Homework Assignment No. 1

Due on Monday, January 12, 2004

1.) (a.) Find the dc current, \( I_{DQ} \), and the dc voltage, \( V_{DQ} \), of the diode in the circuit shown if \( V_{IN} = +10V \). Assume the large signal model for the diode is a short circuit when \( v_D \geq 0V \) and an open circuit when \( v_D \leq 0V \). (b.) Repeat part (a.) if \( V_{IN} = -10V \).

2.) An enhancement NMOS amplifier is shown. The following questions are independent of each other (i.e. the answer of one is not used in the next question).

(a.) If \( I_D = 0.5mA \), \( V_T = 1V \), and \( K = 0.5mA/V \), find \( g_m \).

(b.) If \( g_m = 0.5mA/V \) and \( r_o = \infty \), find an algebraic expression for \( R_{out} \) and \( A_v = v_{out}/v_{in} \).

(c.) Design \( R_D \) and \( R_S \) to give \( R_{out} = 10k\Omega \) and \( A_v = -10V/V \) if \( g_m = 2mA/V \) and \( r_o = \infty \).

3.) A pnp BJT circuit is shown. (a.) Find the dc values of \( I_E \), \( I_C \), \( I_B \), \( V_E \), \( V_C \) and \( V_B \) if \( \beta = 50 \) and \( V_{EB(on)} = 0.65V \). (b.) For what value of \( R_C \) does the BJT become saturated? (Recall that saturation of a BJT corresponds to the BE and BC junctions forward biased.)

4.) For the transistor shown, \( \beta = 100 \), \( r_\pi = 2.5k\Omega \), and \( g_m = 0.04S \). Draw the small signal model and find the numerical values of the small signal voltage gain, \( v_{out}/v_{in} \), the input resistance, \( R_{in} \), and the output resistance, \( R_{out} \).
5.) The following questions give the dc voltages at the terminals of an active device. You are to calculate the designated dc current.

a.) Find the diode current, $I_D$, where $I_S = 100\text{fA}$ and $V_T = 0.025\text{V}$ (2 pts).

b.) Find the drain-source current, $I_{DS}$, where $K_n' = 25\mu\text{A/V}^2$, $V_{TN} = 1\text{V}$ and $W/L = 10$ (2 pts).

c.) Find the collector, emitter, and base currents, $I_C$, $I_E$, and $I_B$ if $I_S = 100\text{fA}$, $V_T = 0.025\text{V}$ and $\beta_F = 100$ (4 pts).

d.) Repeat (b.) if $V_D = 1\text{V}$ and $V_G = 3\text{V}$ (2 pts).