About the labs

In this course, we will have several lab assignments. Sometimes we'll be using the computers to draw pictures of curves and surfaces to help us visualize the concepts from class. Other times, we'll be using them to do computations while working on problems. *Mathematica* can also be very useful for checking homework answers.

Mathematica now is the designated software for the math department at CC. Thus, you often will use it in other courses.

We are grateful to Professor Amelia Taylor from whose work we adapted this lab.

Computer information

- **Computer Lab:** Tutt Science Center 213. This lab is open from 7 a.m. to 10 p.m. on week days (unless it's reserved for a class). You can check the schedule at the door or on the math department website. The labs at Barnes (and possibly other labs on campus) also have *Mathematica* installed, so you can certainly use those if you prefer.
- **To log on to the computers in the Tutt lab:**

  Press: Ctrl Alt Delete. Then enter the username and password that you use for your CC e-mail account.
- **To access Mathematica:**

  Click on the Windows icon on the very bottom left corner of the screen. Then select: All Programs → Math and Stats → Wolfram Mathematica → Wolfram Mathematica 6.

  To get a blank notebook, go to File → New → Notebook.
- **To turn in your work:** On this first lab only, you will be turning your work in on paper. Turn in one lab with all the names from your group listed at the top of the first page.
- **To save your work:** When you're finished, you can save your work in your directory or on a thumb drive/cd/etc. (At any rate, it's best not to save it to the Desktop in the lab.)
- **To log off the computer:** Click on the Windows icon on the very bottom left corner of the screen. Select "Shut down", choose "Log off" from the drop box, then click o.k.

Some notes about using *Mathematica*

Mathematica is a software program that is very useful for doing computations and generating graphs. One of the goals for this class is that you'll leave with a basic facility with this program. The labs for this class are more active and won't consist of just reading and evaluating cells in a notebook that someone else made.

When learning a new computer program the most important thing to know is how to use the help function. To access *Mathematica*'s Documentation Center, click on "Help", then select "Documentation Center" ("Virtual Book" and "Function Navigator" are useful variations).

Here are a few other things that are very helpful to know in order to use *Mathematica*.

- To execute any command in *Mathematica* use Shift Enter.
- Most commands start with capital letters and commands that are several words put together (for example, ArcSin) have each word capitalized.
- Most commands use square brackets [ ] around their arguments. For example, to calculate $\sqrt{625}$, you would enter: Sqrt[625].
- Mathematica allows to assign even complicated expressions to function names. My recommendation is to use := For example, if you execute $f[x\_] := x\hat{}2\,Sin[x] - 3\,Tan[x]/(x\hat{}3 - 1)$, then from now on you can use $f[x]$ to represent this expression in both computations and plots. The _ (underscore) must appear after any variable in the argument of f in this assignment statement.
- The arguments for trig functions are in radians. If you want to use degrees, you need to specify this in the argument. For example, to calculate $\sin 90^o$, you would enter: Sin[90 Degree].
- Lists and sets of numbers are placed inside curly brackets { }.
- Don't be afraid to copy and paste commands or functions from the Documentation Center, then change the specific information as needed. This can cut down on some of the frustration caused by the different types of brackets, capital letters, etc.
- It's sometimes helpful to save a notebook with the functions/commands that you've learned. Later you can copy and paste from this file to save time.
- You will not always have a cursor when you're working in a *Mathematica* notebook. If you want to edit work that you've already completed, you can click on this work and a cursor will appear. Otherwise, you can just click below your last command or text section and start typing. After you've finished typing, hit Shift Enter to make this your new input.

Let's get started.

1. Open Mathematica. Under Help, select "Documentation Center". Use this to help you do the following exercises. For today simply record your results on paper by hand.
   (a) Compute $\cos\frac{\pi}{6}$ and $\arcsin(-\frac{1}{2})$.
   (b) Plot $\frac{\sin x}{x}$ with domain $[-\pi, \pi]$
   (c) The Plot command has many Options that you can specify. Check these out. The right arrow that you need can be obtained with the two character sequence $- >$. Repeat item (b) for smaller domains but restrict the plot range to be from 0 to 1. (You will find PlotRange listed among the Options.) Try the domains $[-\pi/2, \pi/2]$, $[-\pi/4, \pi/4]$, $[-\pi/8, \pi/8]$, and $[-\pi/16, \pi/16]$. Describe the effect of plotting over shorter domains but keeping the range the same. Are you surprised?
2. Use the Manipulate function along with the ideas from the previous problem to see how the length of the plotting domain affects the graph of $Sin[x]/x$ (Here, you'll want to enter: Plot[Sin[x]/x,{$x, -\pi/2\hat{}n, \pi/2\hat{}n$}] for *expr*. If you click on the "+" at the end of the slider, *Mathematica* will display the values of n.) For this exercise confirm that you succeeded in doing it! Otherwise you need not turn anything in on this item.

3. During the first few days of class, we have been learning how to determine the slope of a curve or, equivalently, the instantaneous rate of change. In this exercise, use Mathematica to help you find the slope of the curve $g(x) = \frac{1}{x^3}$ directly from the definition of the derivative. First, factor the expression $g(x+h) - g(x)$ using the Factor[] function. Then divide by h and take the limit using the Limit[] function. Record your results in sequence on paper.