# MATH 442: Mathematical Modeling

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## A1 – due Thursday 1/24/2013

### LaTeXercises

**Instructions:**  Use LaTeX to write up solutions to the following exercises. You will print out your solutions and hand these in on Thursday 1/24/2013 in class.

**You will drive yourself, me, and your classmates pretty crazy if you compose LaTeX in a word processing program and then try to cut and paste it into Kile or another LaTeX editor. Use a text editor and write the best pseudo-LaTeX you can if you must cut-and-paste.**

You may find the websites

- http://detexify.kirelabs.org

- http://webdemo.visionobjects.com/equation.html

useful for figuring out how to make symbols in LaTeX and write equations.

1. LaTeX notes:

   - To make properly formated quotes in LaTeX, we use two left single quotes (`) then two right single quotes ('). ``Hello world!'' makes "Hello world!"

   - To get the accented e in Poincaré use \'e. Try out \^o and \"o – what do you get?

   - To get the formatted word LaTeX use \LaTeX. Sometimes you have to use \LaTeX{\/} to get a space after the word!

   - To insert a blank vertical space after some text, you can use \smallskip for a small space, \medskip for a medium amount of space, or \bigskip for a large of space. If you want a specific amount of vertical space, such as 20 mm, use \vskip 20 mm.

Now type up the following:

a) Henri Poincaré said, "Mathematics is the art of giving the same name to different things."

b) With growing frustration in her voice, Dr. Linhart said, "It drives me crazy when students don't know how to make quote symbols with LaTeX. With LaTeX you just use two left single quotes and two right single quotes to make properly formatted quote marks."

c) Kurt Gödel said, "The more I think about language, the more it amazes me that people ever understand each other at all."

2. LaTeX lessons:

- You can use double dollar signs to open and close a math formula you want centered and displayed on a line by itself. `$$f(x) = x + 2$$` gives

$$f(x) = x + 2$$

A single dollar sign will open and close math that you want to occur in the middle of a sentence. If you type `$f(x) = x+2$`, it looks like this $f(x) = x + 2$.

- If you want a numbered equation, type
`\begin{equation} f(x) = x+2\end{equation}`. You will get

$$f(x) = x + 2 \tag{1}$$

LaTeX automatically generates and keeps track of the equation numbers.

- To get $\sin(x)$, and $\tan(x)$ formatted correctly you use `\sin`, and `\tan`. You can easily guess what we use to get $\ln(x)$, $\cos(x)$, $\log(x)$ and $\arctan(x)$ and most others.
  **Notice that variables have a different font and different spacing than words do, in particular functions.** $\sin(x)$ **makes me happy;** $sin(x)$ **makes me grumpy,** $sin(x) = 0 if x is a multiple of \pi$ **and its cousin** $sin(x) = 0$ $if\ x\ is\ a\ multiple\ of\ \pi$ **drive me wild.**

- To make a superscript we use a caret `$2^3$` makes $2^3$ and to get a subscript we use the underscore, `$x_i$` makes $x_i$. These are only valid in math-mode.

- If we need something complicated as a superscript or subscript, we use {curly braces} to enclose it: `$ x^{-3+n}$` will give $x^{-3+n}$.

Type up the following equations properly.

a) Notice this is centered and displayed on a line by itself.

$$1 + \cot^2(x) = \csc^2(x)$$

b) (Your equation number doesn't need to match the one I have below.)

$$\ln(e) = 1 \tag{2}$$

c) Notice this is centered and displayed on a line by itself.

$$2^{-1} = 0.5$$

d) (Your equation number doesn't need to match the one I have below)

$$2^{2+2} = (2+2)^2 = 16 \tag{3}$$

3. LATEX lessons:

   - To get $\pi$ we just use `$\pi$`. Likewise some other common Greek letters
     - `$\alpha$` gives $\alpha$
     - `$\beta$` gives $\beta$
     - `$\gamma$` gives $\gamma$
     - `$\delta$` gives $\delta$
     - `$\epsilon$` gives $\epsilon$
     - `$\sigma$` gives $\sigma$
     - `$\lambda$` gives $\lambda$

     The two websites given at the beginning of this assignment will help with most other symbol needs!

   - We use carets and underscores with sums:
     `$$\sum_{n = 1}^\infty a_n$$` makes

     $$\sum_{n=1}^{\infty} a_n$$

   - You can also use the underscore with a limit. `$\to$` makes a right arrow $\to$
     `$$\lim_{x\to\infty} \frac{1}{x} = 0$$` gives

     $$\lim_{x\to\infty} \frac{1}{x} = 0$$

   Format the following equation properly.

   $$\lim_{n\to\infty} \sum_{i=0}^{n} 2^{-i} = 2$$

4. LATEX lessons:

   - If you want math to display in the middle of a sentence, you can use a single dollar sign `$` to enter into math mode, and then another single dollar sign to end math-mode.

- The command `\frac` is used to make a fraction. The syntax is `$\frac{1}{2}$` to make $\frac{1}{2}$. The command `\dfrac` makes a displaystyle fraction, which is larger: $\dfrac{1}{2}$.

- The command `\displaystyle` used in math mode changes the appearance of subscripts and superscripts in sums and limits. It also changes the appearance of fractions.
  `$\lim_{x\to c}$` looks like $\lim_{x\to c}$.
  `$\displaystyle\lim_{ x\to c }$` looks like $\displaystyle\lim_{x\to c}$

Use these ideas to type up and format the following:

L'Hôpital's rule is that if $\lim_{x\to c} |f(x)| = \lim_{x\to c} |g(x)|$ with both equal to 0 or $\infty$, and $\lim_{x\to c} \dfrac{f'(x)}{g'(x)}$ exists, then

$$\lim_{x\to c} \frac{f(x)}{g(x)} = \lim_{x\to c} \frac{f'(x)}{g'(x)}$$

This is one way to figure out that

$$\lim_{x\to 0} \frac{\sin(x)}{x} = 1$$

5. Getting (parentheses) , [brackets] and {curly braces} sized correctly in LaTeX is a breeze. You just use `\left` and `\right` before whichever delimiter you want, and it will be automatically sized for whatever it encloses. Since curly braces {} are used as a grouping character in LaTeX, they don't normally display. You have to use `\{` and `\}` to get the curly brace as a delimiter. This works with absolute value signs too!

For example `$$f(x) = \log\left\{\dfrac{x}{x+2}\right\}$$` looks like

$$f(x) = \log\left\{\frac{x}{x+2}\right\}$$

Use these ideas to format the following properly.

$$f(x) = \log\left\{\frac{1}{\left|\sin\left(x+\frac{\pi}{4}\right)\right| + 1}\right\}$$

6. LaTeX and BibTeX keeping a bibliography and making citations a breeze. In fact, you can change the format of the citations from MLA to APA to something specific to a journal you are submitting to by just changing the bibliography style in your document!

Getting started often causes students some major headaches. The easiest bibliography tool with LaTeXthat I know of is Kile, which is what we use on the Calclab computers. Kile may not be something you can install or use at home. I no longer build bibliography entries by hand, I go into Kile and do it there. So a suggestion from me to you is to plan your life so you can build your bibliography with Kile.

Assuming you are using Kile, this is how to build a bibliography entry.

- Open your bibliography or a new file in Kile.
- Select the LaTeX menu from the very top bar of Kile.
- Under LaTeX, choose `Bibliography`.
- Under `Bibliography` choose the type of bibliography item you have. We use `Miscellaneous` for websites, `Book` for books and `Article in Journal` for an article published in a journal. If you need to cite another person's unpublished work, I usually use `Technical Report` if it is a written paper or `Miscellaneous` for verbal communication or an email.
- Kile will insert a template for this item in your document. The cursor will be placed where you enter the name you will use to refer to this item. Use a good name. For example, I would name my bibliography item for the Wikipedia article on the Lorenz Attractor something like WikiLorenz, which is easy for me to remember and type.
- Now you need to enter the information for this bibliography item. Kile has the categories set up for you. Anything that starts with OPT is optional, everything else is **required**. Enter the required and optional information for the item.
- Select LaTeX→Bibliography→clean and this will clean up the entry.
- Save your file with the ending extension `.bib`.
- If LaTeX gives bibliography items incorrect capitalization, enclose the required capital letters in {curly braces}

Now, how do you get a citation in your document? Here I assume your bibliography file is named `mybibliography.bib`.

- At the bottom of your LaTeX document you should include the lines
  `\bibliographystyle{plainnat}`
  `\bibliography{mybibliography}`

- In your document, if I want a citation for my WikiLorenz item to occur, use the command `\cite{WikiLorenz}`
- Assuming you are using Kile, to get the bibliography to display, compile the LaTeX with `pdflatex`, then `bibtex` then `pdflatex` again. You should get a citation and a bibliography entry.

For all Wikipedia articles, the author is Wikipedia, and the year is the one given at the bottom of the article. Use the `note` try to include the information "Online; accessed 03 January 2013"

My bibliography entries for the items below are:

```
@Misc{WikiGompertz,
author = {Wikipedia},
title = {Gompertz Function},
year = {2012},
url = {http://en.wikipedia.org/wiki/Gompertz_function},
urldate = {31 December 2012},
lastchecked = {03 January 2013},
note={Online; accessed 03 January 2013}
}

@Misc{LinhartGrowth,
author = {Jean Marie Linhart},
title = {Math 442 {L}ecture, {T}exas {A}\&{M} {U}niversity},
month = {February},
year = {2013}
}

@TechReport{Smith,
author = {Bill Smith},
title = {Population Models},
institution = {Texas A\&M University},
year = {2013},
note = {Paper for Math 442}
}

@Misc{SmithPersCom,
author = {Bill Smith},
title = {Personal Communication},
month = {January},
year = {2013}
}
```

Use this information to create the following citations and bibliography entries.

a) The Gompertz function is named after Benjamin Gompertz. It is given by $y(t) = ae^{be^{ct}}$ (Wikipedia [2012]).

b) When we discuss the exponential, logistic and Gompertz population models, the growth rate is always given as $\dfrac{p'}{p}$ (Linhart [2013]).

c) (The structure of this section follows that of my classmate Smith [2013a].)

d) You can put code into a LaTeX document using the verbatim environment. Start with `\begin{verbatim}` and end with `\end{verbatim}` (Smith [2013b]).

## References

Jean Marie Linhart. Math 442 Lecture, Texas A&M University, February 2013.

Bill Smith. Population models. Technical report, Texas A&M University, 2013a. Paper for Math 442.

Bill Smith. Personal communication, January 2013b.

Wikipedia. Gompertz function, 2012. URL `http://en.wikipedia.org/wiki/Gompertz_function`. Online; accessed 03 January 2013.