ECE 3050 Analog Electronics Quiz 5
February 11, 2009

Professor Leach Last Name:______________________________First Name:______________________________

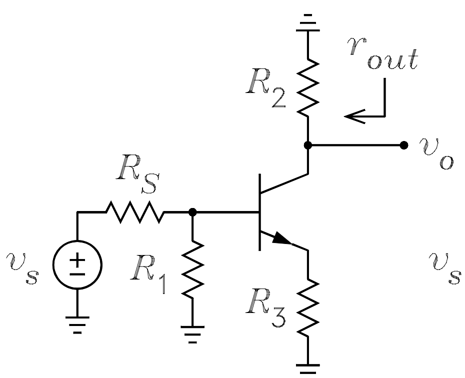
Instructions. Print your name in the spaces above. Place a box around any answer. **Honor Code Statement:** *I have neither given nor received help on this quiz.* Initials ____________

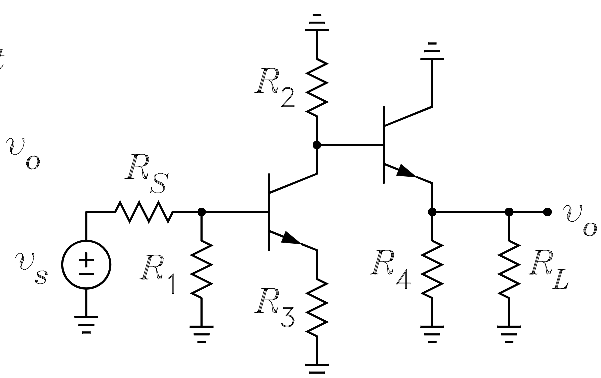
For the transistors in this problem, assume the parameters $\beta = 100$, $g_m = 1/25\,\mathrm{S}$, $r_x = 0$, $r_\pi = 2.5\,\mathrm{k\Omega}$, $r_e = 24.75\,\Omega$, and $r_0 = \infty$ (an open circuit).

$$r_\pi = \frac{V_T}{I_B} \qquad r_e = \frac{V_T}{I_E} \qquad g_m = \frac{I_C}{V_T} \qquad r'_\pi = r_x + r_\pi + (1+\beta)\,R_{te}$$

$$r_0 = \frac{V_A + V_{CE}}{I_C} \qquad r'_e = \frac{R_{tb} + r_x}{1+\beta} + r_e \qquad r_{ic} = \frac{r_0 + r'_e \| R_{te}}{1 - \alpha \dfrac{R_{te}}{r'_e + R_{te}}}$$

(a) The figure on the left shows the signal circuit of a CE amplifier. It is given that $R_S = 1\,\mathrm{k\Omega}$, $R_1 = 10\,\mathrm{k\Omega}$, $R_2 = 3\,\mathrm{k\Omega}$, and $R_3 = 75\,\Omega$. Solve for the small-signal Thévenin equivalent circuit seen looking into its output terminal. The circuit should be in the form of a voltage source $A_1 v_s$ in series with a resistor r_{out}, where you must give numerical values for A_1 and r_{out}.
(b) A load resistor $R_L = 300\,\Omega$ is connected from the output to ground. Use the Thévenin equivalent circuit found in part (a) to solve for the new value of v_o.
(c) The figure on the right shows the signal circuit of the CE amplifier with a CC stage added between the CE stage and the $300\,\Omega$ load resistor. If $R_4 = 2\,\mathrm{k\Omega}$, solve for the new value of v_o.
(d) Why does the voltage gain increase with the addition of a CC stage which has a voltage gain by itself that is less than unity?





Over for solutions.

Quiz 5

$R_S := 1000 \quad R_1 := 10000 \quad R_2 := 3000 \quad R_3 := 75 \quad R_4 := 2000 \quad R_L := 300$

$\beta := 100 \quad g_m := \frac{1}{25} \quad r_\pi := 2500 \quad r_e := 24.75 \quad v_s := 1$

Part (a)

First Solution:

$r'_\pi := r_\pi + (1+\beta)\cdot R_3 \quad r'_\pi = 1.008\cdot 10^4 \quad v_{tb1} := v_s \cdot \frac{R_1}{R_S + R_1} \quad v_{tb1} = 0.909$

$R_{tb1} := R_{p2}(R_S, R_1) \quad R_{tb1} = 9.091\cdot 10^2 \quad i_{b1} := \frac{v_{tb1}}{R_{tb1} + r'_\pi} \quad i_{b1} = 8.276\cdot 10^{-5}$

$i'_{c1} := \beta \cdot i_{b1} \quad i'_{c1} = 8.276\cdot 10^{-3} \quad v_{o1} := -i'_{c1}\cdot R_2 \quad v_{o1} = -24.829$

$r_{out} := R_2 \quad r_{out} = 3\cdot 10^3$

Second Solution:

$r'_{e1} := \frac{R_{tb1}}{1+\beta} + r_e \quad r'_{e1} = 33.751 \quad i'_{e1} := \frac{v_{tb1}}{r'_{e1} + R_3} \quad i'_{e1} = 8.359\cdot 10^{-3}$

$i'_{c1} := \frac{\beta}{1+\beta}\cdot i'_{e1} \quad i'_{c1} = 8.277\cdot 10^{-3} \quad v_{o1} := -i'_{c1}\cdot R_2 \quad v_{o1} = -24.83$

Part (b)

$v_{o2} := v_{o1}\cdot \frac{R_L}{r_{out} + R_L} \quad v_{o2} = -2.257$

Part (c)

$r'_{e2} := \frac{r_{out}}{1+\beta} + r_e \quad r'_{e2} = 54.453 \quad v_{o3} := v_{o1}\cdot \frac{R_{p2}(R_4, R_L)}{r'_{e2} + R_{p2}(R_4, R_L)} \quad v_{o3} = -20.542$

Part (d)

Because the CC stage has a much lower loutput resistance than the CE stage.