{v_{in}} = -19.6mS(204k\Omega||10k\Omega) = -19.6mS(9.533k\Omega) = -186.84 \text{ V/V}$

$R_{in} = 100k\Omega||100k\Omega||2.55k\Omega = 2.426k\Omega$

and

$R_{out} = 204k\Omega||10k\Omega = 9.533k\Omega$