INTRODUCTION

At the end of your lab exercises you will be required to submit a written summary describing some aspect of the work you have just completed. It should be written in the style of an informal report or memorandum meant for an immediate supervisor or other manager within your organization. Usually (but not always) you can assume that a document like this will not circulate outside the organization. That is, clients and members of the general public will never see it. However, you should still pay attention to spelling, grammar, punctuation, and organization, because even an internal document is a reflection of yourself, and you never know what parts of it might appear in another report distributed to customers or partner organizations.

In this type of writing you can get away with some shortcut notation and jargon, as long as your manager knows what they mean. The key is to give your manager the information he or she needs accurately and quickly. Avoid “padding” summaries with a lot of filler material. Filler will definitely not impress your manager. Get to the point, but do not sacrifice important information needed to understand your message in an effort to limit its length. You should assume that your manager knows what you are doing in a general sense but does not know the details. You should therefore make liberal use of circuit diagrams, graphs, figures, a few equations, and brief but concise descriptions of test procedures, if appropriate, to address the assigned topic. A technically knowledgeable reader who did not complete the lab exercise him/herself should be able to understand exactly what you did. Imagine that you are describing your lab experience to another ECE professor.

Be careful when you use jargon and technical slang. Although accurate communication is the primary objective, you still need to sound like a professional. Too much of the wrong kind of slang and jargon can make you sound careless, flippant, and/or unsophisticated. At worst, the reader might think you are putting on a show to mask incompetence or that you do not have a good sense of boundaries.

SPECIFIC ISSUES TO CONSIDER

Several items of technical, grammatical, organizational, and stylistic concern appear often in reports written for this course. The following points address the ones that most commonly occur. The sections below might not be the most fascinating reading you have ever encountered, but they discuss important issues that could affect others’ perceptions of your writing and, by extension, you. Attention to these details will go a long way toward helping you improve your writing (and your grades!).

General Content

1. Write your summaries as if you were responding to a work assignment. Pretend that it is not a classroom assignment. Specifically, do not restate or copy into the summary the problem statements or questions that I give you. Express in your own words why you have chosen your particular course of action.

2. Related to the previous point, if a lab handout contains a number of questions for you to answer, you should not simply copy the questions into your report and then answer them. For one thing, a “Q&A” format like this usually leaves out the context. For example, if you only copy the question “What voltage did you measure?” the reader will not know where in the circuit the voltage appears or how or why it was measured. The “Q&A” format can also be highly unprofessional in many cases.
3. Every summary should begin with a short introduction that describes the “big picture,” that is, the context surrounding the work being described. It should be sharply focused on the work and should explain the motivation for it with reference to some of the details. The introduction should also provide a smooth transition into the body of the report. It does not necessarily have to be very long; sometimes one or two sentences will do.

4. Every summary should also end with a conclusion that summarizes the major findings and/or design effort. Like the introduction, it should be tightly focused on the work described in the body. It should briefly discuss some of the implications of the work (if the implications are not already discussed earlier) and point to reasonable future directions. It should not progress into exaggerated claims (e.g., “Now I feel like I can design an amplifier for any task I am faced with!”). In short, the conclusion should wrap up the discussion and provide the reader with a sense of closure. You will probably find that the conclusion is often the most neglected and yet most difficult to write section of a report.

5. The heading of the conclusion section should be “Conclusion,” not “Conclusions.” You might have formed several conclusions and discuss them all in this section, but there is only one conclusion section.

6. Attachments are appropriate if you have made photocopies of other documents that you wish to show to the reader (e.g., pages from a data sheet). If you do this, cite the source of the attachment.

7. Appendices are not normally used in short reports or summaries. Figures and tables should not usually be added as attachments; instead, they should be numbered (e.g., “Figure 1”) and referred to by number in the text. Refer to attachments as attachments, not as appendices (e.g., “Attachment 1”).

**Technical Content and Style**

1. ALWAYS include a circuit diagram, and refer to it in your narrative text.

2. Define all variables used in figures, equations, and the text that are not widely understood or obvious from context. For example, you should not assume that your reader knows what “$v_{in}$” means. On the other hand, $\pi$ is universally understood to mean 3.141592654…

3. All numerical values should include units, and units should be represented using appropriate symbols, not spelled out. For example, use “50 $\Omega$” instead of “50 Ohms.” You can create most Greek letters in Microsoft Word by typing the corresponding Latin letter and then changing its font to Symbol; capitalization is preserved. For example, the letter “w” in Symbol font is “$\omega$,” and “W” is “$\Omega$.“ The volt unit is represented by a capital (never lower-case) “V” and the watt by a capital “W.” If you spell out units, in most cases they should not be capitalized, even if they are derived from a person’s name (e.g., “volt,” “watt,” and “farad”).

4. Include a space between a value and its unit. For example, write “10 V,” not “10V.” This includes temperatures. Twenty degrees Celsius should be represented as 20 °C. The only common exception is the degree symbol when it is used to represent angles; in that case, there is no space between the value and the symbol (e.g., 120°).

5. Use a hyphen in a value/unit combination only when it acts as an adjective. For example, you should use a hyphen in the sentence “Most communications equipment is designed to have 50-$\Omega$ input and output impedances.” However, you should not use a hyphen in the sentence “Most communications equipment is designed to have input and output impedances of 50 $\Omega$.“ The difference is that “50-$\Omega$” is used as an adjective that modifies the noun “impedances” in the first sentence; in the second sentence “of 50 $\Omega$” is a noun phrase.
6. The metric prefix “k” (for “kilo”) should be in the lower case, not the upper case. “Mega” is an upper-case “M;” “milli” is a lower-case “m;” “micro” is the lower-case Greek letter “μ” (made by typing “m” and then changing its font to Symbol).

7. Include a leading zero in fractional values expressed in decimal form. For example, use “0.01 V” instead of “.01 V.”

8. Pay attention to the number of significant digits in final calculated or measured values. Avoid using more digits than are justified.

9. Do not use the same component labels for different devices in different circuits. For example, if you use $R_1$ and $R_2$ to represent the resistors in a voltage divider, do not label the resistors in a separate voltage divider as $R_1$ and $R_2$ as well. As another example, multiple input voltages should not all be labeled as $v_{in}$; you might use $v_{in1}$, $v_{in2}$, etc. instead.

10. Keep values and their associated units on the same line; do not let them be separated by line breaks. This guideline also applies to figure references, table references, and equation references (e.g., “Figure 2,” “Table 1,” and “Equation 4”). To prevent line breaks in Microsoft Word, type the space or hyphen between the value and the unit while holding down the Shift-Ctrl keys.

11. Do not use an asterisk (*) to represent scalar multiplication. Instead, express a product by writing the variables next to each other or by using parentheses. The asterisk is often used to represent other operations, such as convolution or complex conjugation, so its use to represent multiplication could cause confusion. Be careful when using a dot (·) to represent multiplication, too, since it could be confused with the vector dot product symbol. An exception to this rule applies when Matlab code (or other that of other languages) is listed in the text. In that case, the language syntax should be retained.

12. Reactance values are real numbers, and impedances are complex. Therefore, reactance values should never contain a $j$ (i.e., the square root of $-1$). For example, in the impedance $Z = 300 - j200 \Omega$, the reactance is $X = -200 \Omega$, not $-j200 \Omega$.

13. Percentage error is calculated using the formula

$$\% \text{ error} = \left( \frac{\text{measured value} - \text{reference value}}{\text{reference value}} \right) \times 100\%$$

An easy way to check that you have the correct form is to remember that 105 is 5% higher than 100. The algebraic sign is important and should be retained; a positive error means that the measured value is above the reference, and a negative error means that the measured value is below.

14. Specify whether AC or other periodic voltages and currents are expressed as peak (pk), peak-to-peak (pp), or rms values, if applicable.

**Figures, Tables, and Equations**

1. If you present a figure, table, or equation, you should refer to it by number or position (e.g., “The figure below shows…”) and explain it in the body of the text. Do not force the reader to deduce on his or her own why the figure (or table or equation) is there and what information it is supposed to convey.

2. When referring to labs, figures, tables, and equations by number, do not spell out the number. For example, use “Lab 1” and “Fig. 1” instead of “Lab one” and “Fig. one.” The words “Lab,” “Figure” and “Table” should be capitalized when used with a number to refer to a specific item. The word “Equation” is often capitalized in this usage as well.
3. You do not necessarily have to use figure and table numbers and/or include descriptive captions in a short informal report. However, a citation to a source is necessary if you have copied a figure from somewhere else. Note that it is perfectly acceptable to refer to a figure or table directly in the text (e.g., “In the figure shown below we see that…”). A citation can be given in the body of the text instead of in a figure caption (e.g., “In the figure shown below (from the ELEC 350 Lab #1 handout for Fall 2013 by D. Kelley, Bucknell University, http://...) we see that…”).

4. Figure captions should be placed below figures, and table captions should be placed above tables. Avoid capitalizing every word in the caption. Include a period at the end even if the caption is not a complete sentence.

5. Although equations can be (and frequently are) numbered, they should never have captions. Put all explanations of equations in the text, not in a caption. Citations to sources of equations should be embedded in the descriptive text as well. Equation numbers are usually right-justified on the page.

6. Label individual curves in multi-curve plots. A common example of this is a plot of the input and output voltages of a circuit on the same oscilloscope screen. You need to tell the reader which curve corresponds to which physical quantity. While you can identify individual traces in the figure caption (e.g., “The solid line is \(v_{in}\), and the dashed line is \(v_o\).”), it is better to use a legend or to label the curves directly on the plot. You might have to do the latter by hand if the plot is a screen image captured from a piece of test equipment. Also, label the axes, and indicate the units used on each axis.

7. Figures (especially data plots) and tables should be able to stand alone as much as possible. Busy managers will sometimes look only at the figures and tables and their captions in a report and not read any of the text. That means the axis labels, figure title (if any), and caption need to be specific and highly descriptive.

8. Figure titles are not always necessary, but if you use one, make sure it is descriptive and provides additional information. Do not simply repeat the vertical and horizontal axis labels in a “Quantity 1 vs. Quantity 2” kind of format (e.g., “Voltage vs. Time”). If you do refer to a plot using the “Quantity 1 vs. Quantity 2” format in the text, remember that Quantity 1 is the dependent variable (the vertical axis), and Quantity 2 is the independent variable (the horizontal axis).

9. Figure titles should not normally be used if a caption is present since that would be redundant. An exception would be in the case of multiple plots in a single figure; in that case, plot titles might be helpful.

**Grammar**

1. The words “input” and “output” should not be used as verbs (e.g., “We inputted a signal,” “The circuit outputted 2 V.”). Some suggested alternatives to the use of “input” as a verb are “supply” and “apply.” Alternatives to the use of “output” as a verb are “produce,” “generate,” and “supply.”

2. Avoid colloquialisms and most jargon whenever possible. For example, instead of using the phrases “hooked up” or “wired up”, use “connected,” “assembled,” “constructed,” or “built.” Instead of “set-up” (used as a noun), use “configuration,” “circuit,” or “assembly.” The word “procedure” might also be appropriate (as in “test procedure” rather than “test set-up”). Instead of “plug into” (used in the context of substituting values into an equation), use “substitute.”

3. Know when and when not to use apostrophes. Apostrophes should never be used when forming plural nouns, even in the case of single-letter abbreviations (e.g., “Do you know your ABC’s?”). An exception to this is when comprehension might be affected (e.g., “We ran out of LM741’s.”), although grammar experts debate whether even this type of use is justified. Also, pay attention to the difference between “its” and “it’s.” They mean totally different things.
References and Citations (Treatment of Intellectual Property)

1. Any figure or text you copy from somewhere else (including lab handouts) and any data you obtain from a data sheet must be cited. Other authors’ intellectual property must ALWAYS be acknowledged!

2. Footnotes are not used much in short technical reports and have all but disappeared from use in many serious technical journals. The preferred alternative to footnotes is to use a reference number in brackets (e.g., “[1]”) and then list the cited references in a single list at the end of the report with a heading like “References.” There is nothing technically wrong with using footnotes; they just are not used much in this type of writing, probably because they are somewhat distracting.

3. Data and figures from lab handouts should be cited just like other intellectual property. A complete citation includes the author (usually a professor), the course number, the lab number and title, the institution (Bucknell University, of course) and the semester (e.g., Fall 2013). To aid the reader in finding the material online, you should include the URL of the handout.

4. If you draw a figure yourself that is a copy of another figure, you should label that figure as “adapted from” the source. In this case, the artwork (the figure) is your intellectual property, but the idea you are conveying is someone else’s property.

5. Some diagrams and concepts are considered to be in the public domain. Examples are Ohm’s law and diagrams of inverting amplifiers based on op-amps. Material in the public domain does not have to be cited. However, be careful what you consider to be in the public domain. Many copyright infringement cases result from conflicting opinions on what is public and what is not. Most of the simpler circuits discussed in our textbook are likely to be in the public domain.

6. Direct, unaltered (or mostly unaltered) quotations from a source should be indicated by quotation marks. That is, it is not sufficient simply to cite the source (although that is necessary!). The quotation marks indicate that the text is copied word-for-word, not just paraphrased.

7. One purpose of citing references, besides acknowledging credit for another person’s ideas, is to inform the reader where to find the referenced material on his/her own. You should therefore include enough information to allow the reader to do that. Provide the URL for material available online.

8. If you quote information from a data sheet (e.g., the maximum power dissipation of a diode), you should cite the source of it. A reference to a data sheet on the web should list the complete URL (not a partial URL) where the document can be found. However, it is also important to give the manufacturer, the title (usually just the name and reference number of the component), and the document number and date of the data sheet.

9. Pictures, text, and data obtained from the internet must also be cited. At a minimum, the URL must be provided, but if you know the name of the person or institution that produced or published the item and/or when it was created, you should include that information as well.

10. You may use any standard method for citing references (such as MLA), but you should be consistent.