

**Math 2250**  
**Introduction to Maple**  
Fall 2008

This document is an introduction to Maple for Math 2250 students who may not have done previous work with this software, or who may just want to brush up on their skills. An on-line version of this tutorial, without Maple output, is at <http://www.math.utah.edu/~korevaar/2250fall08/2250mapleintro.mws>

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These notes were created using the software package Maple in order to introduce you to Maple, but also to show you the kinds of documents you will be able to create yourself.

Although this software has been produced by a private company since 1988, it originated with Canadian government support at the University of Waterloo; the originators used the leaf on the Canadian flag to motivate the name "Maple."

You will be using Maple in Math 2250, in order to solve problems and do computer projects. You should think of this software as analogous to the service provided by Microsoft Word as a tool for writing papers - except Maple lets you create documents which combine text and mathematics. Alternately, you may use Maple to generate mathematical output, which you can then export to other documents. That is closer to how engineers use Matlab, which is more efficient than Maple at doing extremely large computations, but lacks Maple's ability to create text documents and to easily do symbolic mathematical work. Your specific assignments and required formats will depend on your particular Math 2250 instructor.

We recommend Maple 8 in Math 2250, because it has superior graphing capabilities over the more recent versions, which are Maple 11 and Maple 12. The main advantage of these latter versions is that they include more Microsoft Word type bells and whistles. Any Maple 8 document should open in Maple 11-12, but if you are using these latter Maple versions and you expect to reopen your document in Maple 8, you must save your file in the "classic" mode. Student computers around campus (Engineering, Marriott, Math Department, Heritage Commons ) have Maple software installed, and in most places you can find both the earlier and latter versions. The University bookstore sells a student version of Maple 12 (\$130), which you may wish to purchase at some point, although it is not at all necessary to do so for Math 2250.

When you open any of these Maple versions you can find a "new user's tour" in a "help" window, and we recommend you take this tour to get an overview of Maple's capabilities. From then on, you will learn to use Maple the same way you learned to use Microsoft Word, i.e. by using it, using the help features, and asking friends, lab assistants, TAs and teachers when you get stuck. We are also be running Maple introductions sessions specifically for this course, Math 2250, and you might be in one of these sections even as you are reading this document. The currently scheduled sessions (we may add more) are:

Saturday August 30: PCLab 1735, in Marriott MMC, 2-3 pm.  
Tuesday September 2: LCB 115, 11:50-12:40 and 2:30-3:20  
Wednesday September 3: LCB 115, 10:45-11:55.

These sessions are first-come, first-serve, and about 30 people can fit into any particular session.

The Math 2250 projects can be done in any of Maple 8, 11, 12, and most instructors will also accept Matlab versions of your answers. But, most Math Department support for these projects will assume you're using Maple.

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**1) Computer Labs on campus, and logging on/off:**

There are many labs on campus, follow the link <http://www.it.utah.edu/services/connected/labs.html>. Most of these labs have Maple software, and in most of these labs you log on using your University ID and password, i.e. the same way you log on to register for courses, get transcripts, etc. For example, if you are using the MMC labs this is the way you log on to your computer. It is generally true that when you log off a student computer on campus, you should not turn off the computer.

**Math account name/password exception:**

One important exception to the universality of your uid/password for logging on to campus computers is the Math Department computer system, <http://www.math.utah.edu/ugrad/lab.html>. All students taking Math courses are assigned a Math Department login name and initial password that are NOT the same as their UID and University password. The undergraduate walk-in computer lab is located in the Rushing Math Student Center, located underneath the plaza connecting JWB to LCB. There is also a computer classroom in LCB 115, where some introductory tutorials are held. Useful information about most aspects of the lab can be found by following links from the Math Department web pages like the one above, or the precursor directory <http://www.math.utah.edu/ugrad>.

If you're working on the Math Department system **your login name** will be of the form c-azbc, where 'az' is first letter- last letter of your last name, and 'b', 'c' are your first, and middle initials, respectively. For example, if your name is Ulysses Attila Eratosthenes, your login name will be c-esua. (Many people have the same initials, so to ensure your login name is unique, a digit may be added after the initials, eg. c-esua1, c-esua2, ...). For people with more complex (eg. hyphenated names) only the first character of each name is used.

Your **initial password** will be the letters as in the login name, followed by the last four digits of your University ID number (e.g., if your UID is 123456789 and your login name is c-esua, then your password is esua6789) or if the login name is c-esua2 the password is still esua6789). You should **change your password** if it's still the default one. To do so, log in, open a terminal window using a mouse or icon selection (depending on the operating system you've logged on with), then type "passwd" (followed by RETURN/ENTER). **Ask a lab assistant** how to do this if you're doing this tutorial on your own and are confused.

If you previously took a math class and used our system, for example if you did "**webworks**" homework, then your old account may still be active, with the last password you used. If all your efforts to log on fail, ask a lab assistant for help.

Don't forget to log out when you're done. Never turn off a Math Department computer.

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## 2) Opening a browser, maple, etc:

Your browser choice depends on your operating system and personal preferences. We **do not** recommend the Microsoft browser **Internet Explorer**, because when you try the "Open URL" option from Maple, in order to download a Maple file from the internet, it doesn't seem to be compatible with Explorer. **Mozilla** and **Firefox** seem to work well with this option, and with the second way of using Maple files you find on the internet, which is to first download them, and then open them from Maple.

Maple versions 8, 11, 12 may appear as icons on your computer desktop and perhaps the icon will contain a picture of a maple leaf. Alternately, you may open Maple with a terminal window command or by searching directories. If you're not sure how to find and open Maple, ask a lab assistant. In the MMC PC labs the Maple software is in the "Class Software" directory.

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## 3) Maple:

If you are starting the tutorial at this point, we assume you have opened Maple version 8, although you may be using Maple 11 or 12, as well as a web browser.

Maple is partly just a very fancy calculator; it can do practically any undergraduate mathematics computation or symbolic manipulation. You can write programs in Maple and draw pictures as well. But you can also use it to create documents which mix text with computations, and you can export Maple output to other software to create interesting documents.

If you are doing a homework assignment you can intersperse text with computations using the toolbar: to get a computation prompt click on the "[>]" box near the top. To insert text click on the "T" box. Or you can change command fields (starting with "[>]") into text fields by putting the cursor into them and then choosing "T". You can use the mouse to cut, paste, and edit a document. You can change fonts, formats, and use other standard text editing tools by choosing appropriate menu items. This document you are reading is a Maple document even though it is largely text. You will learn by doing - and by asking your neighbor or the lab assistant.

### New User's Tour and more:

Under the Help button at the top right of your Maple 8 window you will find the choice "New User's Tour". This is a good way to learn generally about what Maple can do. After making this menu choice Maple may hide the beginning of the tour behind other active windows; use the "Window" menu item to bring the tour window to the front. If you wish you can explore now, or you can continue with the Math 2250 notes below and come back to the tour later. To close the new tour (or any other top window), use the "close" option inside the "file" menu item. To keep the tour open but bring another window to the front, use "window" menu item.

Another good introduction to Maple is located at <http://www.math.utah.edu/~gardiner/Intro.mws>. (If your computer is appropriately configured clicking on this hyperlink will open your browser and go to the indicated URL. You can then save the file to your computer, and then open it from Maple if this does not happen automatically.) Alternately, if you have a browser open, you can open Maple files directly off the internet by using clicking successively on **File -> Open URL**, in the Maple menu items at the top of the Maple window, and pasting or typing the desired URL into the dialog box which appears.

## Entering Maple commands:

To give you a brief taste of what Maple can do, we will try a few commands. Move your cursor into the "Untitled" (new) Maple window which you created in step (2). Commands begin on lines having a command prompt ">", and should be ended with either a semicolon ; or a colon : If you end with a semicolon you will see visible output, if you end with a colon the output will be suppressed even though the command is executed. Maple will not execute a command until you type the "return" or "enter" key. **If you have a multiline command to enter use "shift-return" to change lines without executing.**

If you incorrectly align parentheses or brackets, or do something else which makes your command unexecutable you will get a "syntax error" message and Maple will try to point out your mistake with the cursor and cryptic diagnostic phrases. After a while you will become good at fixing these mistakes but they can be annoying at first. Spaces are ignored in Maple, so you may use them to make input easier to read. You can enter explanatory comments in a command line by inserting a "#" to the left of the comments; Maple ignores any text after the #. Sometimes this is more informative than entering nearby explanatory text, especially if you are explaining various steps in a subroutine.

Now, let's try some commands. (You may try just the math commands, the editorial comments were only added to explain what the particular commands are illustrating !) Check that you understand what each command is doing.

```
[ > 3+4; 4+5: 6 * 7;      #one of these computations will not be shown
                          #even though all three will be done, illustrating the
                          #difference between a semicolon and a colon

[ > (3+4)7;              #if you want to multiply you must use *, so after
                          #trying the command as given, insert a * to fix the
                          #resulting syntax error. You can execute a line or
                          #execution group (bracketed on the left) if
                          #your cursor is anywhere in it. You can move the
                          #cursor with the mouse or the arrow keys. Maple will
                          #try to put it in a good place if it detects an error.
Error, unexpected number

[ > (3+4)^2/7; 3+4^2/7; evalf(3+4^2/7); #the evalf command gives a
                          #decimal approximation instead of an algebraic
                          #expression. Notice that if given a choice, Maple
                          #computes powers first, then multiplies and divides,
                          #and finally adds or subtracts.

[ > diff(x^2,x); #''differentiate x^2 with respect to x''
[ > diff(exp(sin(x))*x^3,x); #a harder differentiation problem
                          #you should get output:
                          cos(x)esin(x)x3+3esin(x)x2

[ > f:= x-> exp(sin(x))*x^3; #this is the syntax for defining a
                          #function, in this case the function we just
                          #differentiated

[ > diff(f(x),x);        #should get the same answer as before.
[ > int(t^2*exp(t),t);  #''integrate (t^2)*exp(t) with respect
```

```

[      #to t'' (Maple doesn't put in the integration constant.)
[ > int(t^3*exp(sin(t)),t); #this shows that Maple is not God, you
      #will get
      
$$\int t^3 e^{\sin(t)} dt$$

[
[ >      # since if Maple can't find an elementary function
[      #antiderivative it just echos what you put in.
[ > evalf(int(t^3*exp(sin(t)),t=0..1)); #But you could do
[      #a definite integral (numerically) even if Maple
[      #can't compute an elementary antiderivative
[ > Pi;exp(1);evalf(Pi);evalf(exp(1));infinity;
[      #some important numbers

```

### Downloading Maple documents:

This xeroxed tutorial is available online in several formats, if you follow the links from Professor Korevaar's 2250-1 Maple homepage at <http://www.math.utah.edu/~korevaar/2250fall08>. Files with suffix ".mws" or ".txt" can be downloaded from your browser and then opened from Maple.

Alternately, if you know the URL you want, you can use the "open URL" file option on most systems. Do this now, for this document's URL, <http://www.math.utah.edu/~korevaar/2250fall08/2250mapleintro.mws>. Maple should download and open the document, and now you can follow the tutorial from your computer instead of from your hard copy - so start doing so.

Sometimes, if you have several windows open Maple will put the wrong one on top. Use the Window menu item to move between windows.

### Making new files which mix text, commands and output:

From the "File" menu item, create a new worksheet.(It will start out being called Untitled(2).mws or something like that. The first time you save this file you can pick any name you want, as long as it ends in **.mws**, for Maple worksheet. (Maple 11-12 files have the suffix **.mw**. You cannot open a **.mw** file from Maple 8, but you can open a **.mws** file from Maple 11-12. To be able to read a file you've been working on in Maple 11-12 in Maple 8, make sure to save it as a **.mws** file ("classic") when working in the higher-numbered version.

In your new worksheet turn the command field into a text field by putting your cursor into it, and then using the "T" menu item. You can usually erase the annoying brackets around text fields you create this way, by highlighting them with your mouse and then typing the "delete" key. Type in the title "My first Maple worksheet" (center it with the menu option on the right side of the toolbar), as well as your name and today's date. When you are doing your Maple projects your instructor may expect you to hand in more than a page of computations: You will likely be expected to add text explanations of what you've been doing. In general, if you move your cursor to a command field and then press the [> button with your mouse, Maple makes a new command field directly below it. If you move to the new command field and press the **T** button you will have a text field into which you may write, using the rudimentary word processing tools on the Maple menu bar.

Use your mouse to copy the following sequence of commands from this worksheet into your new one. Paste into a command field. (Successive lines were entered here without execution by using **shift-return** at the end of each line.)

```
[ > restart: #clear all current definitions from memory
          #(regardless of which window was open when
          #the definition was made).
with(plots): #load plotting library
plot(x^2,x=-1..1,color=red,title='my first parabola');
          #use ` quotes, not ' or " ones
```

After pasting, execute this command field in you new window. By clicking on the plot you are able to rescale it and avail yourself of various new menu options. You could export this plot to other documents as well.

### **Saving Files:**

It is always a good idea to save your maple file periodically. Save all of your documents - this one, which I called 2250mapleintro.mws (you can change the name if you want), as well as your untitled documents. Use the tool bar, using the "save" option under the "File" menu item. The first time you save a new file, and any time you use the "save as" option, you will be asked to name your file and say where you want to keep it. You name it in the left part of the box, being careful to keep the suffix ".mws" so that Maple knows this file is a **Maple Work Sheet**. If you're working on a PC, you can use the directory structure to save your file wherever you want.

If you are on the Math system, your directory is probably new you likely haven't made any subdirectories yet (unix command mkdir, in a local window), but as you create more files you may wish to organize where you save them using the tree structure of Unix directories, which you can follow in the right side of your saving box. You use various UNIX commands in your local or terminal window to organize your directories. For more information about this, go to <http://www.math.utah.edu/computing/unix/unix-commands.html>

It will probably happen some time that you will crash Maple long after your last save. This will not make you feel happy but will teach you an important lesson.

### **Printing:**

This depends on which system/computer you are working on. Ask a lab assistant for help if you don't know how to do this.

### **Execution Groups:**

You can modify the text and input using the toolbar and menu options. You will notice many brackets on the left of the document. These are execution groups. Maple will execute everything in one execution group at once, and then move the cursor to the next execution group. You can create large execution groups by highlighting sections of a document, using **Edit->Split or Join->Join Execution Groups**. You can remove brackets by highlighting them with the mouse and deleting them with the delete key or the menu option. And you already learned how to insert new prompts or new text wherever your cursor is, by using the [**>**] and **T** buttons on your toolbar.

### **4) Warm-up problems:**

If you are in Professor Gustafson's Math 2250-2 section, you will be handing in a warm-up Maple

project. If your instructor is not requiring that you hand this project in, we still recommend that you do it. Professor Gustafson's Maple page is at the URL

<http://www.math.utah.edu/~gustafso/f2008/2250mapleF2008.html>

and the warm-up project is the first one, entitled "maple Lab 1 fall 2008 pdf". Read this .pdf document from your browser and try create the requested output. You can use Professor Gustafson's hints. Alternately, you can practice using the help windows to find commands related to answering his questions. (You may end up finding the commands he recommends, but if you practice finding them on your own you will also be practicing learning how to use Maple.)

**Hint:** Students often approach the task of reading mathematical material as if they were reading a novel; they sort of skim along quickly. That approach is O.K. to get an overview, but in order to have a chance at real understanding you must be prepared to proceed much more slowly, sentence by sentence and thought by thought. Otherwise you will almost certainly find yourself partly lost after several paragraphs and completely lost after several more. (This might happen anyway.) If you are working properly it can easily take half an hour to read through one page of mathematical text. This takes a certain amount of discipline, patience, and practice. With the Math 2250 computer projects there is the added temptation of having Maple execute commands in successive command sections by repeatedly hitting the enter (return) key, without pausing to digest the interlaced text or the meaning of the commands. There is a seductive appeal in having this capability. Resist it.