University of Texas at Austin

# CE 314K

Properties and Behavior of Engineering Materials

# Technical Writing Guide

Fall 2007

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## 1.0 General Information

CE 314K satisfies the University of Texas requirements for courses with a substantial writing component. Therefore, the assignments that you submit this semester will be evaluated for technical content and for your ability to communicate technical information in a straightforward manner. The teaching assistants who supervise your laboratory sessions will evaluate the technical content of your assignments. Teaching assistants with expertise in technical writing will evaluate your communication skills.

This set of guidelines was developed to help you understand the expectations for technical communication in CE 314K. Successful technical communication requires practice. Therefore, you should allot sufficient time to write several drafts of each assignment before submitting the final version.

The data that you measure in the laboratory will form the basis for all assignments, and you must interpret the data correctly to receive full credit on the technical portion of each assignment. In many of the laboratory assignments you will be given a scenario which defines a practical engineering problem that can only be solved using the measured data from the laboratory.

Two types of assignments will be given during the semester: writing assignments and calculation assignments. Guidelines for writing assignments are given in Section 2, and guidelines for the calculation assignments are given in Section 3. You will need to use tables and figures in both types of assignments, and the requirements for these are given in Section 4. Common editorial and grammatical errors are summarized in Section 5. These mistakes are easily avoided by proof-reading your work. Simple guidelines for reporting numerical information are given in Section 6.

A sample writing assignment is provided on the CE 314K Blackboard website to assist you in applying the guidelines. The scenario is based on the first laboratory and addresses the use of rubber for an engineering application. If you have questions about the example, please discuss them with the technical or writing teaching assistants. Your comments will be used to improve this manual and the example.

As a final introductory note, the expectations of the technical and writing teaching assistants are high. You will be expected to devote a considerable amount of time to completing the assignments for this course. However, the expectations of employers of graduates in civil and architectural engineering are higher. In your first job, you will be expected to have the skills being taught in CE 314K. Having the ability to analyze engineering data, perform calculations in a logical fashion, and communicate effectively is essential to becoming a successful engineer.

## 2.0 Writing Assignments

You will be given three writing assignments during the semester. Each writing assignment includes two parts: a short memo or letter to address an engineering scenario and a laboratory report. By writing two types of documents based on the same data, you will learn how to modify your writing style to match the audience for each type of document. In order to prepare a useful engineering document, you must think about the audience and what type of information that individual hopes to learn by reading the document.

For example, if you are writing a letter to a client who is not an engineer, you should use different terminology and emphasize different concepts than if you are writing a memo to your supervisor who has many years of engineering experience. You will be given information about the audience for the

memo/letter in the scenario for each laboratory and the audience will change throughout the semester. On the other hand, the audience for the laboratory report will always be a technical expert, in this case your technical teaching assistant.

You will also be asked to summarize the results of your laboratory experiments in a series of appendices. The number and contents of each appendix will vary depending on the laboratory assignment.

In order to evaluate all students fairly, strict requirements have been developed for each component of the writing assignment. All students are expected to satisfy all requirements and points will be deducted for any deviations. The organizational and formatting guidelines for each of the components are summarized in the following sections.

You will submit 2 complete paper copies of your writing assignments, one for the technical TA and one for the writing TA. Points will be deducted for late submissions, as described in the syllabus.

### 2.1 Cover Sheet

The first page of each assignment must be a cover sheet, which includes the following information:

- Title of laboratory
- Your name
- Names of group members (where appropriate)
- Date submitted
- Section information (laboratory day and time)
- Name of technical teaching assistant

### 2.2 Table of Contents

The second page of each assignment must be a table of contents. List each section and the associated page number.

### 2.3 Memo or Letter

The memo or letter is addressed to the specific audience identified in the scenario. *This document should never be more than two pages in length, including figures and tables.* Points will be deducted on the writing grade for assignments that are longer than the two page limit. The document must briefly state the purpose of the memo or letter, what you have done to solve the problem identified in the scenario, and your recommended solution. Because many types of clients and customers will make decisions based on your work and only need to know the details if they agree with your recommendation, *the conclusion must be stated near the beginning of the document.* The sample memo provides an example of this "bottom line on top" principle.

Memos are used internally within organizations to relay information between an employee and her/his supervisor or between co-workers. Memos contain a header with the following information: To, From, Date, and Subject. You may use the "memo-wizard" in Word to design a template for your memos.

Letters are used when communicating information to a person outside of your organization, such as a client. Letters contain salutations and signatures. Letters must also include the address of both the sender and recipient. Word has a "letter-wizard" if you need help formatting a letter.

Any figures or tables that are *vital for the audience* to understand your recommendation should be included in the memo or letter. Any data, calculations, references, or discussion that are necessary to explain your analysis of the laboratory data, but are not essential for the scenario audience, should be included only in the laboratory report. You may reference this discussion within the memo or letter so the audience knows where to find additional information if he/she has questions.

The technical teaching assistants will evaluate the technical content of your memo or letter and the writing teaching assistants will evaluate your ability to communicate technical information.

## 2.4 Laboratory Report

The technical teaching assistants represent the audience for the laboratory reports. *This document should never be more than five pages in length, including figures and tables.* Points will be deducted on the writing grade for assignments that are longer than the five page limit.

Each report should contain four sections:

- Introduction
- Procedures
- Results and Discussion
- Conclusions

The introduction, procedures, and conclusions sections should be no longer than *150 words* each, written in your own words and not copied from the laboratory manual. (Word has a "word count" function under "tools" that can assist you in determining the length of each section.)

The introduction should first state the objective of the laboratory and include necessary background information. The procedures section should discuss only vital information about the experiments performed. You may reference the laboratory manual in the procedures section to direct the reader to more detailed information on the experiments performed.

You will be given a list of topics to address in the results and discussion section for each laboratory. Write a few paragraphs about each topic. You should first present the experimental results without analyzing or commenting on their significance. Use figures or tables to present the data and follow the guidelines given in Section 4. You must discuss each figure/table in the text. After presenting the data, you should analyze them by discussing the data and interpreting your results. State the significance of your results clearly, and compare your results with theory. Indicate if the results support the underlying theory or contradict it.

The technical teaching assistants will evaluate the technical content of your laboratory report and the writing teaching assistants will evaluate your ability to communicate technical information.

## 2.5 Appendices

The appendices are used to document the information that is not included in the discussion of laboratory results. For example, the data that you measured in the laboratory, sample calculations, and mathematical derivations should be presented in the appendices. You will likely have more than one appendix for each laboratory report. Assign each appendix a letter and a title, and group the items in a sensible manner – for example, "Appendix A: Measured Data." Data that are not mentioned in your discussion should not be included in the appendices.

When mathematical terms are used in the report, include an appendix titled "Notations." Include complete information about all references cited in the memo/letter and report in an appendix titled "References." Citations should be made by placing (Author Last Names, Year) after a referenced statement and listing all cited documents in alphabetical order by author last name in the appendix. The following formats are acceptable:

Folliard, K.J. and Wood, S.L. (2004). "Laboratory Number 1, Rubber Stress and Strain," *CE 314K Laboratory Manual*, Department of Civil Engineering, University of Texas at Austin.

Mamlouk, M.S. and Zaniewski, J.P. (1999). *Materials for Civil and Construction Engineers*, Addison-Wesley, 388 p.

The technical teaching assistants will evaluate the technical content of your appendices.

## 2.6 Technical Writing Style

You will be expected to follow the writing style summarized below for all writing assignments. Points will be deducted if you do not follow these guidelines.

- Every paragraph should develop one idea and include a topic sentence.
- You *may* use personal pronouns (I, we, our, etc.) in the memo or letter. *Do not* use personal pronouns in the laboratory report or in the appendices.
- Use the *active* voice whenever possible.
- Use the *present* tense when describing a theory, the significance of the results, and applications. For example, "As a result of its anisotropic structure, the elastic limit of wood is relatively low."
- Use the *past* tense when describing the purpose of the laboratory, a procedure, and the results of the laboratory. For example, "The data were reduced by averaging two dial-gage readings."
- Provide transitions between sentences and consider combining short sentences. Transitions indicate the relationship between two sentences (for example, causal, complementary, or contradictory.) Be sure that the sentences in your assignments indicate these relationships clearly.
- Provide transitions between paragraphs. Because you will change topics between paragraphs, you need a smooth transitional sentence to guide the reader.

### 2.7 Formatting Requirements

You will be expected to follow the formatting requirements listed below for all writing assignments. Neatness will be considered when grading your assignments. Points will be deducted for sloppy work.

- All components of the writing assignments must be submitted on paper in duplicate.
- The cover sheet, table of contents, memo/letter, laboratory report, and appendices must be typed using 1.5- or double-spacing. (Although most memos and letters are typically single-spaced, the extra spacing is needed for the teaching assistants to write comments about your work.) Use 11 or 12-point Times New Roman font for the text of the assignments. You may use 10, 11, or 12-point Arial or Times New Roman font for headings and captions.
- Number all pages except the cover sheet and the table of contents, which are the first two pages of your submission. The first page of your letter/memo should be page 1. The remaining pages of the memo/letter, report, and appendices should be numbered sequentially.

## 3.0 Calculation Assignments

You will be assigned six calculation assignments during the semester. In order to evaluate all students fairly, strict requirements have been developed for the calculation assignments. All students are expected to satisfy all requirements and points will be deducted for any deviations. The organizational and formatting guidelines for each of the components are summarized in the following sections. Only the technical teaching assistants will evaluate the calculation assignments.

You will submit one paper copy of each calculation assignment. Points will be deducted for late submissions, as described in the syllabus.

### 3.1 Cover Sheet

The first page of each assignment must be a cover sheet as described in Section 2.1.

### 3.2 Calculations

The calculation assignments must include the following information:

- *Equations* – Reference all equations used as discussed in section 2.5. Usually these will be from the lab manual or textbook. Each assignment should have an appendix for these references.
- *Notations* – Define all notations and symbols used.
- *Calculations* – Document your calculations. All figures and tables included in your solution should be formatted as described in Section 4.
- *Assumptions* – Describe any assumptions that you made when making your calculations. If you did not make any assumptions, you may skip this.

### 3.3 Formatting Requirements

Neatness will be considered when grading your calculation assignments. Points will be deducted for sloppy work.

- Calculations should be hand-written. Submissions must be printed on engineering paper. (Cursive is not permitted.)
- You may include printouts from MathCAD, Excel, or Word in your submission. Be sure to explain all formulas used in your calculations and those necessary for interpreting the data.
- Each page of your calculations must have the following information:
  - Name
  - Page number
  - Date
- Number all pages except the cover sheet; the first page of your calculations should be page 1. The remaining pages of the calculations should be numbered sequentially.

## 4.0 Figures and Tables

Figures and tables are an important part of most engineering documents; they must be well integrated with the writing. The following sections offer guidelines on creating and integrating figures and tables into your technical documents.

- Describe in words each figure that appears in your memo/letter and laboratory report. The discussion should be integrated into the document. Also summarize the information that is listed in each table.
- Place each figure and table as close as possible to the point in the text where it is cited, but always *after* the text citation. However, it may be appropriate to present complicated figures or large tables on separate pages. It is not necessary to combine figures and tables with text on all pages.
- Label figures with a number and title *below* the figure.
- Label tables with a number and title *above* the table.
- It is permitted to copy figures and tables from published sources and include them in your laboratory assignments. However, the original source of the material must be identified in the caption. The complete citation must be provided in an appendix.

  Figure 5: Typical Gradation Curve for Sand (Source: Mehta and Monteiro, 2006)
- Keep every figure as simple and uncluttered as possible.
- For all graphs, label and scale axes properly, giving units. It is customary to begin graphs using arithmetic axes at the origin.
- The default parameters used in Excel for generating graphs are not always the best choice for conveying technical information. Figures 1 and 2 contain the same data; however, Fig. 2 is much easier to read. Consider the following items when preparing laboratory reports:
  - The gray background in Fig. 1 looks nice on the screen, but the technical information tends to be lost when the figure is printed in black and white. *Use a white background for all graphs*.

- Whenever possible, select scales so that the axes cross at (0,0). In all cases, position the axis labels outside the graph area.
- It is not always easy to distinguish among the default colors and symbols when the graphs are printed in black and white. Selecting open and filled markers is one way to distinguish one data set from another. Different line types may also be used.
- The default text sizes are often too small when the graph is imported into a Word file.
- The default line widths are often too thin when the graph is imported into a Word file.
- The location of the legend may decrease the available area for displaying technical information. It may be appropriate to move the legend into the plot.
- Because you will label figures with a number and title below, the plot title inserted automatically by Excel is superfluous. *Do not use it.*
- Connect data points with lines. *Do not* use options that fit a curve through the data, unless specifically requested to do so in the assignment.
- Also note that it is best to import graphs into Word documents as images using "paste special" to keep file sizes small.

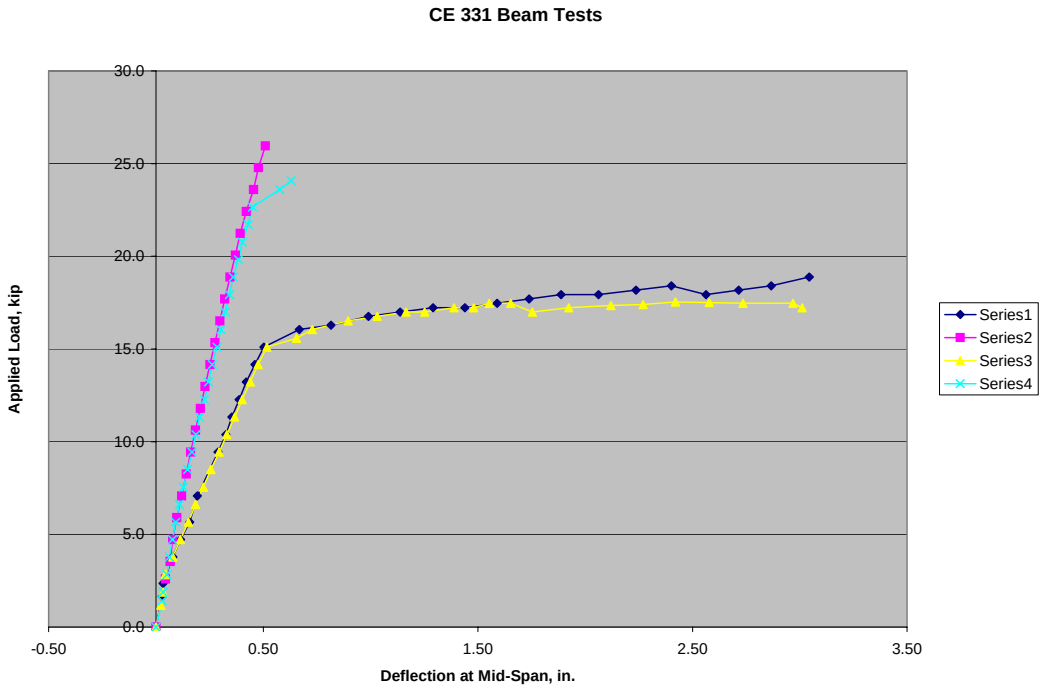


Figure 1: Example of Graph Generated Using the Default Parameters in Excel

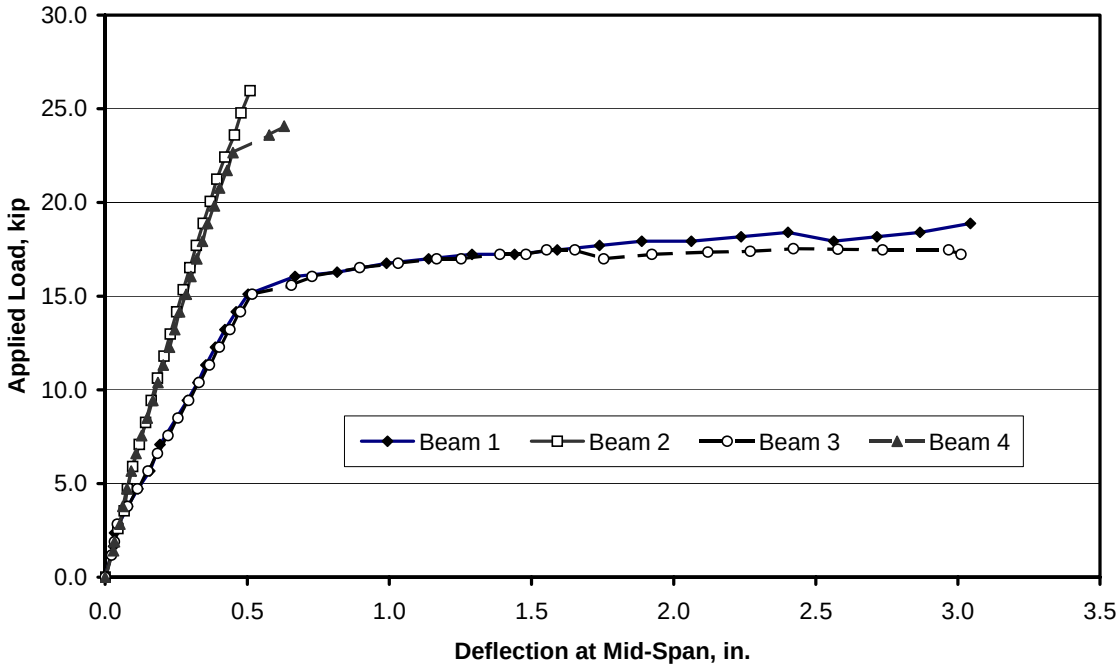


Figure 2: Example of Graph Generated in Excel using Modified Parameters

- The default parameters used in Word for generating tables are not always the best choice for conveying technical information. Tables 1 and 2 contain the same data; however, Table 2 is much easier to read.

Table 1: Example of Table Generated Using the Default Parameters in Word

| Sieve Size | Weight Retained (g) | Percent Retained | Cumulative Percent Retained | Percent Passing |
|---|---|---|---|---|
| #4 | 54 | 10.2 | 10.2 | 89.9 |
| #8 | 78 | 14.7 | 24.9 | 75.1 |
| #16 | 125 | 23.5 | 48.4 | 51.6 |
| #30 | 116 | 21.8 | 70.2 | 29.8 |
| #50 | 88 | 16.6 | 86.8 | 13.2 |
| #100 | 60 | 11.3 | 98.1 | 1.9 |
| #200 | 5 | 0.9 | 99.0 | 1.0 |
| Pan | 5 | 0.9 | 100.0 | 0.0 |
| Total | 531 | 100.0 | | |

Table 2: Example of Table Generated in Word with Modified Parameters

| **Sieve Size** | **Weight Retained (g)** | **Percent Retained** | **Cumulative Percent Retained** | **Percent Passing** |
|---|---|---|---|---|
| #4 | 54 | 10.2 | 10.2 | 89.9 |
| #8 | 78 | 14.7 | 24.9 | 75.1 |
| #16 | 125 | 23.5 | 48.4 | 51.6 |
| #30 | 116 | 21.8 | 70.2 | 29.8 |
| #50 | 88 | 16.6 | 86.8 | 13.2 |
| #100 | 60 | 11.3 | 98.1 | 1.9 |
| #200 | 5 | 0.9 | 99.0 | 1.0 |
| Pan | 5 | 0.9 | 100.0 | 0.0 |
| Total | 531 | 100.0 | | |

## 5.0 Common Grammatical and Editorial Errors

You will identify most grammatical and editorial errors when you proofread your assignment. Points will be deducted for each error, so you are encouraged to check the document thoroughly before submitting it.

- Use the spelling checker included in Word.
- Proofread for typos. Common mistakes that are not detected by spelling checkers include: course/coarse, to/too/two, their/there, form/from, for/four, you/your and this/his.
- Make sure that the subject and verb agree:

  *Wrong:* "The loose and compact unit *weights* for the fine aggregate *was* 90 psf and 102.5 psf respectively."

  *Right:* "The loose and compact unit *weights* for the fine aggregate *were* 90 psf and 102.5 psf respectively."

  *Wrong:* "The *data* for this experiment *is* available in Appendix A."

  *Right:* "The *data* for this experiment *are* available in Appendix A." Note that "data" is the plural of "datum."
- Make sure that all your pronouns mean something[1].

  *Wrong:* "Studs and thick treads make snow tires effective; *they* are implanted with an air gun."

  *Right:* "Studs and thick treads make snow tires effective; *the studs* are implanted with an air gun."

  *Wrong:* "We made the sale and delivered the product; *it* was a big one."

  *Right:* "We made the sale, which was a big one, and delivered the product."
- Eliminate unnecessary words: if you can eliminate a word without changing the meaning of the sentence, *delete it*.
- Use a comma between two independent clauses joined by "and," "or," or "but."
- Use a semicolon between two independent clauses joined by a conjunctive adverb ("however," "therefore").
- Do not use a comma to separate a subject from its verb or verbs (unless you are adding nonrestrictive information, in which case you add commas around the phrase). For example, "The test, which should have taken only two hours, took four days to complete."
- Place periods after, not before, a citation when it appears at the end of a sentence.

[1] The two examples were taken from p. 379 of Brusaw, C.T; Alred, G.J.; and Oliu, W.E. (1976). *Handbook of Technical Writing*, St. Mary's Press, New York, 571 pp.

## 6.0 Reporting Numerical Results

It is *very important* that numerical results be reported using an appropriate number of significant figures. Using too many digits implies a higher level of precision than was actually obtained in the lab procedure. It also indicates that you do not understand the limitations of the measurements.

- The number of significant figures (non-zero numbers) used to report results should be appropriate to the sensitivity of the measurement.

  *Wrong:* Young's modulus, *E*, for aluminum was found to be 12601.01 ksi.

  *Right:* Young's modulus, *E*, for aluminum was found to be 12600 ksi.

  It is impossible to determine a .01 ksi difference in *E* given the instrumentation that we use in the CE 314K laboratories; therefore, 12601.01 contains too many significant figures.

- When **adding** or **subtracting** numbers, the result must have the least number of decimal figures from the measured data.

  *Wrong*: $65.43 + 1.245 + 0.4652 \neq 67.1402$

  *Right*: $65.43 + 1.245 + 0.4652 = 67.14$

  65.43 has two decimal figures, 1.245 has three decimal figures, and 0.4652 has four decimal figures. The sum may not have more than two decimal figures.

- When **multiplying** or **dividing** numbers, the result must have the least number of significant figures that occur in all numbers.

  *Wrong*: $0.156 \times 84.24 \times 1.7854 \neq 23.4627$

  *Right*: $0.156 \times 84.24 \times 1.7854 = 23.5$

  0.156 has the three significant figures, 84.24 has four significant figures, and 1.7854 has five significant figures. The product may not have more than three significant figures.

- More examples of counting significant figures:

  564 three significant figures
  564.0 four significant figures
  564.3 four significant figures
  600 number of significant figures depends on the context.
  If other readings are 400, 500, and 700, then 600 has one significant figure.
  If other readings are 620, 590, and 540, then 600 has two significant figures.
  If other readings are 621, 592, and 538, then 600 has three significant figures.

- Special case:

  $\pi$ can have as many significant figures are needed and should never limit the accuracy of a calculation. 3.14 has three significant figures. 3.141592654 has ten significant figures.

- The examples in Table 3 of recommended precision (the number of decimal places or number of significant figures used to represent a measurement) are taken from the American Concrete Institute *Style Manual* (2005)[2] and are appropriate for laboratories in the second half of the semester.

Table 3: Examples of Recommended Precision

| Quantity | Recommended Precision |
|---|---|
| Unit Weight | Nearest 0.1 lb/ft$^3$ |
| Concrete Batch Quantities | Nearest 1 lb/yd$^3$ |
| Specified Concrete Compressive Strength | 500-psi increments |
| Measured Concrete Compressive Strength | 10-psi increments |
| Measured Concrete Flexural Strength | 5-psi increments |

[2] ACI Style Manual, http://www.concrete.org/COMMITTEES/COM_FORMS.HTM#STYLE