

Math 211 Project Reports

The projects are exercises in communication as well as in mathematics. Your grade will reflect your communication skills as well as your mathematical skills. The project report should be written in a professional manner, following the style of a report meant to be published in a scientific journal, or presented to the management of a corporation. This document briefly provides some guidelines for preparing your report.

Addressing Your Audience

When writing, it is important to know your intended audience. If your audience consists of scientists, they will feel patronized if you assume too little or emphasize the obvious. On the other hand, if your audience does not have a technical background, you cannot use any mathematical arguments, and you will have to be very careful when explaining your graphics.

A difficult task arises when it is necessary to address these two audiences in the same paper. You can solve this problem by providing both technical and non-technical sections. For example, you can write the introduction and the conclusion in a non-technical manner and put all of the technical analysis in the body of the report. When one uses this solution, omitting some critical information from the non-technical sections is easy to do. Therefore, do a reading limited to the non-technical sections of the paper and from a non-technical point-of-view to see if you address the audience in a consistent and appropriate manner.

Project Style

In preparing your project report, you should try to use good mathematical and scientific style. The report should be designed to communicate your results to the reader. Model your presentation on what you see in your mathematics and application-area textbooks. Prepare your project submission with the same care as you do a paper in any course. The only concession we make is that typing your paper is not necessary because typing mathematics and making the paper readable and attractive is quite difficult. Remember! Allow yourself enough time to transform your figures, formulas, and findings into a readable, understandable write-up.

A good report is clear and concise, complete, logical and as direct as possible. Let's expand on these attributes.

Clarity. The purpose of a report is to communicate the results of your investigation to the reader. Demonstrating your understanding is only part of this issue. The emphasis here is on communication. Every effort should be taken to make the concepts, derivations, and conclusions as clear as possible to the reader. Every concept should be clearly defined when it is first used, and the same applies to every symbol used in the text, in derivations, and in figures. Every derivation should be easy to read through. Every figure should be almost self-explanatory, or should be carefully explained in the text.

Conciseness. It is highly likely that anyone who reads your paper is very busy. In the case of project reports in Math 211, the reader will have to read many reports. The reader will be grateful to see a short report. Make your reports as concise as possible: Eliminate irrelevant passages. Keep the number of figures to the minimum absolutely needed. Do not repeat arguments if you can avoid it.

A lengthy report does not necessarily indicate a more knowledgeable report. In fact, a wordy report is often a sign that the author did not really understand the material.

Completeness. The reader should be able to read the report without doing extensive research. The report, therefore, should contain what is necessary to make this possible. This often means that the report will have to include a summary of source or reference material—that is, what is in print elsewhere. The summary should be concise, but it should contain sufficient detail that the reader does not have to refer to the source material in order to understand your paper. Of course, when using the work of others the author should give credit to the sources by referencing them in footnotes or in a bibliography.

Clearly the requirements of completeness and clarity conflict with the requirement of brevity. To write an effective argument, you need to strike the correct balance. Providing guidelines about this matter is difficult. One learns this balance by looking at examples and by writing. Section 10.3 of your Math 211 textbook provides a good example.

Logic and Directness. A written report is a linear document. The argument in a paper has to respect that, and the argument should flow continuously through the document. Accomplishing this requires that the reader be able to refer easily to needed sections of the paper and to formulas and figures as they are used. Sometimes achieving this flow requires that sections of the paper be given headings, and that formulas and figures be given numbers. Additionally, the use of transitional sentences and paragraphs helps to connect one section of the paper to the next.

Although a written report is of necessity linear, frequently an argument is not. For example, it may be necessary to develop several independent ideas that are brought together at the end. When this is the case, put the separately developed arguments into different, labeled sections. Then, in the paper's introduction, tell your reader upfront what to expect in the remaining sections (that is, forecast your paper's organization).

Report Organization

A paper can be made easier to read by organizing the material into sections delimited by appropriate headings. The number of sections depends on the length and the complexity of the topic. However, there should be at least three sections --- the introduction, the body of the paper, and the conclusion.

The introduction. Here in the introduction you either capture the attention of the reader or perhaps lose it completely. Get to the point immediately. Explain the problem you are going to discuss. Explain briefly the method of analysis. Then state your conclusions. All of these items can be explained in more detail in the body of the report. The introduction should be very concise.

The body of the report. If the statement of the problem is not completely spelled out in the introduction, state it here in the body. Then do the analysis of the problem, keeping in mind the four requirements pertaining to project style stated above. Finally, it might be appropriate to draw some conclusions in the body instead of saving all of them for the conclusion.

While these principles are useful general guidelines, there are some special requirements for the project reports in Math 211.

- **The Model.** Modeling is a very important part of this course. We expect you to be able to give the reasons why a differential equation or a system of equations models the phenomenon at hand. In a paper where you were trying to convince someone of something, the details of the modeling would be critical. In some projects you are presented with the model. In others you are expected to derive the model yourself. In either case, you should explain the derivation of the model in your report.
- **Mathematical derivations.** In a homework assignment or on a test, we require you to give fairly complete derivations while not being too critical of the style with which you do the derivation. In a project report, we expect that the derivation be both correct and well-presented while we do not require that you give every possible step. Simply put, the criterion is that the reader should be enabled to follow the derivation without difficulty. To achieve this in your paper, remember to *avoid* these strategies.
 - **Equation chains.** A list of math formulas, each differing in some usually minor way from the previous equation, without textual explanation is not easy to decipher. You can improve on this by mixing equations with text. Sometimes a line of text can explain two or three steps in the derivation.
 - **Backwards arguments.** For some reason it is often easier to derive a mathematical result by starting with what is to be proved and then working backwards to the conclusion. Chances are that you have never seen such an argument in a book. There is a good reason for this. Unless each step in the process is reversible, the argument is invalid. If such an argument is used in a report, the reader is left with the task of verifying that the steps are reversible. Because this is too much to expect from the reader, the author is required to reverse the argument.

Provide reasons for the claims you make in your paper. For example, a statement such as “the graph of the solution curve in `dfield5` shows that...” merely describes and does not provide true mathematical support. Refer to theorems where appropriate. Example 7.20 on page 96 of the textbook is a good example of a proper way to provide reasons for the claims you make.

The conclusion. This is the section where everything is wrapped up. You should summarize the results of your analysis and argue to your conclusions. It also is appropriate to add remarks that are not parts of your conclusions. These might be about the analysis and your conclusions, the problem in general, possible extensions of the model and the problem, and the applicability of the model. In a research paper this would be the place to discuss future research and open problems.

Generating and Incorporating Graphics

Confucius is quoted as saying that “a picture is worth a thousand words.” Whether he said it or not, it is certainly true. You should strive to make your graphics as good as possible. Here are some ideas about producing effective graphics.

- ◆ **Use a Computer.** You have MATLAB available to you, and MATLAB can draw wonderful graphs. Use it. The results are so much better than you can do by hand or on a calculator.
- ◆ **Avoid Kinky Graphs.** Many students plot relatively few points, which results in a graph with noticeable kinks. You should use enough points to make your graphs look smooth. In MATLAB you can use the following commands:

```
>> t = linspace(a,b);
>> plot(t,y(t))
```

- ◆ **Use Captions and Descriptions.** Every graphic should be given a caption to enable the reader to understand what is being depicted. Sometimes a graphic must be explained in the text. These explanations are easier for the audience to read if the graphic is located near the text and is properly captioned. If there is more than one graphic, the figures should be numbered to facilitate later reference.
- ◆ **Content.** Include in a graphic everything you need (and nothing more). Including information on a graphic that is not necessary to make your point will probably just confuse your audience. In particular, make sure that you understand everything in your graphics.
- ◆ **The Graph Window.** A graph should show the pertinent part of the function and should ignore what is not pertinent. Picking the x- and y-limits for a graph is an art. However, if you give some thought to this issue whenever you produce a graph you will improve the results. If you are using MATLAB, you can often use the command `axis` to good effect. Execute `help axis` to find out how to use it.

Mathematics and Typing

To type math really well you have to use either an equation editor or TeX. Microsoft has an equation editor, which is a standard part of Word, Excel, and PowerPoint. A more advanced version of the equation editor is available at extra cost. In the past, several people have used this software to good effect.

TeX is a mathematical typesetting computer language used by almost all mathematicians and by many scientists and engineers. For example, both the textbook and the manual were prepared using TeX. Once you have learned the basics of TeX, you can easily prepare documents that interlace mathematical formulas and text. However, there is a rather steep learning curve. If you think you would like to learn TeX, you should first find out if TeX is used in your intended field of study. If it is, then learning it is worthwhile. Rice Information Services has an [online TeX tutorial](#).

The upshot of this rambling is that typing the math in your project report is not required—simply because it is so difficult. We have found in grading these projects that handwritten math is much easier to read than math that is poorly typed. However, only easily readable handwriting will be acceptable. Of course, if you do not find typing readable formulas onerous, then this is the best way for you.

In the past, some students have typed their papers, leaving space for entering the formulas by hand. If done carefully this method will yield a very nicely resented project report. Others have typed their projects, while putting all of the math in appendices. This strategy can be effective but does require the reader to page back and forth while reading the paper.

You should try to improve this aspect of your papers. To judge your output, compare what you write with what you see in your math, science, and engineering textbooks.

Formatting Your Paper

- ◆ Include a separate cover sheet as the first page of your project that contains the following information: project title, your name, your instructor's name, and your section number.
- ◆ Caption your figures. If there are more than one, number them and refer to them by number in your text so readers can find them when needed.
- ◆ Number those formulas in your paper that you will refer to later, so readers can find them when needed.
- ◆ Number your pages.

- ◆ Credit your sources by referencing them in footnotes or in a bibliography.
- ◆ Organize your write-up into complete sentences and paragraphs. Separate your report into labeled sections.

Resources

The following links are useful resources that discuss a variety of topics including report writing, grammar, and style.

Report Writing at NASA

http://134.117.206.17/www/resources/report_writing/pages/vidcover.htm.

Grammar Resources from the University of Chicago Writing Program

<http://writing-program.uchicago.edu/resources/grammar.htm>

IEEE Standards Style Manual

<http://standards.ieee.org/guides/style/>