Engineering 1620 – Spring 2016

Laboratory Hints and Corrections

Here are some hints about the labs and some additions to instructions I have put together in response to questions. I am putting actual corrections into the on-line lab manual as I find them. This list is organized by lab number, and I hope to update it throughout the semester.

Lab 1:

1. Remember the TAs have to see you do at least one such operation to give you your magic number.

2. When you are trying to determine the output impedance of the voltage source with a square wave signal, you do not want the complication of the waveform changing shape as you change the load on the source. Applying a simple voltage divider relation to the signal only makes sense if its spectrum does not change as the divider is formed. The 10X probe does not load the circuit with sufficient capacitance to affect the waveform seriously. Use the 10X probe when doing that part of the experiment NOT the 1X probe. (When you use the 1X probe, the waveshape changes dramatically as you connect a load resistor. Why?)

Lab 2:

1. There is one high-voltage power supply (120 VDC max.) wired to the bias terminals of the capacitance meter through a resistor and zener diode network mounted on the back of the meter to protect the meter and the supplies. Please do NOT remove that circuit. We also have a multimeter connected to the back terminals of the capacitance meter to make voltage measurements easier. You may use a second meter to check polarity on the front terminals but please **leave the main meter alone.**

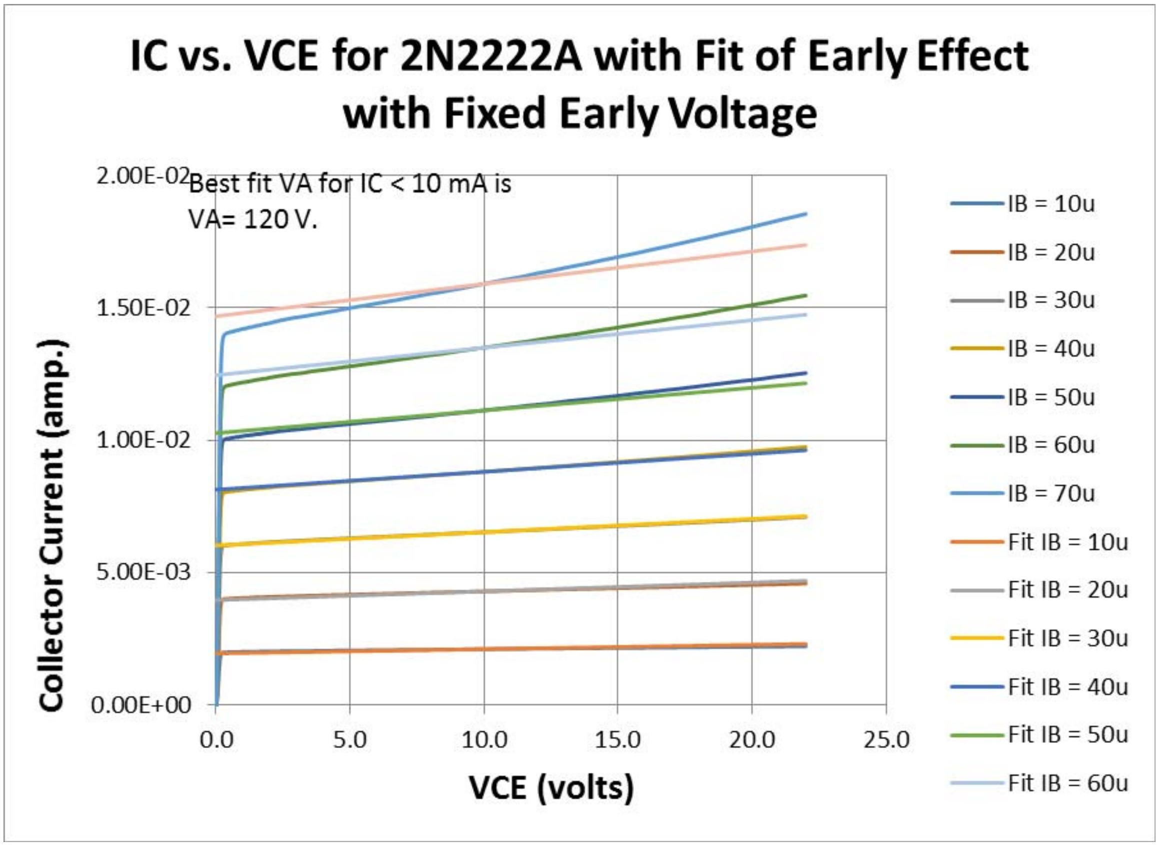
2. The relatively high voltage power supply (120 VDC) on the capacitance meter is not easily adjusted to produce low test voltages. Because of the safety network on the back of the analyzer, you can get a much lower effective supply voltage for the measurement points near zero by connecting a 1.0 K resistor across the multimeter attached to the back terminals. Without the resistor the measurement range is zero to 120 volts and with it the range is zero to 6 volts. (There is a 21 K resistance in series with the power supply.) I have put a mounted resistor on the meter leads that can be plugged and unplugged depending on what voltage range you need. Please do not lose that little piece.

3. The software to run the HP4145B parameter analyzer is on the D:\ drive of the computer next to the analyzer. To find it, browse to `Start > All Programs > ENG-EL17\` and double click on par_analyze.exe.

4. To find ideality constants from the Gummel plot, you will need the junction temperature. Please be sure to record the temperature of the environment at the time you do your tests. There is a digital thermometer on one side of the shelf over the analyzer. (I know that such toys are attractive, but please don't steal it. I've had that happen twice and it is really unfair to other people and a nuisance for me.) The accepted value of k/q is 86.17 microvolts per degree K and 0 degrees C is 273.15 degrees K.

5. A brief word about the subscripts on alpha, beta, and h_{fe} or h_{FE}. Lowercase subscripts indicate differential quantities, e.g., $h_{fe} = \frac{dI_C}{dI_B} \approx \frac{\Delta I_C}{\Delta I_B}$. These are usually measured by measuring the change in quantity for a relatively small change (20 to 40 %) in the denominator quantity. Uppercase subscripts mean whole quantity ratios as, e.g., $h_{FE} \equiv \frac{I_C}{I_B}$. There is usually not a very large difference between the differential and whole ratios, but at very low and very high currents they can differ by as much as a factor of 2, which is why the distinction is made. As a reminder, $\beta_F = h_{FE}$ and $\alpha_F \equiv \frac{I_C}{I_E} = \frac{\beta_F}{1+\beta_F} \approx 1$.

6. Determining the Early voltage from the IC vs. VCE data is a bit tricky because the fit is inexact. The intercept of the extended IC vs VCE line is actually a function of the collector current rather than an exact constant. I have found that the intercept is reasonably constant for currents in the range of 1 – 10 mA and collector voltages of 2 to 15 volts. Here is a plot of some data showing that range.



Labs 5:

The Bode plotter for lab 5 is in back to the right of the computer for the parameter analyzer. This separate Bode plotter can be used for labs 4, 5, and 7 but is really set up for the high voltage needed for this lab. There are other plotters for labs 4 and 7. This plotter is easy to use with these instructions:

1. Set your lab up to operate with the power supply that is on the shelf above the Bode plotter and get it running.

2. Turn on both the function generator and the gain/phase meter. Please do not tinker with the cables. (Note that cabling is different for the two experiments.)

   The settings on the gain/phase meter are:
   - Both inputs set for 2mV – 20V
   - Phase set to –A
   - Frequency range 10 – 100 KHz
   - Function B/A

3. In Windows Explorer go to D:\TestSoftware\en162\en162bodeplotter and run "Exp5.bat". Enter your protoboard serial number and let the program run to completion.

4. Microsoft EXCEL will open with data from the last user when the measurements finish. The spreadsheet has a macro to import and display your data that has to be enabled with the "Options" button.

5. Select the sheet with the data – the tab is "temp_bode". Hit the "Import Data" softbutton. Your data will be imported and you can then save this spreadsheet to the U:\ drive for the lab writeup.

6. Have a TA give you the magic number for this run.