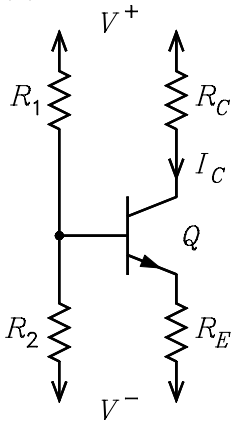
ECE 3040 Microelectronic Circuits Quiz 7

June 30, 2004

Professor Leach Name_____

Instructions. Print your name in the space above. The quiz is closed-book and closed-notes. The quiz consists of 2 problems. **Honor Code Statement:** *I have neither given nor received help on this quiz.* Initials _____

1. The BJT has the parameters $\beta = 199$ and $V_{BE} = 0.65\,\text{V}$. It is given that $V^+ = +15\,\text{V}$, $V^- = -15\,\text{V}$, $R_1 = 300\,\text{k}\Omega$, and $R_2 = 33\,\text{k}\Omega$.
   (a) Solve for R_E such that $I_C = 2\,\text{mA}$.
   (b) What is the maximum value that R_C can have for the BJT to remain in the active mode?



Answers:

$$V_{BB} = \frac{V^+R_2 + V^-R_1}{R_1 + R_2} = -12.027\,\text{V} \qquad R_{BB} = R_1 \| R_2 = 29.73\,\text{k}\Omega$$

$$V_{BB} - V^- = \frac{I_C}{\beta}R_{BB} + V_{BE} + \frac{I_C}{\alpha}R_E \Longrightarrow R_E = \alpha\left(\frac{V_{BB} - V^- - V_{BE}}{I_C} - \frac{R_{BB}}{\beta}\right) = 1007\,\Omega$$

$$\begin{aligned} V_{CB} &= \left(V^+ - I_C R_C\right) - \left(V_{BE} + \frac{I_C}{\alpha}R_E + V^-\right) > 0 \\ &\Longrightarrow \quad R_C = \frac{1}{I_C}\left[V^+ - \left(V_{BE} + \frac{I_C}{\alpha}R_E + V^-\right)\right] < 13.66\,\text{k}\Omega \end{aligned}$$

2. The BJT active mode currents are given by the equations $i_C = I_{S0}\left(1 + v_{CE}/V_A\right)\exp\left(v_{BE}/V_T\right)$, $i_B = i_C/\beta$, and $\beta = \beta_0\left(1 + v_{CE}/V_A\right)$. Describe how these equations are used to plot the transfer, output, and input characteristic curves. Show how the parameters g_m, r_0, and r_π in the hybrid-pi model are defined on the curves. Assume the Q-point values I_C, V_{CE}, and V_{BE}. **Answers:** The plots of the characteristic curves are covered in the class notes. At the Q point, g_m is the slope of the transfer characteristic curve, r_0 is the reciprocal of the slope of the output characteristic curve, and r_π is the reciprocal of the slope of the input characteristic curve.