Single Transistor Amplifier
Lab Worksheet

Note: Work out the exercises on this sheet *before* the lab. It must be turned in when you arrive for the lab and will be graded. If you have any problems with these exercises, please [see, call, email] the instructor well in advance of the lab.

A. Read sections 2.01 and 2.02 in the text. We'll need the first two transistor rules, which can be summarized as follows:

Golden Rules for Transistors

1) *If* the transistor is **not** "cut off" (i.e., if $I_C > 0$), then $V_{BE} \sim 0.6$ V.

2) *If* the transistor is **not** "saturated" (i.e., if $V_{CE} > 0$ — really $> \sim 0.2$ V), then $I_C = \beta I_B$.
   (usually $\beta \gg 1$)

B. Figure out the operating ("Q") point of the circuit in the lab writeup. Get the data sheet for the 2N1480 transistor as well as the lab writeup from the web site.

Outline of procedure for doing this:

1. Assume that the "If's" in the rules are satisfied. You should check this at the end.

2. For the first cut, assume that β is very large, and therefore from 2nd rule, $I_B = I_C/\beta \approx 0$.

3. With no current into the base, the bias circuit of R_1 and R_2 is a simple unloaded voltage divider, so you can find V_B (single subscripts on V's mean with respect to ground).

4. Use V_B and rule 1) to find V_E.

5. V_E is the voltage across R_E, so you can find the current through it, which is I_E.

6. Kierkoff's laws (just conservation of charge), require that the current into the collector plus the current into the base equals the current out of the emitter. Since $I_B \approx 0$, $I_C = I_E$.

7. Use I_C to find the voltage drop across R_C. Subtract this from V_{CC} (the power supply voltage at the top of R_C) to get V_C (with respect to ground).

8. The difference $V_C - V_E \equiv V_{CE}$. Calculate this and check the "If" in rule 2.

C. Now calculate the 1st-order correction for finite β:

1. Use your first-cut value for I_C to calculate I_B for a β of say, 30. ($I_B = I_C/\beta$, from rule 2.)

2. Make a Thevenin equivalent circuit of the bias divider:

$V_{TH} = $ _____

$R_{TH} = $ _____
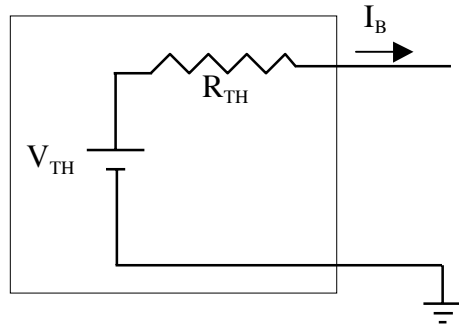
3. Find V_B. ($V_B = V_{TH} - I_B R_{TH}$, from ohm's law.)

4. Repeat 4 and 5 from part B to get V_E and I_E.

5. $I_C = I_E - I_B$ from conservation of charge.

6. Again find V_C as in B7.

7. You could use the new I_C to find a new I_B and iterate, or (horrors!) write down the equations and solve simultaneously to get an exact V_C. In practice, ***neither of these is normally necessary!***

D. Read Appendix F in the text on load lines.

E. Figure out what the "Voltage Gain" (A_V) of the circuit is: $A_V \equiv \Delta V_C/\Delta V_{In}$. In this circuit, $\Delta V_{In} = \Delta V_B$. Remember that ohm's law is linear, and with linear equations, you can solve for just the changes from your operating point.