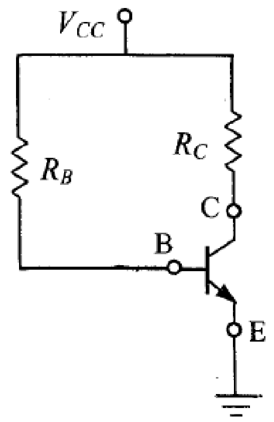
BJT Biasing Homework Problems

1. Emitter Biased, Common Emitter
   Determine the quiescent operating point (I_{CQ} & V_{CEQ}) and $V_{CE\ Cut\text{-}off}$ & $I_{C\ Saturation}$

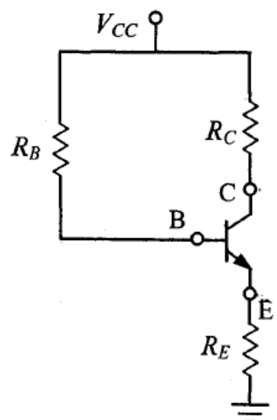
   β = 150
   V_{CC} = 10 V
   R_B = 300K Ω
   R_C = 1100 Ω



Find:
   a. Quiescent Current I_{CQ}
   b. Quiescent Voltage V_{CEQ}
   c. $V_{CE\ Cut\text{-}off}$
   d. $I_{C\ Saturation}$

2. Emitter Biased, Common Emitter with Emitter Resistor
   Determine the quiescent operating point (I_{CQ} & V_{CEQ}) and $V_{CE\ Cut\text{-}off}$ & $I_{C\ Saturation}$

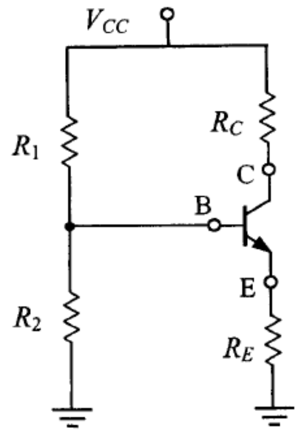
   β = 180
   V_{CC} = 16 V
   R_B = 330K Ω
   R_C = 1100 Ω
   R_E = 550 Ω



Find:
   a. Quiescent Current I_{CQ}
   b. Quiescent Voltage V_{CEQ}
   c. $V_{CE\ Cut\text{-}off}$
   d. $I_{C\ Saturation}$

BJT Biasing Homework Problems

3. Voltage-Divider Biased, Common Emitter Configuration
   Calculate the quiescent points (I_{CQ} and V_{CEQ})
   And determine $V_{CE\ Cut\text{-}off}$ and $I_{C\ Saturation}$



   β = 100
   V_{CC} = 16 V
   R_1 = 47K Ω
   R_2 = 12K Ω
   R_C = 2200 Ω
   R_E = 1800 Ω

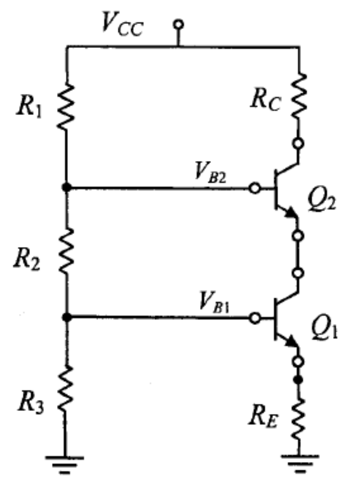
Find:
   a. Quiescent Current I_{CQ}

   b. Quiescent Voltage V_{CEQ}

   c. $V_{CE\ Cut\text{-}off}$

   d. $I_{C\ Saturation}$

4. Voltage-Divider Biased, Cascaded Amplifier
   Calculate the quiescent points (I_{CQ} and V_{CEQ}) for Q_1 and Q_1.



   β_1 and β_2 = 100
   V_{CC} = 21 V
   R_1 = 47K Ω
   R_2 = 10K Ω
   R_3 = 15K Ω
   R_C = 1200 Ω
   R_E = 1800 Ω

Find:
   a. Q_1 I_{CQ}

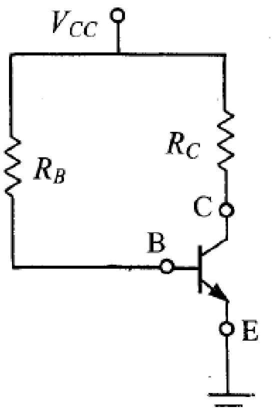
   b. Q_1 V_{CEQ}

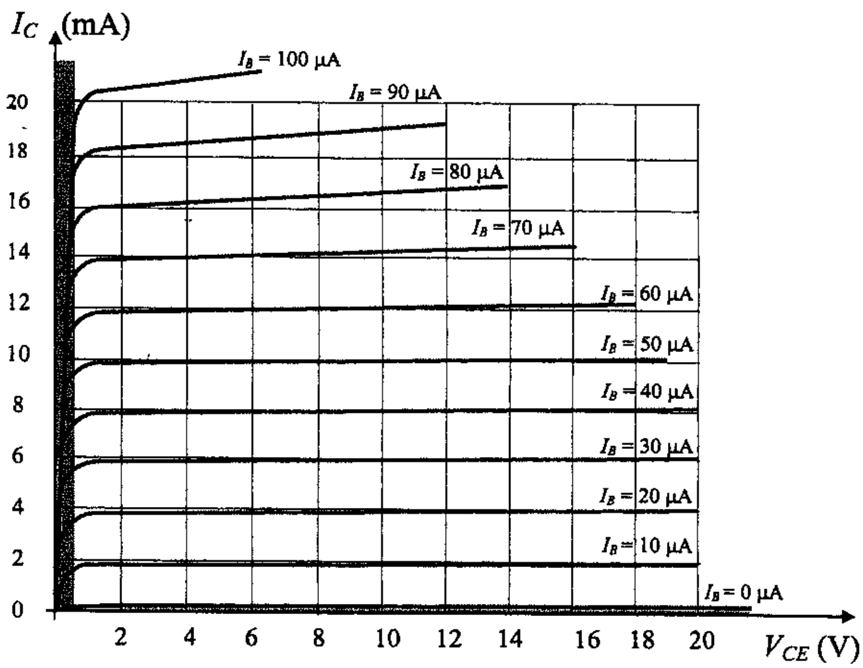
   c. Q_2 I_{CQ}

   d. Q_2 V_{CEQ}

BJT Biasing Homework Problems

5. Use the Collector Characteristic Curves for I_B, I_C, & V_{CE} to determine values for R_B and R_C for the BJT circuit below.





Transistor collector characteristic curves

Set the quiescent point at approximately I_{CQ} = 8 mA and V_{CEQ} = 9.5 V with V_{CC} = 16 Volts.

Hint: Use the chart to determine a value for $\beta = I_C / I_B$.
Calculate a value for R_B, consult the web or a catalog or your textbook to choose the nearest real world valued resistors and then recalculate values for I_B and I_C.

a. Calculated value for R_B

b. Real world value for R_B

c. Re-calculated value for I_{BQ}

d. Re-calculated value for I_{CQ}

Calculate a value for R_C, consult the web or a catalog or your textbook to choose the nearest real world valued resistors and then calculate values for V_{CEQ}, $I_{C\ sat}$, and $V_{CE\ cut\text{-}off}$.

e. Calculated value for R_C

f. Real world value for R_C

g. Calculated value for V_{CEQ}

h. Calculated value for $I_{C\ sat}$

i. Re-calculated value for $V_{CE\ cut\text{-}off}$

BJT Biasing Homework Solutions

1. Emitter Biased, Common Emitter
   a. I_{CQ} = 4.65 mA
   b. V_{CEQ} = 4.9 V
   c. $V_{CE\ Cut\text{-}off}$ = 10 V
   d. $I_{C\ Saturation}$ = 9.1 mA

2. Emitter Biased, Common Emitter with Emitter Resistor
   a. I_{CQ} = 6.4 mA
   b. V_{CEQ} = 5.4 V
   c. $V_{CE\ Cut\text{-}off}$ = 16 V
   d. $I_{C\ Saturation}$ = 9.7 mA

3. Voltage-Divider Biased, Common Emitter Configuration
   a. I_{CQ} = 1.4 mA
   b. V_{CEQ} = 10.4 V
   c. $V_{CE\ Cut\text{-}off}$ = 16 V
   d. $I_{C\ Saturation}$ = 4 mA

4. Voltage-Divider Biased, Cascaded Amplifier
   a. Q_1 I_{CQ} = 2 mA
   b. Q_1 V_{CEQ} = 2.9 V
   c. Q_2 I_{CQ} = 2 mA
   d. Q_2 V_{CEQ} = 12.0 V

5. Note: $\beta = 200$, for I_B = 40 µA and I_{CQ} = 8 mA, set Q at I_{CQ} = 8 mA and V_{CEQ} = 9.5 V with V_{CC} = 16 Volts.

   a. First-cut value for R_B = 382,500 Ω

   b. Pick R_B = 390 KΩ

   c. Re-calculated value for I_{BQ} = 39.2 µA

   d. Re-calculated value for I_{CQ} = 7.84 mA

   e. First-cut value for R_C = 829 Ω

   f. Pick R_B = 820 Ω

   g. Calculated value for V_{CEQ} = 9.6 V

   h. Calculated value for $I_{C\ sat}$ = 20 mA

   i. Calculated value for $V_{CE\ cut\text{-}off}$ = 16 V

Calculating Operating Points (Quiescent I_{CQ} & V_{CEQ}) for Voltage-Divider Biased BJT Cascaded Amplifiers

Caveats:
The following is NOT a computational algorithm; nor is it a step-by-step cookbook recipe to be followed blindly. But rather, it is a list of insights illustrating a generalized method for solving similar problems.

Refer to Take-Home Quiz cascading amplifier schematic.

Insights:

To find I_{CQ}, V_{CEQ1}, and V_{CEQ2}

1. $I_{C2} = I_{E2} = I_{C1} = I_{E2} = I_C$

2. V_{B1} is the voltage from the base of Q_1 to ground:

   Voltage Divider $$V_{B1} = V_{CC}\frac{R_3}{R_1 + R_2 + R_3}$$

   Calculate V_{B1}

   V_{B1} also equals $$V_{B1} = V_{BE1} + I_C R_E$$

   So $$I_C = \frac{V_{B1} - V_{BE1}}{R_E} \quad where \quad V_{BE1} = 0.7\,V$$

   Calculate I_{CQ}

3. V_{B2} is the voltage from the base of Q_2 to ground:

   Voltage Divider $$V_{B2} = V_{CC}\frac{R_2 + R_3}{R_1 + R_2 + R_3}$$

   Calculate V_{B2}

   V_{B2} also equals $$V_{B2} = V_{BE2} + V_{CE1} + I_C R_E$$

   So $$V_{CE1} = V_{B2} - V_{BE2} - I_C R_E \quad where \quad V_{BE2} = 0.7\,V$$

   Calculate V_{CEQ1}

4. Finally, $$V_{CC} = I_C R_C + V_{CE2} + V_{CE1} + I_C R_E$$

   So $$V_{CE2} = V_{CC} - V_{CE1} - I_C (R_C + R_E)$$

   Calculate V_{CEQ2}