Chapter 7 Common Issues and Problems

Introduction:

This chapter is based on a message that was sent to a class in EE283 in reaction to submission of formal lab reports which were far from satisfactory. This manual is in part an attempt to provide students with additional guidance so that a plea of "We don't know how!" or "We haven't received enough instruction!" has been addressed in advance. Work to make sure your lab report complies with the general intent of clear communication, that it is responsive to all of the requirements of the lab instructions and the general guidance for lab reports (including this document). It would be a good idea also to look at the deficiencies described here and make sure that, if you do have mistakes, they won't duplicate the ones described below.

Preliminaries – Do What's Required Before Coming to the Laboratory:

One of the more common reasons for bad laboratory reports is that the problem isn't just the report. It was a bad laboratory exercise all around. The most likely cause: failure to read the assignment. Or, perhaps it is failure to read and comprehend the assignment. Thus, doing a good laboratory report is not only about writing; it is also about reading. You very much need to read the description of the laboratory exercise before coming to the laboratory, and give the matter some thought. Often laboratory assignments have preliminary work that is supposed to be done before getting to the laboratory. Be sure it gets done; you will have a better understanding of what you are going to do in the lab, and you will be less likely to waste time in work that has to be repeated. Often it will even be possible to do some construction, or even testing, before coming to the laboratory. Be sure that you have read the whole laboratory exercise description, especially the reporting requirements, so that you take down all of the data that you will need for your report. You don't want to discover, only when you are writing the report, that there was some bit of data that you failed to record, or even a whole step that you left out. The bottom line is, "Be Prepared!"

Knowing What's Required:

One technique that I've seen used by well-organized students is to highlight, in the laboratory exercise directions, the key steps of the procedure and the reporting requirements. It can even be useful to use different colors for each. Keep in mind that if the instructions direct you to do something, there is a data collection activity for it, whether explicitly stated or not. As an example, here is the text from an EE252 Laboratory exercise with those points highlighted (important steps in yellow, reporting requirements in blue):

2.1 Pre-Lab assignment

The first part of the preliminary work is to design the bias network that establishes our Q-point. Follow the "rule-of-thumb" the textbook gives of making V_C = 2/3 of V_{CC} and V_E = 1/3 of V_{CC}, which we will specify as 12 Volts. Now, assume a Q-point Collector current. Pick a current between about 1mA

…[Details of design process omitted]…

to make the base about .7 Volts above the emitter. (We will also be trying a Q-point with 5 times as much current. That should be achieved by simply dividing all the resistor values by about 5, without changing the voltages.) If you need a resistor value that you do not have, let me know.

Now we would like to predict the AC performance. We will make C_E, C_B, and C_L "large" so that they do not affect the AC performance of the circuit. Note that C_E shorts the emitter to ground for AC, and C_B directly connects our signal source. Since the Base-Emitter junction is basically a diode, we can estimate its AC resistance as about .026V/ I_B. (You will recognize V_T there.) Now we should be able to calculate the input impedance, and the AC gain we will have with no load (R_L= infinite). Calculate this for the x5 bias point as well. Then, see if you can predict what the gain would be without having C_E in the circuit. Try the circuit with simulation, and check your bias and gain calculations. You should try out all of the things we will be doing in the lab with simulation ahead of time.

2.3 Build and check bias network

Construct the transistor and bias network part of the circuit shown in Figure 1, using the component values you calculated earlier. Power it up, and check the Q-point. Record the voltages and currents. If what you see is way off, there's an error, or you may need to adjust the resistor values to get at least close to the desired values. (And, go back and check your work!)

2.4 Complete the amplifier and Measure AC performance

Add the remaining components, except for R_L. Use your 470 μF capacitors for C_E and something around 10 μF for C_B. (Remember, they are polarized; be sure that the positive end is where it ought to be!) Connect the signal generator to the input, and use the oscilloscope to watch both the input and output voltages. (You may need to use a potentiometer or other Voltage divider to reduce the input Voltage to a small enough value to avoid clipping, since the signal generator doesn't go below 10-20mV!) Vary the input voltage magnitude and watch what happens to the output. Find the value of input and output that gives "clipping" (the output is no longer sinusoidal). Go to a voltage well below that, and record input and output magnitudes. Then figure the AC gain. Now yank out C_E and see if it makes a difference. Record the AC gain for that condition. Now add a load of 1KΩ (remember to include a C_L coupling capacitor of perhaps 10μF!) and see what happens to your performance (With C_E back in). Make the necessary measurements, and calculate both Voltage gain and Current gain. Also, calculate r_π, the base-emitter diode AC resistance. Note that you will have to measure the input AC current to do this. (For extra credit, change the frequency and see when performance starts to drop off. Or, try smaller capacitors, such as the tantalum (2.2 μF ?) capacitors, and see how they change the response.)

2.5 Other bias point:

Repeat 2.3 and 2.4 for the higher bias point, keeping R_L in the circuit. (With C_E in.)

2.6 Report:

Report your results formally. Include your design process. Be sure your schematic is properly drawn and annotated. Compare the results you got in the lab with the results from simulation as well as what you might expect from circuit theory models of the devices based on the diode equation for $r\pi$ and other models in the book. You may find it desirable to re-run the simulation with values adjusted to what you actually did in the lab, and include cases you may not have earlier if necessary to understand and explain your results. The report is due one week after the lab work.

Another thing that might be helpful is to know how the report will be graded. If the schematic counts 40 points, it needs to be a point of special emphasis in your report. If it is only 10 points, the graphs and tables may instead deserve that attention. Your instructor may or may not have guidance that indicates how the assignment will be graded. It can't hurt to ask. You can also see what your instructor has done on previous exercises, or even in previous classes, and extrapolate that to the present. As an example, I have used the following grading sheet for EE252 Lab 2 (the one described above).

EE252 Lab #2 Report grading — Student:
Reviewer: ________________________

Abstract (5)	________
Background and Specification (10)	________
Design: Q/bias (DC): (10)	________
Gain (AC): (5)	________
Rin (AC): (5)	________
5x bias point (DC,AC): (5)	________

Simulation: Q/bias (5)	________
Transient (AC gain) (5)	________
5 x bias point (DC+AC) (5)	________
Procedure:	________
Lab Results: Q/bias (5)	________
Clipping V (5)	________
AC gain (5)	________
No CE (2)	________
With 1K load (5)	________
Find rp (3)	________
5x bias (5)	________
Conclusions	________
Deductions for usage, organization, formatting etc.	________
Bonus stuff	________
Grade:	________
Comments:	

A Checklist:

The following is a list of points you could ask yourself as you are completing a laboratory report or reviewing it prior to submission. It should also be useful to go down this list ahead of time before starting to write.

1. Does the report organization match requirements? (For example, is an abstract required?)
2. Are figures and titles properly numbered, titled, and given callouts in the text?
3. Are general issues of English usage correct? Person, voice, tense, sentences not too long?
4. Is all of the raw data collected in your report?
5. Did you use appropriate numbers of significant digits? Or error bands?
6. Did you use appropriate units throughout the report?
7. Are graphs and other figures properly annotated?
8. Did everything that happened make sense? Did you comment on surprises?
9. Does the conclusions section adequately wrap up the whole exercise and address all issues?
10. Does the Abstract summarize the whole exercise, including conclusions?
11. Does the Format, including cover sheet if any, meet the course format requirements?

Working with your Partner:

You should be sure to establish a good working relationship with your laboratory partner or team. Understand ahead of time who will do what, including writing the report or parts of the report. Check your partner's work, and he should check yours. Often it is difficult to proof-read one's own work, and your partner might have noticed something in the reporting requirements that you missed. If the report grade is shared, you will be helping not only yourself, but also your partner, by doing a good job. If reporting responsibility and grading alternates, take advantage of the opportunity to help your partner to a better grade. Both are matters of professionalism and consideration for others. Make sure you keep your partner informed. You should be accountable to each other for not only doing the work, but keeping the partner informed of progress. This is an extra reason to write your reports well ahead of the time when they are due: it is considerate to your partner, who needs time to carry out his share of the responsibility. It also makes reporting progress easier and less critical.

If you have problems with your partner, you won't be the first person for that to happen to. Any shared endeavor is subject to such things, and that's just as true in industry. The first thing to ask yourself is whether you are doing everything you should, and communicating (or attempting to communicate) in a timely manner. Second, try to evaluate and consider your partner's situation. Your partner may have at the moment a crisis of some sort. Find out, and see if there is a solution, such as a reallocation of workload and assignments. The key to many problems is better communication.

A good principle to follow in working with a partner is to endeavor to make your contribution to the joint effort more than 50%. Not just 50%; more than 50%! Perceptions will vary. It may seem to you that you are doing 50%, but from your partner's point of view, it looks like only 40%. Then the partner thinks that he, unfairly, is consequently having to do 60%. Be aware of the potential for such differences in perception. If you both follow the principle of doing more than 50%, you should come to appreciate each other more, and you'll be an effective team.

It is also possible that one partner, seeing that the other person is doing more than 50%, will pull back his own effort so that he does less. Over time, the active partner doing more will increase his share of the effort while the passive partner defaults on more and more. Pretty soon that sad state of that situation will be very apparent: one partner is an energy source and the other is an energy sink. This is not sustainable, and is not right. But, it can and does happen. You can try to talk out the problem, but in my experience that doesn't often help. The partner expecting the other person to do most of the work often becomes defensive and perhaps combative.

In such a situation, or perhaps in others, such as when a partner just disappears and stops communicating, the course instructor needs to be made aware of the problem. At best, some satisfactory solution will be found. At worst, there is no solution and the difficult problem continues. In that case, the best you can do is to soldier on, doing the best you can, and take satisfaction in what you have done, however that works out for the course. In an extreme case, you may need to talk to other faculty members in the department, starting with your advisor. If no solution can be found, a grade appeal may be necessary, if the instructor does not consider the defaulting partner when it comes to assigning a grade.

The best way to avoid such difficult circumstances is by finding a good laboratory partner at the beginning of the course. If you are a conscientious student, and other students in your discipline come to know that, you should be in demand as a laboratory partner. Get to know the other students in your discipline, so that you will know who is likely to be a good partner, and, more importantly, who is likely to not be a good partner. You should be able to find someone else with a similar attitude and work ethic, with whom you can establish an effective and productive partnership. Try to arrange to be partners before the class meets. Make a point of being early to the lab on the first day, to have a better choice of lab station and partner. The worst situation is to show up late and be paired with the worst student in the class at the last open seat in the lab. A similarly difficult situation is to be the last to arrive and find yourself the odd student, randomly assigned as the third person in a partnership that has already been established. It is possible that your instructor will assign places and partners. But if the issue is in your hands, you can help yourself a lot by being proactive rather than passive.

Additional Stuff:

Appendix H contains information on laboratory record keeping. That appendix is specifically addressed to EE337, but the ideas and general approach is potentially applicable to other courses. Requirements for record-keeping in industry vary greatly with the nature of the business. Often scientists and engineers are required to keep very complete and documented records of everything they do, especially where intellectual property is likely to be an issue.

Appendix I is a debugging guide for digital circuits that was originally prepared for EE283, but the ideas are more broadly applicable. It is included here for convenience.

Appendix J contains a variety of good student laboratory reports that may serve as useful examples. Note that even these, by good students, have some issues, which are summarized at the end for each one.