Mathematica is an extremely useful and powerful software package / programming language invented by a mathematician named Stephen Wolfram. Early versions of *Mathematica* came out in the late 1980s and early 1990s; as of Winter 2017-18, the most recent version available to you is *Mathematica* 11.

Mathematica does symbolic manipulation of mathematical expressions; it solves all kinds of equations; it has a library of important functions from mathematics which it recognizes while doing computations; it does $2-$ and $3-$dimensional graphics; it has a built-in word processor tool; it works well with Java and C++; etc. One thing it doesn't do is prove theorems, so it is less useful for a theoretical mathematician than it is for an engineer or college student.

How to obtain *Mathematica*: Go to my webpage `http://mcclendonmath.com`, choose your course from the left-hand menu, then follow the link that says "**Students:** to obtain your copy of *Mathematica*, click here."

A bit about how *Mathematica* works: When you use the *Mathematica* program, you are actually running two programs. The "front end" of *Mathematica* is the part that you type on and the part you see. The "kernel" is the part of *Mathematica* that actually does the calculations. If you type in 2 + 2 and hit [ENTER] (actually [SHIFT]+[ENTER]; see below), the front end "sends" that information to the kernel which actually does the computation. The kernel then "sends" the result back to the front end, which displays 4 on the screen.

About *Mathematica* notebooks and cells: The actual files that *Mathematica* produces that you can edit and save are called *notebooks* and carry the file designation `*.nb`; they take up little space and can easily be saved to Google docs or on a flash drive, or emailed to yourself if you want them somewhere you can retrieve them. **Suggestion:** when saving any file, include the date in the file name (so it is easier to remember which file you are supposed to be open).

A *Mathematica* notebook is broken into *cells*. A cell can contain text, input, or output. A cell is indicated by a dark blue, right bracket (a "]") on the right-hand side of the notebook. To select a cell, click that bracket. This highlights the "]" in blue. Once selected, you can cut/copy/paste/delete cells as you would highlighted blocks of text in a Word document.

To change the formatting of a cell, select the cell, then click "Format / Style" and select the style you want. You may want to play around with this to see what the various styles look like. There are three particularly important styles:
- **input:** this is the default style for new cells you type
- **output:** this is the default style for cells the kernel produces from your commands
- **text:** changing a cell to text style allows you to make comments in between the calculations

Executing mathematical commands: To execute an input cell, put the cursor anywhere in the cell and hit [SHIFT]+[ENTER] (or the [ENTER] on the numeric keypad at the far-right edge of the keyboard). The [ENTER] next to the apostrophe key (a.k.a. [RETURN]) gives you only a carriage return.

Multiplication: use a star or a space: 2 * 3 or 2 3 will multiply numbers; a x means a times x; ax means the variable ax (in *Mathematica*, variables do not have to be named after one letter; they can be named by words or other strings of characters as well).

Parentheses: used for grouping only. Parentheses mean "times" in *Mathematica*.

Brackets: used to enclose all functions and *Mathematica* commands. For example, to evaluate a function $f(x)$, you would type f[x]; for $\sin x$ you type Sin[x]; etc.. Brackets mean "of" in *Mathematica* and cannot be used for multiplication.

Capitalization: All *Mathematica* commands and built-in functions begin with capital letters. For example, to find the sine of π, typing sin(pi) does you no good (this would be the variable "sin" times the variable "pi"). The correct syntax is Sin[Pi].

Spaces: *Mathematica* commands do not have spaces in them; for example, the inverse function of sine is ArcSin, not Arc Sin or Arcsin.

Pallettes: Lots of useful commands are available on the Basic Math Assistant Pallette, which can be brought up by clicking "Pallettes / Basic Math Assistant" on the toolbar. If you click on a button in the pallette, what you see appears in the cell.

Commands *Mathematica* knows: Sqrt, Sin, Cos, Tan, Csc, Cot, Sec, ArcSin, ArcCos, ArcTan, ArcCsc, ArcSec, ArcCot, ! (for factorial). It knows what Pi and E are (but not pi or e).

Logarithms: Log[ ] means natural logarithm (base e); Log10[ ] means common logarithm (base 10).

% refers to the last output (like ANS on a TI-calculator).

Exact answers versus decimal approximations: *Mathematica* gives exact answers for everything if possible. If you need a decimal approximation, click "numerical value" or use the command N[ ]. For example, N[Pi] spits out 3.14159...

To solve an equation: make sure there are two equals signs ("==") in your equation.

Getting help from the program: To get help on a command, type "?" followed by the command you don't understand (with no space between the ? and the command).

To export graphics: Once *Mathematica* produces a graphic, you can right-click the graphic, and select "Copy Graphic". Then you can go in a Word document or a PowerPoint, and paste the graphic. You can subsequently resize it and/or move it around as you see fit.

Troubleshooting: For a command to run correctly, you usually want everything in your command to be black. If anything is purple or red, that suggests where the problem is. Variables that don't have values should be blue. Next, check that everything is capitalized appropriately. Next, check that you aren't missing a space if you are trying to multiply two variables. Next, if you are using variables in your code, try clearing the variables by executing something like Clear[x] (if your variable is x). Then re-run the command that is giving you trouble.

If *Mathematica* freezes up in the middle of a calculation and you see "Running..." at the top of your screen, click "Evaluation / Abort Evaluation" on the toolbar. If this doesn't help, kill the program and restart it.

To get help: Email me, and attach your *Mathematica* file to your email. I can troubleshoot things pretty quickly if the file is attached. If the file isn't attached, it is hard for me to figure out what you are doing wrong. Alternatively, seek assistance from another math major who has experience with *Mathematica*.