Written Communication

In the Real World, written communication is a vital aspect of an engineer’s professional activities. Your writing can take the form of a short email to a colleague, a lab report, a memorandum to one’s boss, a letter to an associate, or an article in a technical journal. Every time you put a word to paper you create an everlasting reflection of yourself. The writing that you do in this class, and the requirements that I place on your homework and exam solutions, are not intended to be busy work or to burden you with meaningless details. Learning to write well marks you as an exceptional engineer. These skills will serve you in ways that go far beyond the rote memorization of equations or definitions, for many years to come.

The Languages of Engineering

Like it or not, most of your communication will use what we loosely refer to as “The English Language”. You must use the words, syntax, and grammar of English to express your ideas clearly and concisely to the reader. Arranging the proper words in the appropriate sentence structure maximizes the likelihood that your meaning will be understood. Adhering to commonly accepted forms and style will make your writing a pleasure to read.

- Avoid slang, jargon, and vague terminology. Words like “perfectly”, “exactly”, and “infinitely” are rarely usable in engineering. Don’t write like a salesperson.
- Avoid common mistakes with homonyms:
  - The word it’s is a contraction that means “it is”. The word its is the possessive form. The word its’ is just sad.
  - Know the difference between their, there, and they’re.
  - In most cases, effect is a noun and affect is a transitive verb.
- Any writing done on a computer should not have spelling errors. This is doubly important for group presentations.
- Look for incomplete sentences or other syntax errors.
- Make sure you use plural verbs with plural subjects and singular verbs with singular subjects.
- Acronyms should be defined before their first use. Don’t use an apostrophe to make an acronym plural: We needed three FPGAs because each FPGA’s performance was low.
- I accept the word data when used as a singular or plural noun, but be aware that some people have strong feelings that data must always be plural. I usually avoid the issue altogether by changing “data” to something more descriptive (results, measurements, points, values) and then it becomes clear what sort of verb should be used.
- Avoid confusing symbols for $I$, $1$, and $l$; for $i$ and $j$; and for $+$ and $t$. Avoid san serif fonts for technical writing and be careful that your handwritten work is neat and clear. While the reader can often sort these out from the context of normal writing, it’s easy to mix them up in technical writing. For presentations and written work that will only be viewed on a computer screen you should use san serif fonts with distinctly different glyphs for $I$, $1$, and $l$, such as Verdana or Tahoma.
In many technical fields the language of mathematics is used to represent complex and abstract concepts that would otherwise be impossible to communicate. As with plain old English, we can only use mathematics to communicate if we abide by our shared notions of meaning, syntax, and grammar. You can redefine the meaning of “logarithm” but your work will be relegated to obscure blogs that you compose in your pajamas while eating potato chips at 3:00 in the afternoon.

- All quantities must be expressed in the appropriate units (volts, amperes, ohms, watts, bits, etc.) Units are optional for dimensionless quantities if they are obvious in context. You can say “…the voltage gain is 100…” or “…the gain is 100 V/V…”. Note that the abbreviation for seconds of time is just ‘s’, not ‘sec’.
- All answers must use standard prefixes. For example, $3.14 \times 10^{-2} \text{V}$ is wrong, $31.4 \text{mV}$ or $0.0314 \text{V}$ is correct. Remember that the symbols for all prefixes of mega and above are capitalized. Also note that one of the vowels is dropped when we combine kilo and mega with ohm… the correct units are kilohm and megohm.
- Computer engineers should be aware that the correct abbreviations for bit and byte are bit and B, respectively. There are also defined prefixes that are powers of two instead of powers of ten, so a memory with $2^{10}$ 8-bit data words would contain 1 KiB (or one kibibyte) of information. The corresponding prefixes for $2^{20}$ and $2^{30}$ are mebi and gibi, with symbols Mi and Gi.
- Don’t use the letter ‘u’ as the abbreviation for the micro prefix unless writing a plain text file, such as an email message or program source file. Similarly, don’t use the letter ‘e’ for exponential notation in formal writing.
- Don’t let your word processor split a line between a unit and its value. For example, you shouldn’t talk about a capacitor in a power supply circuit and have something like 2700 µF in your text.
- Remember that the symbol for a unit that is named after a person is always capitalized (e.g. V, A, Hz, W) but the unit is not capitalized when written out (volt, ampere, hertz, watt).
- If you abbreviate the prefix, abbreviate the unit as well. Don’t write “kohm”, use “kilohm” or (even better) kΩ.
- When presenting calculated values, don’t use more significant digits than were used in any of the variables. If you pick a 1 kΩ resistor from the bin and measure a current of 1.002 mA flowing through it, don’t write that the voltage across the resistor is 1.002 V… the resistor value has an error tolerance of 5% so you can’t justify having more than two significant digits in your voltage calculation. You should also pick units that allow you to convey the accuracy of a value, so for this example it is better to give the calculated voltage as 1.0 V rather than 1000 mV.
- Use a centered dot to separate compound units, particularly if it prevents ambiguity. For example, the SI unit of thermal conductivity is the watt per meter kelvin and the correct abbreviation is W/(m·K). Without the dot the units could be seen as watt per millikelvin (W/mK).
- Don’t use a comma to separate groups of three digits. The preferred style is to use a thin space when there are five or more digits, as in $c = 299,792,458 \text{m/s}$.
- For decimal numbers less than one, always use a leading zero to the left of the decimal point. Write 0.2 W instead of .2W.
Tables

- Use the same format for all values of the same quantity. At the very least this applies to all numeric values in a single column. If one of the values in your table is 1.234 mA then all of them should be given with three digits to the right of the decimal point. Write 2.000 mA, not 2 mA.
- Don’t split tables across a page boundary. When this is unavoidable, the column headings must be repeated on each page.
- Tables should have a caption and a table number, just like figures. Be sure to refer to the table by number in the text. The caption must be on the same page as the table itself.
- Boolean truth tables should use descriptive names for signals.

Graphs, Diagrams, and Figures

Graphic material can often be used to help convey complex concepts clearly and precisely. Unfortunately, a poorly done data plot will do more harm than good. Always assume that someone will print your document on a black-and-white printer or sit in the back of the room to view your presentation.

- Make sure that different curves or points on the same graph can be distinguished without relying on their color. Make it easy for the reader to tell which curve corresponds to each plotted variable by using different line styles (solid, dotted, dashed) and/or adding labels adjacent to each curve. Avoid using light colors such as yellow or very thin lines.
- Label each plot axis with a clear description of what it represents and the correct units.
- For a linear axis, choose units so that the number of digits for the axis labels is reasonably minimized, while using only the SI prefixes. If you are plotting current values from 100 µA to 2 mA, don’t use units of A or µA...use mA for all of the axis labels.
- For a logarithmic axis you should always plot data using the base unit (e.g. hertz, volts, amperes). Label the axis using powers of 10, such as $10^2$ or $10^{-1}$, or multiples of an SI prefix, such as 1k, 10k, and 100k.
- Change the axis ranges to eliminate excessive white space and emphasize the data of interest. When plotting the r.m.s. value of typical residential power use an axis range of 100 V to 130 V rather than 0 V to 130 V. Of course, you shouldn’t do this to make a small change look more significant. Leave that to the marketing department.
- Don’t try to fit the data to a particular type of function unless you have reason to believe that the data really behaves like that function. Fitting a current-vs.-voltage curve to a linear function might make sense for a resistor but probably shouldn’t be done for a diode.
- When plotting measured data it’s usually better to plot the individual data points without trying to connect them in any way. Allowing the software to “connect the dots” can result in very misleading plots.
- The caption for a figure should be no more than one sentence. Text that describes the figure should be in the body of the document. If the figure is copied or adapted from another source be sure to provide a citation in the caption.
- Make sure the caption for a figure stays on the same page as the figure itself.
- Don’t use the JPEG format for graphics unless you are including a photograph. The preferred formats for graphics are Postscript (PS), Encapsulated Postscript (EPS), Portable
Document Format (PDF), and Tagged Image File Format (TIFF). The Portable Network Graphics (PNG) format can be used for small graphics and clip-art in presentations.

- Signal names in logic diagrams should be descriptive and reflect the meaning of a signal when it is logically true (a ‘1’). Use RoomLightsOn instead of just Light.
- Unless you are demonstrating how to use a particular software tool, snapshots of your computer screen are usually unacceptable.
- Using a photograph of a circuit in place of a schematic diagram is not acceptable.

**Grading Homework and Exam Problems**

Homework and exam problems will typically be worth a total of 5 to 20 points. If you show your work and obtain the correct answer then you will obviously receive full credit, but I will usually try to determine if you were on the right track and should be given partial credit. Failing to use the correct units for an answer will typically cost you one point per problem. If you set up an equation correctly but make a minor error in arithmetic you may lose one point. If the equations are incorrectly formed or difficult to decipher then you may lose half of the points available. If it seems that you didn’t understand the fundamental concepts needed to solve the problem then you may not receive any points at all.

**Homework Requirements**

- Homework is due at the beginning of the class period. Homework turned in after I start speaking is considered late.
- Most homework assignments will be in the form of a worksheet that you can complete and hand in. If you don’t use the worksheet or none is provided, write your name in the upper left corner of each page, and write the due date below your name. In the upper right corner of each page, write the course number. Below this write the homework assignment number. Below this indicate the page number, such as “page 1 of 3”.
- Use 8.5-by-11 inch paper, with all pages stapled together. Don’t submit paper torn out of a spiral notebook with ragged edges.
- Homework assignments should be handwritten and legible (don’t copy-and-paste from Matlab or Excel).
- For handwritten homework and exams, draw a box around your answers.
- If you are asked to submit material in a particular form, don’t convert it to a different file format. For example, if you are asked to submit verilog source files then don’t embed them in a Word document.
- **Do not** send files to the instructor that use proprietary formats, such as Microsoft Word documents or Excel spreadsheets. Anything sent to the instructor as a machine-readable file must be in an open format. Documents should be sent as Adobe Acrobat (pdf) files using embedded fonts. Seriously, don’t send me Word files.
- Unless specifically stated otherwise, you may discuss homework with other students and work together to solve problems but each student must submit their own original work.