

## General Instructions for Final Draft of Short Paper (18.310)

Your first draft was in every case reasonably well written, but I want you to make an attempt to make your final draft look professional.

To this end, I want you to look at what professional journal papers look like, and try to emulate them. This involves:

1. Using a standard format for the paper which will be described below
2. Including an abstract, and using “correct” notations and handling of equations
3. Including a reference section at the end in which you describe the sources for your work and in particular for any statements in the paper not derived in them.

So what is an abstract? It is a short summary of the most significant content of the paper.

Why have an abstract?

You wrote this paper because we asked you to do so. In most cases in your future you will write because you want to communicate something to an audience of some kind. You know how busy you are, and that is, believe it or not, characteristic of how busy you, and the people you will write for will be in the future. You will want people to read what you write, and not put it on a pile to read in the indefinite future. The abstract is the best way to influence the potential reader to actually read the paper.

A busy person cannot afford to spend the time necessary to read the paper in order to decide whether it is worthwhile to read it. Instead he or she reads the abstract and from it decides whether to read further. If that decision is positive, he/she reads the introduction, and decides again whether to continue. So these sections are crucial to the success of the paper in promoting its being read.

In writing these things it is usually wise to write them after the rest of the paper is completed, There are two reasons for this. One is that the writing of the bulk of the paper often changes your conception of it from what it was when you began to write. Second, many people find it awkward to write about something that doesn't exist, which is necessary if you write these things first.

In the abstract you should aim for clarity, and conciseness. The introduction should include some motivation for the paper, a somewhat more detailed but still short description of what its contents are, and a description of what is contained in each of its remaining sections.. And it is a good idea to divide the rest of the paper into sections, so that the reader can easily locate the portions of the paper that he/she is most interested in seeing.

As a reader you probably find that following a multi-step description of a process that is written concisely in one paragraph can be tough to do. If you want your reader to understand such things it is usually wise, as author to take a simple example and show how the process applies to it. You should use your own judgment as to whether such examples are necessary, but if it took you a while to figure out what the method you describe actually was, you should give the reader some help by supplying examples.

Two things that you should learn, if you do not know already, are how to handle and place equations in your paper, and how to create diagrams and illustrations, The possibility of submitting a paper electronically actually allows you to go much further, such as creating an interactive spreadsheet or applet that the reader can fiddle with (like your spreadsheet for encoding and making and correcting errors which should allow the reader to make what errors he/she sees fit to make. We will not require such things, but the ability to create them is something worthwhile having.. You will be in trouble

however if you cannot put in equations to your paper.

There are two reasonably convenient ways to do so, and you must learn one or the other. The one that is most common in the mathematical and scientific world is LATEX. It has fairly simple rules for creating equations, but you must learn the syntax for doing it. Excel has a built in equation editor (which you can access on its insert menu.) It is more or less self explanatory, so there is almost nothing to learn in order to use it, and it is roughly as powerful as LATEX. With either you can compose almost any equation, even a matrix equation with elements that are ratios of definite integrals involving double exponentials, for example.

If your paper topic is one which allows you to avoid writing equations, PLEASE add an appendix in which you create and use some equations, just for the practice doing it. If you have never done so you will be amazed how easy it will be.

There is something else about equations beyond creating them that you should consider, and that is how they are to be handled grammatically. The answer to that is not what you think it is. When you write an equation you think of it as you write. Consider the simple example,  $x=y$ . When you write this you say to yourself “ $x$  equals  $y$ ” which is a clause grammatically. But technically, an equation (or inequality) is supposed to be treated as a noun and not as a clause. And what does that mean? It means that the following sentence is incorrect:

We find that  $x=y$ .

What is correct is: “We find  $x=y$ ” (Similarly, it is correct to write: “I lost my pen”, not “I lost that my pen.”)

Why is this? It is strange from the writer’s viewpoint but natural from the point of view of the reader who is scanning the paper before reading it in detail. Such a reader will generally treat the equation as an unread blob which reads best as a noun. As a noun, an equation cannot be considered to be a sentence, and so must be imbedded in a sentence that makes grammatical sense with it considered as a mere blob. This sometimes requires you to add seemingly useless little phrases like “we get” here and there before equations.

Though this is the grammatical rule for handling equations, you will find that most authors occasionally lapse and do not do this all the time. So you can be excused if you screw this up occasionally, but please try to treat equations as nouns to the best of your ability.

One thing that a paper most definitely should have are references and even footnotes. The references should include every source you used in creating the paper. It is important to do so; not referencing a source is considered unethical, and also can annoy the source if he/she finds out about it, which is something usually worth avoiding. Try to use the format for references that you typically find in papers in the literature. (Look at some!) When you make a statement without proof or argument it is appropriate (and necessary in some circumstances) that you provide a footnote which gives your source for that statement.

By the way there are degrees of laziness that are unacceptable. The lowest is not writing the

paper at all. The next is copying directly from some one source, without engaging your brain in any material way. The third is copying the ideas, structure and format from such source, merely changing words, unless you acknowledge that you are doing this. Obviously your efforts will be of greater value to you the more that you try to do yourself and the less you get from any one source, so you should certainly try to creating your own form for the paper. Sometimes though you find a presentation in the literature that is so good that you cannot do better, and you follow it. Then you must note that you are doing so, or you can be accused of plagiarism. Nowadays it is so easy to find good references in places like wikipedia that one can write a paper very easily just paraphrasing what is in some such thing. M.I.T now tends to frown on your doing this. But if you state explicitly that your work is based on some such source, nobody can accuse you of being dishonest; only perhaps of being a bit lazy.

So construct your next (final unless you want to enlarge to make the final paper) draft so that it resembles papers in mathematical literature. This means have an abstract an introduction and divide the rest into appropriate sections. There should also be a list of references at the end. And use single spacing except around displayed equations. Refer to equations as much as you can. Refer to literature to decide your style. And remember that a worked out example is very useful if you want your readers to understand something complicated.

One other thing I would like you to that you will not often see in literature is a short statement in which you guide the reader toward efficient use of your references. Which ones are most helpful? What if anything is helpful in this one or that one, and so on. Try to convey what would have been helpful to you had you known it at the start of your investigations.