ECE 3050 Analog Electronics Quiz 2

June 2, 2010

Professor Leach Last Name:_____ First Name:_____

Instructions. Print and sign your name in the spaces above. Place a box around answers when appropriate.

Honor Code Statement: *I have neither given nor received help on this quiz.* Initials _____

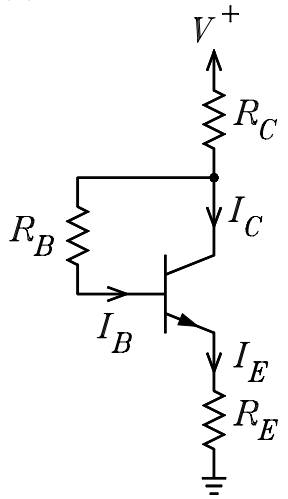
1 of 2. Given: $R_C = 12\,\text{k}\Omega$, $R_B = 82\,\text{k}\Omega$, $R_E = 1.5\,\text{k}\Omega$, $V^+ = 15\,\text{V}$, $\beta = 99$, $V_{BE} = 0.65\,\text{V}$, and $I_C = \beta I_B = \alpha I_E$

(a) Write the equations for V_{BB} and R_{BB}. Why is R_B not a part of the equation for V_{BB}?

(b) Write the equations for V_{CC} and R_{CC}.

(c) Draw the bias equivalent circuit and write the loop equation for I_C.

(d) Use the equation found above to solve numerically for I_C.



$$V_{BB} = V^+ - I_C R_C \qquad R_{BB} = R_B + R_C$$

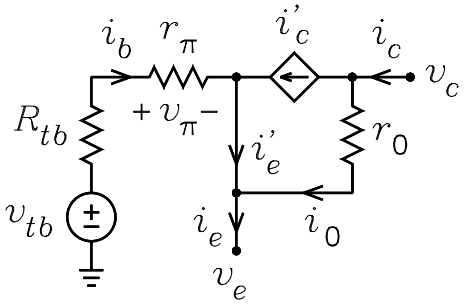
R_{BB} is not part of V_{BB} because you set $I_B = 0$ to solve for V_{BB}.

$$V_{CC} = V^+ - I_B R_C \qquad R_{CC} = R_C$$

$$V_{BB} - V_{EE} = I_B R_{BB} + V_{BE} + I_E R_{EE} \Longrightarrow V^+ - I_C R_C = \frac{I_C}{\beta}(R_B + R_C) + V_{BE} + \frac{I_C}{\alpha} R_E$$

$$I_C = \frac{V^+ - V_{BE}}{R_C + \dfrac{R_B + R_C}{\beta} + \dfrac{R_E}{\alpha}} = 1\,\text{mA}$$

2 of 2. (a) The hybrid-π model of the BJT is shown with a Thévenin equivalent source connected to the base. Write the equation for the emitter voltage v_e as a function of v_{tb}, i_b, and any appropriate resistors.
(b) If i_0 is neglected and $i_c' = g_m v_\pi = \beta i_b = \alpha i_e'$, solve the equation obtained above for v_e as a function of v_{tb}, i_e, and any appropriate resistors.
(c) Use the equation obtained above to obtain and draw the Thévenin equivalent circuit seen looking into the emitter.



$$\begin{aligned} v_e &= v_{tb} - i_b\left(R_{tb}+r_\pi\right) = v_{tb} - \frac{i_e'}{1+\beta}\left(R_{tb}+r_\pi\right) \\ &= v_{tb} - \left(i_e - i_0\right)\frac{R_{tb}+r_\pi}{1+\beta} \simeq v_{tb} - i_e\frac{R_{tb}+r_\pi}{1+\beta} \end{aligned}$$

The circuit is a voltage source v_{tb} in series with a resistor $\left(R_{tb}+r_\pi\right)/\left(1+\beta\right)$.