ECE ### Lab #:

[Title of Report]

[Person 1], [Person 2]

Month Day, Year

Abstract

In this section, give the reader a general idea of what your lab is about. This section should go right on your cover page. Highlight the major sections of the circuit without going into too much detail. The abstract should stand alone, meaning that the reader should not have to look at the report itself to get an idea of what the report is about. Additionally, provide one or two of the most important results you obtained in lab. For example, if you built an amplifier, you would say what the gain of the amplifier was. Some ways to begin the abstract include:

"The design, construction, and testing of a [circuit] are described."

"A [circuit] was designed, built, and tested."

On another note, when you list the names of the people up top, put them in alphabetical order by last name.

Table of Contents

Notes on Table of Contents:

- Don't just have one subsection (e.g. 2.1). You need to have at least two subsections (e.g. 2.1, 2.2)
- Keep the structures of the subsection titles the same for each large section. For example,

GOOD	BAD
2.1 Design of Amplifier 1	2.1 Design of Amplifier 1
2.1 Design of Amplifier 2	2.2 Amplifier 1 Design

- If you have the sections in the table of contents, you need to have those same sections in that exact order in the body of your paper.
- The appendix, Section A, should contain sets of data that are either too big to fit in the report or disturb the "flow" of your report. For example, if you measure the output voltage over a frequency range of 100Hz to 100kHz at increments of 100Hz, you shouldn't put that right in the main part of your report. Put the table of raw numbers in the appendix and a graph of the data in the main part of the report.
- Make sure that your pages are numbered and that the table of contents is up-to-date with the actual page numbers. I put page numbers in the footer. Mine are centered and two font sizes smaller than the font size used for the bulk of the report. Also, make sure that the font type of the page numbers is the same size at the font type used in the bulk of the report (e.g. if you use Times New Roman to write your report, make your page numbers Times New Roman).

1 Introduction

The introduction is kind of what it sounds like – an introduction to the report. State the purpose or main goal of the lab. Provide some discussion on things like the parts of the circuit (e.g. your DC-DC circuit is made of the boost circuit, astable multivibrator, etc.). It's a good idea to give some background theory (if there is any) just to make sure your reader is familiarized with your lab a little more. I also like to include a picture of the circuit template or something so that the reader gets a visual right off the bat.

In this section, you should also include any requirements or specifications pertaining to the lab. For example, in future labs you will be building amplifiers and the professor will want you to have a certain gain at a specific frequency. You would put specifications like that here. You can also preview your results here, but I don't think it's required. Besides, you already previewed your major results in the abstract.

When it comes to formatting, I like to have the text justified (as opposed to aligning it on the left). I use 12pt Times New Roman for the main text. I don't indent for each new paragraph. Instead, I just have a line space between the paragraphs. In terms of length, the introduction should be about a page, maybe a little less depending on how much material your lab goes over.

The last thing you should do in the introduction is forecast the rest of the sections. This doesn't have to be an exhausting list, just a brief overview of the major lab sections so the reader knows what to expect. Here's an example:

Section 2 of this report describes the design of the differential amplifiers. Simulations are shown in Section 3 and the experimental results in Section 4. A discussion of the results, sources of error, and possible improvements are provided in Section 5. Section 6 concludes the report.

2 Circuit Development and Analysis

Start the next section immediately after the previous one (don't go to a new page). After each big section header, make sure you include a few sentences of mini-introductory material about the section. Don't put the little section header right after the big section header.

GOOD	BAD
2 Circuit Development and Analysis The amplifier was constructed in two stages: the gain stage and the output stage. A common-source amplifier was used in the first stage to provide the bulk of the gain of the amplifier circuit. To stabilize the output signal, a class AB output stage was implemented. **2.1 Common-Source Amplifier Gain Stage** Circuit design stuff, blah blah blah.	**2 Circuit Development and Analysis** **2.1 Common-Source Amplifier Gain Stage** Circuit design stuff, blah blah blah.

Also, if your big section has a lot of subsections, you can do some forecasting here as well.

2.1 [Section Title]

As you might have guessed, you have to discuss how you designed your circuit in this section. Even if the professor gave you the template, you need to talk about how you determined things like component values, time-constants, etc. This section, as well as the majority of the report, should be in **past** tense because you are describing what you *did*. Furthermore, never use first or second person in your report at all. Always use **third person.** You might want to start out with a template of the circuit (or a portion of the circuit) to give your reader a visual. Put pictures in figures.

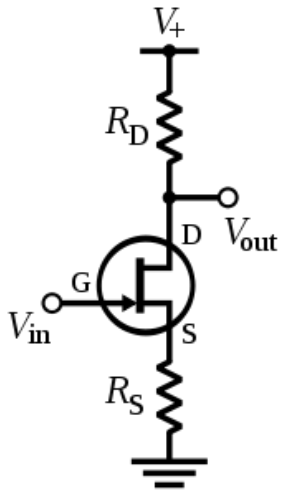

Figure 1: Basic common-source amplifier design utilizing an NMOS transistor.

Do not put a figure in the middle of a sentence. Always finish a sentence before putting in a figure. Also, make sure you label the figures – don't just put "Figure 1." When you refer to figures in the text, you can say something like, "The common-source amplifier shown in Figure 1 was used to provide the majority of the gain for the amplifier circuit." Alternatively, you could say something like, "To provide the majority of the gain for the amplifier circuit, a common-source amplifier was used (Figure 1)." Just make sure you capitalize the word "Figure" if you are referring to a specific figure number. You don't need to capitalize it if you are saying something like, "By looking at the figure, this equation can be derived."

2.2 [Section Title]

Speaking of equations, let's talk about how to format them and whatnot. When you use equations, you only need to put the equation itself. Don't put the equations with the number substitutions – the reader can do the substitutions his-/herself. To put the equations in, I like to "cheat" and insert a two-cell table. I put the equation number in the right cell and align that cell to the right. Then I put the equation itself in the left cell and center it. Then I click "Borders and

Shading" and click "no borders." This makes the equations look nice and neat without having to bother with spaces and tabs and junk.

GOOD	BAD
To calculate the voltage across the resistor, Ohm's Law was used (Equation 1). Substituting 10kΩ for R and 1mA for A, the voltage was calculated to be 10V. V = IR (1)	Ohm's Law was used to calculate the voltage across the resistor. V = IR (1) V = (1mA)(10kΩ) V = 10V

When you refer to equations in the text, you can either use just the equation number (1) or say "Equation 1." I like to say "Equation 1" because it just reads more smoothly than having a random number pop up in the paragraph. But it's totally up to you – both ways are fine. Also, as with figures, try to avoid putting an equation in the middle of a sentence. It can get kind of awkward and you run the risk of writing an incomplete sentence. I would recommend just finishing the sentence and then inserting the equation. For example:

When operating by itself, the differential amplifier produces a differential gain proportional to the difference between the inputs (Equation 1).

$$A_d = \frac{v_{o1} - v_{o2}}{v_{id}} = -g_m(r_{oN}||r_{oP}) \qquad (1)$$

I like to use the equation editor right in Microsoft Word. It's a little awkward at first, but once you get used to it it's not that bad.

When reporting numbers, always put the units right next to the numbers themselves. Don't leave the numbers "naked."

3 Simulated Performance

Again, don't forget to add a little blurb here about the section. You can say things like you did simulations in MicroCap, the resistor values needed to be adjusted in simulations, and so on. Just avoid having the section titles one right after the other. Don't forget to put this section in past tense and third person too.

3.1 [Section Title]

So you put your simulated stuff here. Generally speaking, if you split up your circuit in a certain way in Section 2, you should report the simulations in a similar way. For example, if you were doing the common-source amplifier with the output stage, you might write Section 2.1 about the

common-source amplifier and Section 2.2 about the output stage. Then, in your simulations, you would do Section 3.1 about your simulations for the common-source amplifier and Section 3.2 about the simulations for the output stage. This isn't always the case, but it's a good starting point if you're stuck on how to format things.

Also, when you're reporting simulation data, make sure the figures and graphs are clear. For example, if you have two lines on one graph, say that the blue line is voltage and the red line is current (or whatever). That way the reader knows what he's looking at. Also, label your axes. It sounds obvious, but a lot of people forget to do it.

3.2 [Section Title]

Don't forget to add some discussion about your simulated results. Some people just report the results and move on without saying anything about them. It's a nice idea to have a table comparing the calculated versus simulated results if it's possible. However, don't just put all of your data in tables – that's not cool, bro.

4 Experimental Implementation

I would recommend including the final schematic right after the first sentence or two of this section. You need to have a final schematic and this is the most logical place to put it. To make life easier, put the measured component values (e.g. resistor values) right in this final schematic. That way you can just say, "Measured component values are shown in Figure 4" instead of writing a bunch of awkward sentences about the resistor values. Insert your little blurb here. You can talk about things like equipment numbers or preview the problems you encountered. It really depends on the lab. Again, use past tense and third person.

4.1 [Section Title]

As I said earlier, if you're not sure how to break up Section 4, take a look at how you broke up Sections 2 and 3. Just make sure things are broken up in a way that makes sense. If you built a common-source (CS) amplifier with an output stage, try having one section on the CS amplifier and the other on the output stage.

When you're describing how you made measurements, you don't need to be too specific. For example, if you connected an oscilloscope to your circuit to measure voltage, you don't need to say, "One probe was connected to the resistor and the other probe was connected to ground." Just say, "An oscilloscope was used to measure the voltage across the resistor." The reader should have enough "know-how" to understand how you connect an oscilloscope to a circuit.

Oh, and before I forget, if you use an abbreviation such as MOSFET, make sure you define it before you use it. For example:

A metal-oxide semiconducting field-effect transistor (MOSFET) is popular device for use in amplifiers and integrated circuits (ICs).

4.2 [Section Title]

Make sure that your section titles are on the same page as the section. Don't leave the section title on the bottom of one page and start the section on the next. It's poor formatting. Feel free to add another line space or two to make sure the section title and the text are together.

Sometimes you'll find that writing in third person is super awkward. I know I'm being "unprofessional" and I'm writing in first and second person (see Table 1), so I'm kind of setting a bad example with my example. I apologize. But always make the circuit, the measurement, or the task the subject of the sentence, not you.

Table 1: Comparison of First, Second, and Third Person

Words Used in First Person	Words Used in Second Person	Words Used in Third Person
I	you	this
me	your	those
we	you're	it

For example, instead of saying, "We measured the voltage across the resistor and we got 2V," say, "The voltage across the resistor was measured to be 2V." It will take a while for you to get into the habit of writing like this.

Usually this is where you'll get a million data points. Don't put all of those data points here. Just represent them with a graph and put the raw data in the appendix. If you do use an appendix, make sure you say that the raw data can be found in the appendix.

While I'm at it, **never** use contractions in professional writing. Contractions are those combined words with the apostrophes. Always use "do not" and "cannot" instead of "don't" and "can't." I know I did it all the time in this instructional thing and I'm a bad person for it. But please don't do it in your reports.

5 Discussion

The end of the report is on the horizon! Use this blurb section to say things like, "Overall, the circuit operated as expected." (This, after all, is the point of the lab.) You can briefly touch on some good things and bad things. Be sure to quantify.

5.1 [Section Title]

Now is your chance to really discuss the lab. What happened? Did the circuit you built in lab operate as expected? Why? Why not? Integrate some circuit theory to explain deviations from expected results. If you messed up something, now is your chance to tell your TA you messed up. If you say how and why you messed up, you can still get some redemption points. So don't skimp on this section! Also, it's your chance to demonstrate that you really understood (well, hopefully you did) what went on in lab.

I like putting comparison tables in this section. Your TAs will like it too. Compare the calculated, simulated, and experimental results. Provide reasons for the deviations.

5.2 Sources of Error

This is one section I would *highly* recommend having no matter what. You should always talk about sources of error and how they impacted the performance of the circuit. This section might get slightly repetitive with respect to your other discussion sections, but having a separate section devoted just to talking about sources of error is important. It also helps your TA see where you went wrong and where you know you went wrong. If you talk intelligently about your sources of error, you can get some redemption points if you messed up your lab.

5.3 Possible Improvements

This is another section I would recommend having. You should always have an idea of how to improve your circuit. Also, this is a chance to rack up some points.

6 Conclusion

Yay! We're done! Use the conclusion to tie up your report. Re-state the purpose of the lab and say whether or not you met the goals. Provide some of the major results and write a sentence or two about sources of error. In my conclusion, I would like to apologize for doing all of the bad things I said not to do in your reports. These bad things include writing in first person and using conjunctions. I'm sending mixed messages and I'm sorry. This outline is more of "do as I say, not as I do" type of thing. Anyway, good luck with writing your own report.

A Experimental Implementation Raw Data

Table A: Fake Raw Data Obtained in Lab		
Input Signal Frequency (Hz)	**Input Voltage (V)**	**Output Voltage (V)**
100	1	2
200	2	4
300	3	6
400	4	8
500	5	10
600	6	12
700	7	14
800	8	16
900	9	18
1000	10	20