Common Mistakes for E2 Technical Memos

Breakdown of Categories

1. General Writing Mechanics
   a. Writing based formatting such as page limit, numbering pages, etc.
   b. English

2. Technical Writing Mechanics
   a. Technical based formatting such as symbols, units, table and figure captions, etc.
   b. Formatting of technical information in figures and tables, legend entries, etc.
   c. Appendices

3. Quality of Writing
   a. Organization of ideas
      i. Purpose?
      ii. Conclusion?
      iii. Major points/arguments?
   b. Ability to communicate ideas
      i. Word choice/phrasing
      ii. Clarity of statements
      iii. Etc.
   c. Writing style
      i. Third person narrative?
      ii. Tense consistency?
      iii. Formal diction?
      iv. Etc.
   d. Clarity in communicating technical material

4. Technical Understanding and Interpretation
   a. Comprehension of mathematical/engineering concepts
   b. Viability of interpretations/explanations for data
   c. Blatant errors?

Technical Understanding and Interpretation Mistakes

1. There seems to be confusion about the bounds for theoretical voltage output accounting for the possible 5% variance in resistor values. These bounds mark the region in which
the theoretical curve resides. **Note that these are bounds for the theoretical curve and not for the measured data.** There is little meaning in stating that all of the measured points lie within the bounded region. Resistors affect the slopes and shifts in the theoretical curves, so more meaningful information comes from comparing the trends of measured points to the bounds. Having trends of measured points break the boundaries may suggest that something beyond the 5 % uncertainty in resistor values could be affecting the measurements. These bounds were meant to visualize the possible explanation for errors in measured gains or offsets in measurements due to the 5 % variance in resistor values. Attributing the fluctuations of measured points about the theory line to the resistors does not make sense. **There may be 5 % uncertainty in the resistor values, but unless the resistor values are changing for each measured point, the resistor values should not be contributing to the fluctuations about the theoretical curve or fitted curve.** Those fluctuations are better explained by precision. All measurements have some error associated to the precision of the measurement device. For the signal conditioning lab, the sensor interface box can read voltages out to the hundredths place value. The “true” voltage signals probably require many digits beyond the hundredths place value, so there is an error on the order of thousandths associated with each measured voltage value obtained on the sensor interface box. The amplifier may amplify values in the thousandths place enough to become significant in the hundredths place. This suggests that the amplified signal measurements may capture parts of signal that was not accounted for in the theoretical calculations.

2. The low-pass and high-pass filter equations uses angular frequency which has units of radians per second. The frequency on the function generator has units of hertz. Be careful with units! The experimental magnitude ratio can be calculated by dividing the output signal’s amplitude by the input signal’s amplitude. The amplitude of a sinusoid is half of the difference between the max value and the min value. The magnitude ratio is not the output voltage divided by the input voltage; the voltages are functions of time and vary.

3. When suggesting possible sources of error, explain how your measurements or data would be affected by the suggested error sources. Throwing out generic sources of errors such as “human error” or “bad connections” usually signifies to the reader that you have no clue as to what may be causing error in your measurements. Having suggestions that are not explained is almost as useless. There is a difference between regurgitating memorized words and applying concepts to explain observations particular to your situation. A five year old child can be taught to memorize that “all measurements have precision error.” One should not assume that a five year old child can explain the relationship between measurement and precision just because the child can state that measurements have precision error.
4. The signal filtering study seemed to be less understood by the class in general: explanations were vaguer, mistakes in calculations were more frequent, and suggestions for error sources were more weakly supported. Lecture notes and the course text should help you understand the theory and calculations. If you need extra help understanding filters, contact a TA. Effectively identifying possible error sources is a skill that relies on understanding the theory and instrumentation involved and mapping relationships between relevant concepts. For the magnitude ratio plots, discrepancies between measurement and theory included horizontal shifts, complete overshooting, complete undershooting, and even fluctuations between over and undershooting. Resistors affect the scaling of the magnitude ratio and the value of the cutoff frequency. The cutoff frequency determines horizontal placement of the roll-off region on the magnitude ratio as a function of input frequency plot. The 5% uncertainty in resistor values may increase or decrease the cutoff frequency, shifting the curve horizontally right or left respectively. The 5% uncertainty in resistor values may also scale the magnitude ratio by ten percent; the scaling factor ranges from about 0.905 to about 1.105. This helps explain the complete overshoot and complete undershoot cases. The combination of shifts and scaling resulting from resistance variation depends on whether the filter of interest is a high pass filter or a low pass filter. For a low pass filter, \( R_f \) determines the cutoff frequency, and for a high pass filter, \( R_{in} \) determines the cutoff frequency. The oscilloscope was used to measure the amplitudes of both the input and output signals. The measurements were affected by the scale settings on the oscilloscope. Using the smaller scaling increments tends to result in more accurate amplitude measurements provided that the peaks and the troughs of the sinusoid signals are visible on the oscilloscope screen. Think about measuring an unknown length with a ruler. Suppose the smallest increment marked on the ruler was a centimeter. How accurate would your measurement be if the length of interest happens to fall between two marked increments? You would have to estimate the fraction of a centimeter that best describes the length you are trying to measure. Suppose the smallest increment marked on the ruler was a millimeter. If the length of interest falls between two marked increments, you would only have to estimate a fraction of a millimeter instead of a centimeter. Error in amplitude measurements carry over to error in magnitude ratios calculated from the amplitudes. Other sources of amplitude error may involve noise. The oscilloscope data of raw voltage values saved onto the floppy disk may appear “fuzzy” or “jagged” when plotted. This noise may result in a higher measured maximum value and a lower measured minimum value than the maximum and minimum values of the signal, respectively. The severity of effect may be dependent on the signal to noise ratio. This may explain the large errors in magnitude ratios in the extremely high input frequency range for a low pass filter. The signal’s amplitude may have dropped low enough to where the amplitude of the noise becomes significant or even dominant. For phase error, the resistances affect the value of the time constant which horizontally scales the phase as function of input frequency plot. Phase
data was computed using the raw data that has voltage and time information. From the raw data, the wavelength of the detected signal can be obtained and used to calculate a “measured” frequency that may or may not match up with the indicated frequency on the function generator. Because the phase was calculated using the same data set, comparing the theoretical phase calculated using the “measured” frequency to the “measured” phase may show better agreement.

Format Mistakes

1. Equations should be integrated into sentences and punctuated accordingly. They should also be labeled and referenced by the appropriate labels. Well known equations may be identified by name.

2. Figures and tables are not part of sentences. They also should not be placed in the middle of paragraphs or sentences. Tables should not be broken up by page breaks unless the table is larger than the page. If this happens, add column and row labels as necessary.

3. Symbols are italicized and should be defined. However, if the table is larger than a page, consider alternate options for presenting data if possible.

4. Units are not italicized. All values should have appropriate units, and there should be a space between values and units. Read the chapter on formatting in the course text.
   a. For units named after people, capitalize when abbreviating the unit and do not capitalize when spelling out the unit.
   b. Either abbreviate both the metric prefix and the base unit or spell both out; do not mix.

5. Values should not lead with a decimal point. Have a zero in the ones place before the decimal point. If there are more than three significant digits on either side of a decimal point, break the digits into groups of three using spaces. Read the chapter on formatting in the course text.

6. Figure captions are placed below figures; table captions are placed above tables. Page breaks should not separate figures and tables from their captions.

7. Do not add titles to plots if they do not contribute new information to the figure. Many plot titles in the E2 tech memos reiterated information obtainable from the axis labels and figure captions.

8. Legends in figures should not cover up plots if they can be moved to empty space in the graph. When printing in grayscale, be sure that each legend entry is distinguishable from the other entries.

9. References for figures, tables, and citations should appear in text in numerical order.
a. Rearrange figures, tables, and bibliography entries accordingly; do not reference out of order

b. If a figure, table, or citation is not explicitly referenced in the text, do not include it in the write up.

   i. Figures and tables that have important information should be discussed in the text.

   ii. “References” that are not referenced by the text are not actual references.

c. Do not use the reference labels as objects of prepositions. Use the author or the work and then indicate the reference label.

   i. Avoid writing, “from [1],” or “in [1].”

   ii. Instead, write, “from Dunn [1].”

10. Appendices should only have supplemental information. Figures and tables with important information should not be placed in the appendix. The reader should be able to throw away the appendix and still obtain and understand necessary information.

   a. For example, if you develop a new equation and explain the basis in text, then a detailed derivation of the equation may be placed in the appendix.

   b. If you discuss an algorithm on the high level (macro scale or “big idea” level) in text, then a low level (micro scale or “gritty details” level) may be placed in the appendix.

   c. As with referencing figures, tables, and citations, if the text does not inform the reader of the content in the appendix, then that content might as well not be included.

11. Number the pages. Everything counts towards the page limit. “Everything” includes references and appendices.

12. Avoid beginning sentences with digits or symbols.

Writing Mistakes

1. Many summaries answered “What?” and “How?” effectively, but neither the question of “Why?” nor the “Big Takeaway” was clearly communicated. In some cases, there were clear purposes and clear conclusions, but the conclusions had nothing to do with the purpose.

   a. One of the most important things (if not the most important) to communicate is the purpose. Why was the study conducted? What is the motivation or goal? Once the purpose is established, it serves as the anchoring point for both the writer and the reader. The writer uses the purpose to organize important
information, and the reader uses the purpose a guide to “what to look for” while reading.

b. The conclusion emphasizes the key findings, concepts, ideas, etc. of the study with regards to the purpose. To establish the conclusion, think about your study in the following manner: “If there is just one (or a few) thing(s) you want your reader to remember or understand, what is it?”

c. In short, conclusions state what your study contributes to the purpose, and everything else supports your conclusion.

2. Organization is critical to effective communication. Some of the write ups had many values, findings, concepts, discussions of trends in data, etc. without any clear direction or connection between points. Avoid presenting and rambling about a “random” mess of data. Think about the data you have, the points you want to make, the connections between your points and the purpose, and the presentation of your data to reflect your arguments.

   a. This should help you decide what should and shouldn’t be included. Presenting things that do not relate to your purpose can be detrimental in that the reader may be sidetracked or even confused.

   b. For things that do relate to your purpose, be sure to explain how they are relevant. If that connection is not made clear, then relevant information may be just as detrimental as irrelevant information.

   c. More effort is required to write concisely. Writing concisely forces the writer to think about what is necessary and what is not. Reaching the page limit should not be the problem. The real challenge is staying under the page limit. When writing technical documents outside of this class, there probably would not be a specified page limit. Remember that shorter is better as long as everything that needs to be communicated is communicated.

3. In many discussions, there were claims that were suggested without anything to support them. The most common mistake regarding this point involved explaining possible sources of error.

   a. If suggesting a possible source of error, give some sort of rationale to why that suggestion may be valid.

      i. How does said error source affect your data? Would you expect more fluctuations in your plotted data? Would you expect a shift in the plotted curves? Would said error source offset your measurements? Would said error source affect your data processing in some manner?
4. Some memos had a step-by-step walkthrough of the lab procedures. That level of detail is usually not needed unless the purpose involves the evaluation of procedures, measurement techniques, etc.

5. In regards to tense consistency, there is a fuzzy gray area regarding the tense of “facts that are true now.” Try to think of it this way: A description may reflect the current state of an object, but the document reports the description of that object’s state at the time of observation. The ball is red now. The ball was red yesterday. The ball was blue last week.

6. Avoid abbreviations such as “vs.” Spell out the word. Abbreviations and acronyms defined in writing for lengthy ideas are okay. For example, many defined signal conditioning box (SCB).

English Mistakes

- Run-On Sentence: incorrectly combined compound sentences or compound sentences that contain more than two independent clauses
  - comma and conjunction: Two independent clauses may be joined together, but they must be compounded correctly.
  - semicolon: There is another method of compounding independent clauses; the semicolon provides an alternative option.

- Ambiguous Pronoun Reference: the implied antecedent of a pronoun does not make sense or multiple possible antecedents for given pronoun
  - implied antecedent: Although Fall Break is around the corner, it is unknown whether or not the students will survive mid-terms week.
    “it” is implied to refer to “Fall Break” → replace “it”
    Although Fall Break is around the corner, one does not know whether or not the students will survive mid-terms week
  - multiple possible antecedents: Leibniz told Newton that his derivative notation sucks.
    Context suggests that “his” refers to “Newton,” but “Leibniz” is still a possible antecedent. Leibniz could be bashing his own derivative notation while conversing with Newton.

- Parallel Structure: listed items conjoined with coordinating conjunctions should have similar syntactical frameworks
  - parallel: Jenna likes to read, to write, and to draw.
    structure: <infinitive>, <infinitive>, <conjunction> <infinitive>.
  - not parallel: Jesse likes to swim and biking.
structure: <infinitive> <conjunction> <gerund>

- parallel: The report suggested that werewolves howl under full-moon skies, spirits wail in eerie tones, and zombies stroll through abandoned streets.

• Placement of Modifiers:
  - dangling modifiers: object of modification is not present in sentence
    Realizing that the deadline was quickly approaching, the writing process began.
  - misplaced modifiers: modifier intended to modify something else in sentence
    With the first five decimals digits of π in mind, the echoes of the Beaver Cheer rang across campus as students chanted in perfect unison, “Three point one four one five nine!”

• Capitalization
  - proper nouns are capitalized
  - units that are named after people
    i. capitalized when abbreviated: μF, kPa
    ii. not capitalized when spelled out: microfarad, kilopascal

• Punctuation
  - colon usage
    i. placed after independent clauses in sentences
    ii. introduces a list
    iii. introduces an elaboration
  - Punctuating phrases and clauses
    i. This gets tricky. I recommend reading about identifying and punctuating different types of clauses and phrases. There are a lot of different cases (many more than the few mentioned here), and many have exceptions.
    ii. In general, phrases and clauses that modify clauses need to be separated from the main clause using a comma or commas. Phrases and clauses that modify a predicate do not need to be separated from the main clause.
      Flynn dragged his feet and released a heavy sigh, suggesting that the seemingly innocent request would burden him greatly.
      Tightening her grip on the leash, Kayla commanded Rex to heel when two squirrels darted across the lawn.
iii. In general, introductory phrases and clauses need to be separated from the main clause using a comma. In general, interrupting phrases and clauses need to be separated from the main clause. In many cases, these clauses and phrases are separated using commas on both ends, but some cases require other punctuations such as parentheses and dashes.

As if under a narcotic spell, Jason slowly closed his eyes and slouched over the armrest of his chair.

After the clock rang half past midnight, Hal, he who seeks treasure of all shapes and sizes, barged through the door presenting the most valuable discovery of his latest expedition: coffee.

Miscellaneous Comments

1. Technical writing is about communication. Make sure what your words communicate agree with what you intend to communicate. Being sloppy with word choice reveals some combination of lack of thought, effort, and comprehension.

2. Quantify! How small is “very small?” How much larger is “a lot larger?” The notion of “small” and “large” is relative. For some applications, having 10 % error may be acceptable. For other applications, 2 % error may be too much error for practical purposes. Emphasis is placed on quantifying because descriptions such as large, small, close, etc. do not reveal useful information.

3. The idea was to get you to start thinking about organizing and interpreting data. For example, one student plotted two data sets from the differential amplifier cases on the same plot to show the offset in output voltages between two specific cases: supplying a constant 0.50 V signal to the negative input terminal and supplying a constant 0.05 V signal to the negative input terminal. This helped illustrate the effect that the negative input signal has on the output signal and reduced the number of plots needed to display both cases.

4. Do not ink in things by hand on the printed hard copies. Proofread and check your document before you print it out. This is especially sloppy for figure plots and legend entries.

5. The example MatLab script posted online was supposed to demonstrate how to call the findDifferentialBounds function and how to plot the information returned. Many students repeated the legend entries from that example verbatim. Those legend entries were not the best descriptions of the plots. Also, some students plotted the bounds and did not mention anything about the bounds. If the bounds are not important enough to be noticed, then don’t plot and show them.

6. Some students referred to the bounds that accounted for the 5 % uncertainty in resistor values as “differential bounds.” The function was named to indicate that the bounds calculated correspond to a differential amplifier and not the non-inverting amplifier.