ECE 3050 Analog Electronics Quiz 4

September 16, 2009

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Instructions. Print your name in the spaces above. Place a box around any answer. **Honor Code Statement:** *I have neither given nor received help on this quiz.* Initials _____

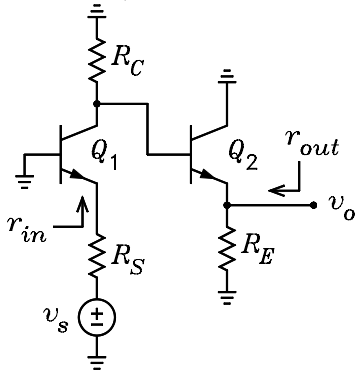
Given equations: $i_c' = g_m v_\pi = \alpha i_e' = \beta i_b$, $g_m = I_C/V_T$, $r_\pi = V_T/I_B$, and $r_e = V_T/I_E$, and $I_C = \alpha I_E = \beta I_B$.

1 of 2. The signal circuit of a two-stage BJT amplifier is shown. It is given that $I_{E1} = 1.25\,\text{mA}$, $I_{E2} = 2.5\,\text{mA}$, $\alpha = 0.99$, $\beta = 99$, $r_x = 0\,\Omega$, $r_0 = \infty$, $V_T = 0.025\,\text{V}$, $R_S = 50\,\Omega$, $R_C = 2.4\,\text{k}\Omega$, and $R_E = 300\,\Omega$.

(a) In terms of CE, CB, and CC, how would you describe this circuit?

(b) Solve for r_{in}.

(c) Denote the Thévenin equivalent circuit seen looking out of the base of Q_2 by v_{tb2} and R_{tb2}. With Q_2 erased, solve for v_{tb2}/v_s and R_{tb2}. Use any one of the small-signal circuits covered in class.



Let $v_s := 1$ The value off v_o is the voltage gain.

$r_{e1} := \frac{V_T}{I_{E1}}$ $r_{e1} = 20$ $r_{e2} := \frac{V_T}{I_{E2}}$ $r_{e2} = 10$ $r'_{e1} := r_{e1}$

$i'_{e1} := \frac{-v_s}{R_S + r'_{e1}}$ $i'_{e1} = -0.014$ $v_{tb2} := -\alpha \cdot i'_{e1} \cdot R_C$ $v_{tb2} = 33.943$

$r_{in} := r'_{e1}$ $r_{in} = 20$

2 of 2. Replace the circuit seen looking out of the base of Q_2 with a voltage source labeled v_{tb2} in series with the resistance R_{tb2} found in problem 1.

(a) Solve for v_o/v_{tb2} and r_{out}. Use any one of the small-signal circuits covered in class. Note – you don't need a number for v_{tb2}, but you do need a number for R_{tb2}. Even if you don't know how to work problem 1, you should be able to tell the value of R_{tb2} by inspection of the circuit diagram given.

(b) Put the answers for problems 1 and 2 together to solve for v_o/v_s.

$R_{tb2} := R_C$ $\quad r'_{e2} := \frac{R_{tb2}}{1+\beta} + r_{e2}$ $\quad r'_{e2} = 34$ $\quad i'_{e2} := \frac{v_{tb2}}{r'_{e2} + R_E}$ $\quad i'_{e2} = 0.102$

$v_{o1} := i'_{e2} \cdot R_E$ $\quad v_{o1} = 30.488$ Solution 1

$v_{o2} := v_{tb2} \cdot \frac{R_E}{r'_{e2} + R_E}$ $\quad v_{o2} = 30.488$ Solution 2

$r_{out} := R_{p2}(R_E, r'_{e2})$ $\quad r_{out} = 30.539$