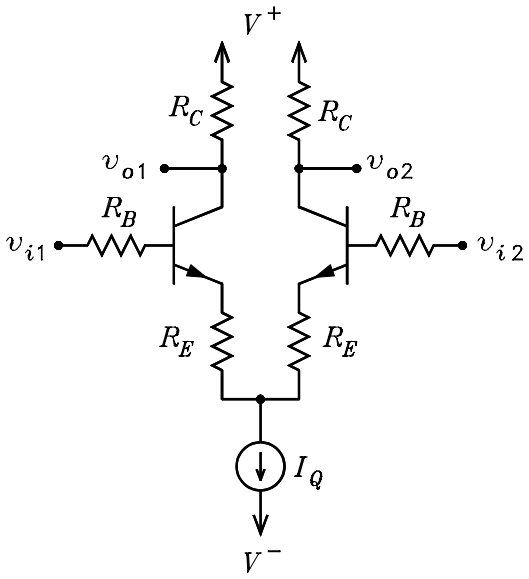
ECE 3040 Microelectronic Circuits Quiz 9

July 14, 2004

Professor Leach Name_____

Instructions. Print your name in the space above. The quiz is closed-book and closed-notes. The quiz consists of one problem. **Honor Code Statement:** *I have neither given nor received help on this quiz.* Initials _____

1. It is given that $V^+ = 18\,\text{V}$, $V^- = -18\,\text{V}$, $I_Q = 1\,\text{mA}$, $R_B = 1\,\text{k}\Omega$, $R_E = R_C/200$, $\beta = 99$, $r_0 = \infty$, and $V_T = 25\,\text{mV}$. Solve for R_C such that $v_{o1} = -v_{o2} = -50\,(v_{i1} - v_{i2})$.



In the simplified T model of each BJT, r_e' is given by

$$r_e' = \frac{R_B}{1+\beta} + \frac{2V_T}{I_Q} = 60\,\Omega$$

From the simplified T model circuit

$$i_{e1}' = -i_{e2}' = \frac{v_{I1} - v_{I2}}{2\,(r_e' + R_E)} = \frac{v_{I1} - v_{I2}}{2\,(r_e' + R_C/200)}$$

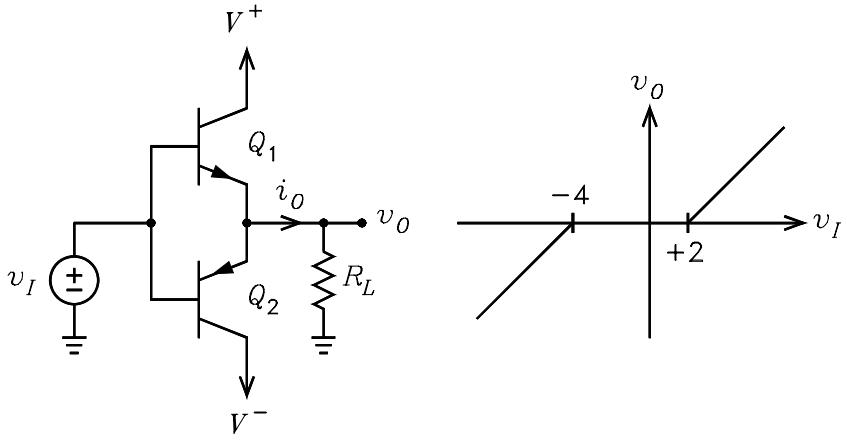
The two output voltages are given by

$$v_{o1} = -v_{02} = -\alpha i_{e1}' R_C = \frac{-\alpha R_C}{2\,(r_e' + R_C/200)}\,(v_{I1} - v_{I2}) = -50\,(v_{i1} - v_{i2})$$

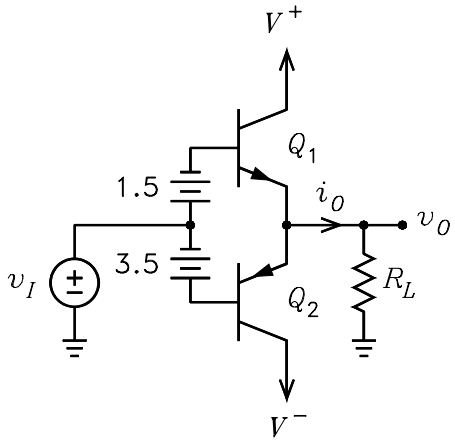
It follows that

$$\alpha R_C = 2 \times 50\left(r_e' + \frac{R_C}{200}\right) \Longrightarrow (\alpha - 0.5)\,R_C = 100 r_e' \Longrightarrow R_C = \frac{100 r_e'}{\alpha - 0.5} = 12.24\,\text{k}\Omega$$

2. (a) Q_1 and Q_2 both have the cutin voltage $V_\gamma = 0.5\,\text{V}$. How can the circuit be modified to produce the given v_O versus v_I graph? Draw and label the circuit. You may add any circuit element or elements to achieve the desired graph.



The simplest circuit uses two batteries as shown.



Transistors with the base-emitter junctions in series could also be used. It would tke 4 NPN transistors and 8 PNP transistors.

(b) Let v_I be a sine wave with a peak voltage of 10 V. On the same axes, draw and label the graphs of v_I and v_O versus time. For the given graph of v_O versus v_I, assume that the two lines have a slope $m = +1$.