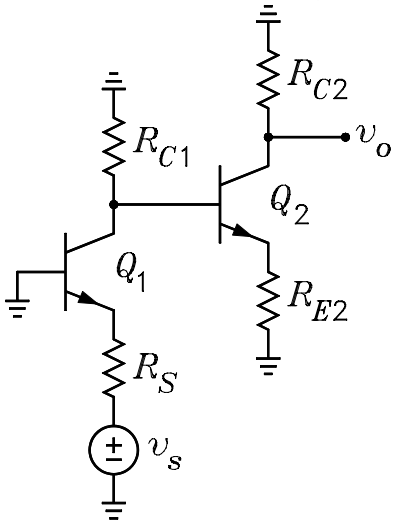
ECE 3050 Analog Electronics Quiz 5

September 23, 2009

Professor Leach Name_____

Instructions. Print your name in the space above. Place a box around your answer. Express each numerical answer as a decimal number. **Honor Code Statement:** *I have neither given nor received help on this quiz.* Initials _____

The figure shows a CB/CE amplifier. For each transistor, $r_x = 100\,\Omega$, $\beta = 99$, $\alpha = 0.99$, $I_E = 1\,\text{mA}$, $r_{ic} = 100\,\text{k}\Omega$, and $V_T = 25\,\text{mV}$. The circuit element values are $R_S = 82\,\Omega$, $R_{C1} = 12\,\text{k}\Omega$, $R_{E2} = 50\,\Omega$, and $R_{C2} = 16\,\text{k}\Omega$. Reference equations: $g_m = I_C/V_T$, $r_\pi = V_T/I_B$, $r_e = V_T/I_E$, $i'_c = g_m v_\pi = \beta i_b = \alpha i'_e$, $r'_\pi = r_x + r_\pi + (1+\beta)\,R_{te}$, $r'_e = (R_{tb} + r_x)\,/\,(1+\beta) + r_e$. **First express your answers in symbolic form. Then evaluate them numerically. Draw a box around your answers.**



$$r_e = \frac{V_T}{I_E} = 25\,\Omega \qquad r'_{e1} = \frac{r_x}{1+\beta} + r_e = 26\,\Omega$$

$$R_{tb2} = R_{C1} \| r_{ic1} = 10.71\,\text{k}\Omega \qquad r'_{e2} = \frac{R_{tb2} + r_x}{1+\beta} + r_e = 133.143\,\Omega$$

The following solutions are based on the simplified T model.

(a) Solve for i'_{c1}/v_s.

$$i'_{c1} = \alpha i'_{e1} = \alpha \frac{-v_s}{R_S + r'_{e1}} = -9.167 \times 10^{-3} v_s \qquad \Longrightarrow \qquad \frac{i'_{c1}}{v_s} = -9.167 \times 10^{-3}$$

(b) Solve for v_{tb2}/i'_{c1}.

$$v_{tb2} = -i'_{c1} R_{C1} \| r_{ic1} = -10.71 \times 10^3 i'_{c1} \qquad \Longrightarrow \qquad \frac{v_{tb2}}{i'_{c1}} = -10.71 \times 10^3$$

(c) Solve for i'_{c2}/v_{tb2}.

$$i'_{c2} = \alpha i'_{e2} = \alpha \frac{v_{tb2}}{R_{E2} + r'_{e2}} = 5.406 \times 10^{-3} v_{tb2} \qquad \Longrightarrow \qquad \frac{i'_{c2}}{v_{tb2}} = 5.406 \times 10^{-3}$$

(d) Solve for v_o/i'_{c2}.

$$v_o = -i'_{c2}R_{C2}\|r_{ic2} = -13.79 \times 10^3 i'_{c2} \qquad \Longrightarrow \qquad \frac{v_o}{i'_{c2}} = -13.79 \times 10^3$$

(e) Combine the above answers to solve for v_o/v_s.

$$\frac{v_o}{v_s} = \frac{i'_{c1}}{v_s} \times \frac{v_{tb2}}{i'_{c1}} \times \frac{i'_{c2}}{v_{tb2}} \times \frac{v_o}{i'_{c2}} = -7323$$