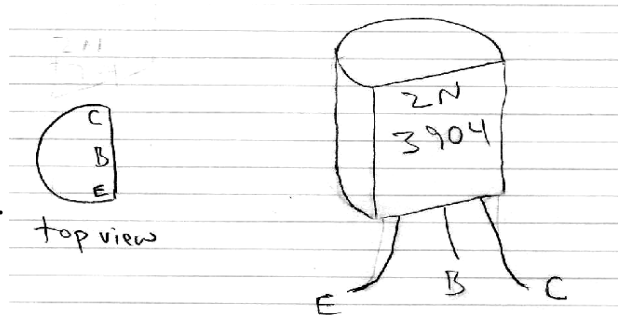


Physics 364 – fall 2010 – Lab #6 – due by lecture, Monday 2010-10-25, along with Lab #5

Lab #6 is the second of three transistor labs, and is essentially a continuation of Lab #5. This week, we will look at a few additional circuits built using Bipolar Junction Transistors. The grand finale, if you have time, will be to build your own simplified two-stage opamp from two NPN and three PNP transistors.

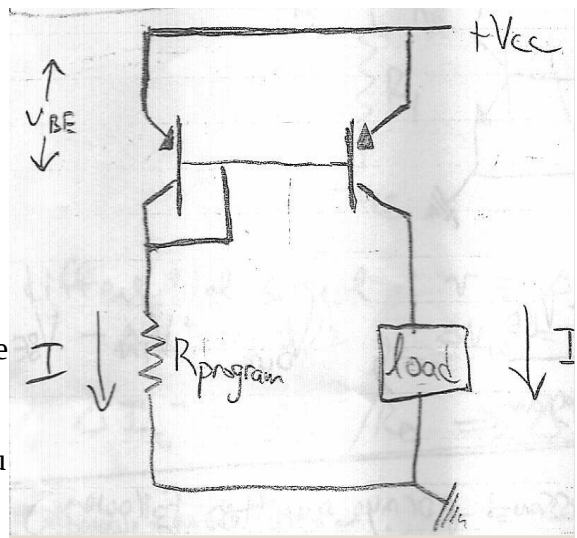


Part 0.

Start by doing the “optional” parts of Lab #5, which are no longer optional.

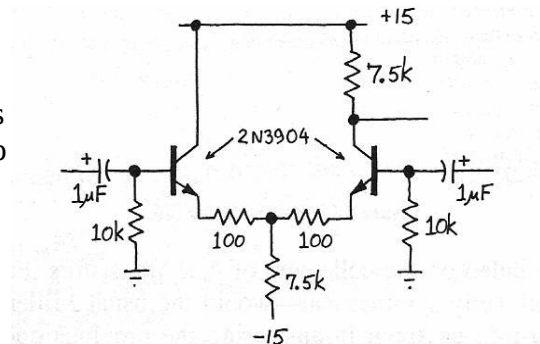
Part 1.

Build the current mirror shown to the right, using two 2N3906 PNP transistors, $V_{cc}=+15V$, and $R_{program}=4.7K$. Initially use a short circuit for a load. (A current source prefers to see a short circuit (very small load resistance), while a voltage source prefers to see an open circuit (very large load resistance).) Measure the voltage drop across $R_{program}$. What current do you infer? Is it what you would predict? Now use the current meter as a load and measure the current on the right-hand side of the mirror. Now try various load resistors in series with the current meter to see to what degree the current is independent of the load. (It's probably easiest to use a 10K pot.) At some point, you should see the right-hand transistor go into saturation. You may also be able to see the Early Effect in your data – that I_C has a small dependence on V_{CE} , as seen in graphs of transistor characteristics.

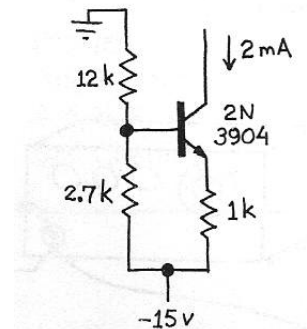


Part 2.

Build the differential amplifier shown at right. (From Hayes & Horowitz.) What differential and common-mode gains do you predict? (Don't forget to include $r_e = 25mV/I_c$.) Devise a way to measure the differential and common-mode gains, and measure them.



Now replace the 7.5K tail resistor with the current source drawn at right (also borrowed from HH). This change should make the common-mode gain very small. Can you measure it (or if it is too small to measure, can you place an upper bound on it)?



Part 3.

Build the high-gain, DC-coupled differential amplifier shown below. It is basically a simple opamp. Try it first as an open-loop amplifier and check that it works as a (not very fast) comparator.

Now think of a few ways to see whether it works as an opamp. Try building a follower. Or a $\times 10$ non-inverting amplifier. Or an inverting amplifier. I managed to get mine to work as a non-inverting amplifier; I haven't tried the other configurations yet.

What is the amplifier's gain-bandwidth product? Try changing the compensation capacitor and see how the bandwidth changes.

Note: if you have trouble making this circuit work or run out of time in the lab, just look over someone else's shoulder, and then analyze the LTSpice model for this circuit for your writeup.

