EE252 Lab #2, 3 comments

Dear class,

I've finally gotten the last of the Lab #3 submissions graded. Sorry it took me so long. I'll be returning them Monday. So, now everyone has done a formal laboratory report. I have tried to mark labs #2 and #3 very similarly for fairness and consistency. (The #3 grades were lower.) You will notice lots of red ink on them. What I have tried to do is be thorough in marking things I thought could be improved. Some of the remarks are suggested wording. Some are remarks on orgnization. Some are "Good!" when I see something I particularly like. The intent is to help you with your technical writing. I spent a lot of time on these to try to help you with particulars. Yes, the ink is red, but think of the exchange: your paper, my comments, as being a dialog about writing a report. This first one is a learning experience. I hope to see better performance on the next ones. Everybody will write two more formal reports, though I will give a pass on the third formal report for anyone who scored 90+ (adjusted) on either of their first two. (It can be informal instead. The point is that those folks apparently don't need the practice of doing a third one.)

Overall, this is probably a first experience in writing a fairly complicated laboratory report. The people that did EE241 and wrote a report for that class last spring benefitted from that previous experience, it appears. But this report was considerably more involved. It has a few elements not in that earlier report: drawn waveforms, comparison of performance across design to simulation to performance for analog, which is more complex than digital (at least per wire). You need to be able to work skillfully with word processing programs (most of us use Word) to create a complex document that includes equation, illustrations, normal text, citations, and images (or sketches), all done on the computer.

One problem that seems to be pervasive is either leaving out waveform sketches entirely, or when included they are simply screen shots that are poorly presented at best and at worst completely unreadable. If you do not know how to do image manipulation on a computer, you ought to learn. EE students do not take CS115, the basic computer skills course, because it is assumed that you can figure out how to do basic computer tasks yourself. That's the course where students learn word processing, spreadsheets, and a little bit of computer art, at least the last time I taught it. There are two basic forms of computer graphics: line art and images / bitmaps. Line art represents things as objects like rectangles, lines, shaded circles and such. If you want to draw something, that's often a good choice. On a PC, Powerpoint can be used for drawing things. It's far from being a good graphics program, but you can do some basic diagrams with it. And, it's readily available. Draw your art in Powerpoint then paste it into Word.

Images (or "paint") graphics are made up of arrays of pictures. That's what you get if you do a screen shot (as a .jpg or maybe a .png or .tiff usually). Resolution is limited, but 300 dots per inch prints very well. There are "Paint" programs that allow you to manipulate images. "Photoshop" is the best known (but complex and expensive) but there are lots of others. I use "Photostudio" that came free with a Canon inkjet printer. I'm not sure what's most readily available for a PC. With such a program you can take a "negative" of a picture, changing black to white and white to black. Most of you need to do that! When you take a screen shot from LTSpice, process the image to make the background white. You can then make the image greyscale, and adjust the level or contrast or brightness so that you have a nice crisp image. Most such programs allow you to draw (axes, gridlines, etc.) and write (numbers, labels, etc.) on the image. That's what you need to do to get your screen shots from the oscilloscope or LTSpice into a form acceptable as a properly annotated graph in a lab report. (Setting up the simulation displays to make the numbers big enough, add grids, etc. reduces the work to be done later.)

Here are some other general remarks about the lab reports:

1. An abstract is a summary of a whole document. It is not really part of the document proper; it is often used separately, for example in a compilation of abstracts to form sort of a catalogue of reports with a bit of summary about each. Here's the point: what you say in the abstract does NOT count as content of the paper. It is not an introduction. You must have an introduction or background or overview that introduces the subject and tells the reader what the paper is about. You may think the abstract serves that purpose, but it does not. Indeed, the abstract is what you ought to write last of all. It summarizes what the paper is about, the most interesting points touched on or general methodology taken, and summarizes the most important results and conclusions. Think of it as being an advertizement to convince the casual browser to take the time to read your important paper. A lot of people lost credit for starting the body of the report with no introductory material, jumping right in to describe the design of an amplifier without even saying what is to be done with it and why.

2. Have you ever learned about presenting numbers with an appropriate number of significant digits? You should have

learned about that in Physics, if not High School. When you make a measurement, the number of digits you use matters. If you are not specifically giving accuracy data, the number of digits implies a general level of accuracy.

3. Distinguish between:

a. Specifications: These are constraints given to you in instructions and guidance by the client. In this case the type of amplifier was specified. Also, the power supply Voltage was 12V, and you were required to use VD (or VC) = 8V, VE (or VS) as 4V. The target frequency was specified for Lab #2. In both there were instructions concerning capacitors and/or frequency response. It's a good idea to define the project specifications early, perhaps right after the introduction when you have just told the reader in general terms what you are doing. Specs are needed before you dive into design.

b. Design choices: These are parameters that you can choose. Usually VC (or VD), VE (or VS) and IC (or ID) are choices that you make. If you want a large Voltage swing, you would choose VE and VC lower than the usual 1/3 / 2/3 rule, for example. In the MOSFET lab you had a degree of freedom in the bias resistors. When you make a design choice, you should have a resaon for it, and state that reason.

c. Assumed values: These are values which you don't choose, but you don't really have a good specification for either. For example, transistor specs give you a range for Beta or VT, but you have to make an assumption of the value to use in your calculations. You might have to make an assumption about the source or load impedances for some designs. An assumption is different from a design choice, even though you have to choose the value to use. You should have a reason for the assumptions you make.

d. Calculated values: These numbers are determined by others; it's just a matter of doing the math. Most component values fall into this category.

Doing design requires making design choices and assumptions within the context of specifications, and then calculating all needed values.

4. Tense: Normally you should be using past tense. You are reporting something you did, and all that is in the past with respect to both the writer's and the reader's time frame. Occarionally you will see writers use future tense in the sense of something "will be shown" anticipating a future in the reader's time frame, a detail that is addressed further into the paper. In this, simplicity is probably best, and that is to use past tense for everything unless you have a particularly compelling reason to do something different.

5. Use proper notation for signals and circuit components. Have you noticed that r pi is all lower case? That's because it is relevant only to AC circuits; for DC you use a diode approximation (that we call VBE, with BE subscripted). Use capitals for both basic symbol and subscript for DC components like resistors. Use lower case for both basic symbol and subscript for AC (only). Use lower case basic symbol and upper case subscript for combined AC+DC. So, if you are writing Av = vout/vin (the out and in would be subscripts), we use lower case for both; it's all AC. Other AC parameters are gm, hfe, ro. We do use upper case for resistors, capacitors (other than c pi and c mu) because they do (and are designed to) affect DC, and don't change for AC. Some of that is convention from of old. But, do be sensitive to case and usage for circuit symbols and parameters.

6. If you are using a schematic to describe what is built, you must show the aluminum electrolytics (and tantalunms) as

polarized capacitors. The polarity does matter, as some of you have discovered. Your schematic shows how you built it, and how someone wanting to test your results should build it. That includes capacitor polarization.

7. If you use material which you have not originated, you must give attribution with a proper citation. Simply listing sources at the end is not good enough. You must note, where the material is, that it has been taken from another source (usually by putting it in quotes, and often by using indentation to set it off). The citation should come after the material. That includes graphics that you have “borrowed”. I saw an awful lot of material, both in text and in figures, which were very obviously copied from elsewhere without attribution properly given. That is plaigerism. Don’t do it. Alwatys cite your sources, and that includes giving the page number so that the reader can look it up. The Little, Brown book you should have gotten in ENG101 composition is supposed to be the Wilkes official writing guide. Of the styles described in that book, the Chicago style for making citations is closest to what you generally see in technical writing. The IEEE style would be better. I’m not picky about the details, but you MUST give proper citations for any material you get from elsewhere. On this first set of lab reports, I’m just giving a warning. The next ones, I’m very serious about this. This should not be a new issue for you.

8. Capitalize Volts, Amperes, Ohms, Siemens and other units that are derived from a person’s name. That includes Bode and Nyquist plots, Smith Charts, Hertzsprung-Russell diagrams, and other artifacts names after a person. Don’t capitalize seconds, feet, and units not named after a person. 5s is 5 seconds; 5S is 5 Siemens (Amperes per Volt). An interesting case is the “mho,” a unit of conductance (now called Siemens). It is not capitalized,

even though it is derived from a name (Ohm spelled backwards for the reciprocal of Ohms). You don't see mhos used much anymore, but they pop up occasionally.

9. Almost everything we are doing is a design exercise, where we design a circuit, simulate it, then build and test it in the lab. We are interested in the circuit's performance in an absolute sense: What is the gain, for example, or what is the bandwidth or the fL and fH limits on the bandwidth. We also need to see a comparison between the design valuse, the simulated values, and the laboratory values. This is true for the parameters we are most interested in (gain, fL, fH usually) but we also want to see Q point comparisons. Why? Because Q point deviations can explain differences in other characteristics. We want to know whether we can confidently design and build things and expect them to behave as designed. If they don't, we need to know why. On this MOSFET exercise, there was a surprise. (There could have been more, but this is the important one). Every MOSFET had a significantly lower VT than expected. The expected value was 2.1V (or 2V, from some data sheets). If you paid attention to the Q point, and observed VGS, you would see a Voltage closer to 1.5V! That's still within spec! For a MOSFET circuit, changes in VT (or Kn) does not affect VG. What is affected? VS! So, VS is higher (and VD lower), which means ID is higher, and anything that depends on ID (like gm) is higher. But if gm is higher, why didn't the transistor amplify as much as expected? Or more? Well, there's another joker in the deck. Maybe gm (and Kn) are lower than expected as well. How much range of possible values are there for these parameters? Lots! (Maybe this is one of the reasons this transistor is primarily considered suitable for Digital (off/on) switching. Its characteristics vary a lot, making the design of good analog amplifiers with predictable characteristics more difficult, especially at low

Voltages.) So, did you notice this? Did you wonder about it? Did you try to explain it?

All about these for now. I'll have some comments to make about Lab 4 soon.

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