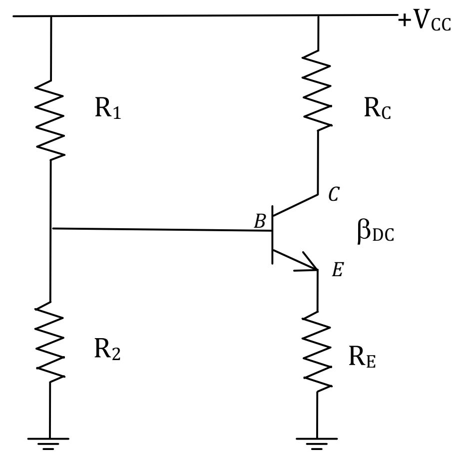
PHY2250, Dr. Hawley

A Method to Design the Q Point (DC Operation) of a Transistor Amplifier



First Exercise: Here are values for the DC part of one amp Dr. Hawley designed using the method described below: V_{CC} = 12V, β_{DC} = 150, R_1 = 10kΩ, R_2 = 1650Ω, R_C = 500Ω, R_E = 99Ω. Work "forwards": Find V_B, V_E, I_E, I_{CQ}, V_C, V_{CEQ}, $I_{C(Sat)}$ and draw the DC load line. Compare your answers with those on the back side of this sheet.

Second Exercise: You and a partner design your own (DC part of an) amplifier using the steps below ("The Design Method") on a sheet of paper. Then exchange *only* resistor and β values, and V_{CC}, with your neighbors and each group try to solve the others' problem – i.e. solve for voltages and currents given resistor values, β_{DC} and V_{CC}. Check your answers with the other group.

The Design Method: We're going to work "backwards" from the desired end-state to the choice of resistors.

1. Choose V_{CC}, typically 5 to 20V.
2. Choose V_C, a volt or more higher than half V_{CC}
3. Choose V_{CEQ}, equal to or a bit less than half V_{CC}
4. Choose I_{CQ}, typically 10 to 80mA
5. Choose β_{DC}, typically 50 to 200.
6. Choose R_2, typically in the kΩ or tens of kΩ range
7. Calculate R_C using $V_C = V_{CC} - I_{CQ}R_C$ and solving for R_C
8. Calculate V_E, $= V_C - V_{CEQ}$
9. Calculate I_E using $I_E = I_{CQ}\,(\beta_{DC} + 1)/\beta_{DC}$
10. Use Ohm's Law to find R_E
11. Calculate $I_{C(Sat)}$ by assuming $V_{CE} = 0$, using V_{CC}, R_C and R_E in series.
12. Draw the DC load line for the circuit, and show the Q point.
13. Use $V_B = V_E + 0.7V$
14. Write the voltage divider formula for V_B, and solve for R_1 given V_{CC}, V_B(=V_2) and R_2.
15. Draw the schematic, label it, and work "forwards" to verify your values.

Answers to First Exercise:
V_B = 1.7V, V_E = 1V, I_E = 10.1 mA, I_C = 10.0 mA, V_C = 7V, V_{CEQ} = 6V, $I_{C(Sat)}$ = 20mA