

## BEFORE STARTING:

- Plan on experimenting, and make extensive use of the Help menu. You can learn all sorts of cool things just by doing "topic searches". **Give Maple a chance!**
- In the beginning, using Maple's palettes and contextual (shortcut) menus is easy and helpful, so the *Getting Started* section focuses mainly on those.
- You may eventually decide it's easier to enter some expressions using the keyboard. Some are mentioned in the *Getting Started* section. For more, see the on-line version of this document – in the section *Further Exploring Maple* are additional tips and the most relevant commands for Calc 2. (The on-line version is on my public webpage. Scroll down to the section on Computers in the Classroom. Midway through that section is a link for a *list of commands*.)
- Always check Maple's output to make sure you entered what you meant to.

## WHAT YOU'LL SEE:

- There are two interfaces for Maple, *Worksheet* and *Document*. *Document* mode is probably easiest to learn with (although I don't use it). Go to **File - New - Document Mode**.
- There are also two types of input – *Math* and *Text*. *Math* is the default; click the *Text* button if you want to enter text.

## GETTING STARTED

- The many palettes on the left are handy templates for Maple's syntax, especially the **Expression** and **Common Symbols** palettes. Open a palette by clicking on the triangle next to its name.
- The templates will allow you to enter all the operations (+, −, ×, ÷) as well as square roots, exponents, sines and cosines, logarithms, functions, derivatives, integrals, and summations. Enter specific values or variables by tabbing from one entry to the next.
- Some expressions you may find easier to enter using the keyboard :
  - +, −, \*, / for addition, subtraction, multiplication, and division.  
Don't omit the \* when typing in something like  $5x$  or  $5x \cos(x)$ . Sometimes, Maple knows what you mean, but other times it won't – and it won't give you an error, it will just ignore part of what you type (treating it as a long variable).
  - ^ for exponents
  - *Pi* for  $\pi$ .  
**Maple is case-sensitive!** pi is **not** the same as Pi ! In Maple, pi represents the Greek letter, while Pi is the number.
  - exp(x) for  $e^x$ ; In Maple, e is a variable not a number.
  - sqrt(x) for  $\sqrt{x}$ .
- Maple prefers to deal with exact numbers, rather than approximations. Unless you tell it otherwise, it will produce results involving  $e$ ,  $\pi$ , fractions, etc.  
For a decimal approximation,
  - The simplest option is usually to add a decimal point: change (for example) 5 to 5. in an expression, and Maple will return a decimal approximation of your calculation.
  - You may also use the evalf command, by either.
    - \* enclosing the original command line with evalf( ).

- \* In Maple, the % sign refers to the last result Maple calculated, so after receiving an exact answer, type in `evalf(%)`
- Contextual, or shortcut, menus are accessed by right-clicking (control-clicking, on a Mac) on the blue output after you enter something and hit return. Different options will appear in the pop-up menu, depending on the context. For example, if you right-click on an expression like  $\exp(x)$ , Maple will give you options to:

Differentiate, Integrate, 2-D Plot, Evaluate at a point, Approximate, etc

Experiment!

- Maple comes with many packages containing extra commands. For instance, in this class, you may want to load a package with extra commands that will calculate or plot a left Riemann sum, or that will allow you to plot an expression like  $x^2 + y^2 + z^2 = 1$ .
  - The Plots package will allow you to plot 3D curves, plot implicitly defined curves or surfaces, display multiple plots that have been defined over different domains, plot polar curves, contour plots, and vector fields.
    - \* To load the Plots package (for instance), from the menu bar across the top of your screen, choose **Tools-Load Package - Plots**.
  - The Calculus 1 package will allow you to quickly calculate or graph a left sum, right sum, or midpoint sum.
    - \* To load the Student Calculus 1 package, proceed as above, but choose **Tools-Load Package - Student Calculus 1**.
  - For more on these packages, see *Further Exploring Maple*, below.

## FURTHER EXPLORING MAPLE:

On the course website is a link to some Maple tutorials; although developed for an older version of Maple, you still might find them helpful.

On the next several pages are many of the commands we'll use, roughly organized by type.

Command	Description
<b>CONSTANTS:</b>	
Pi	The constant $\pi$
exp(1)	The constant $e$
sqrt(5)	$\sqrt{5}$
cos(Pi/4)	$\cos(\pi/4)$

**COMMON FUNCTIONS:**

exp(x)	The natural exponential $e^x$ . For example, to get $e^2$ , you would enter <code>exp(2)</code> .
sqrt(45+sin(x))	The expression $\sqrt{45 + \sin(x)}$ .

**THE BASICS OF DEFINING FUNCTIONS AND ASSIGNING VALUES:**

<code>w := x^2 + 3*x</code>	Assigns $w$ to be the <i>expression</i> $x^2 + 3x$ . From that point on, whenever you use $w$ , Maple will substitute $x^2 + 3x$ .
<code>w:='w'</code>	Unassigns $w$ . Now, $w$ is just $w$ .
<code>f := x -&gt; x^3 + sin(x)</code>	Defines a <i>function</i> of one variable $f(x) = x^3 + \sin(x)$ .
<code>L:=[ [1,10], [2,5], [4,2]]</code>	Defines a list of points
<code>restart</code>	Clears all definitions and reinitializes Maple.

**VARIOUS USEFUL COMMANDS:**

<code>value(3*sqrt(Pi))</code>	Returns the <i>exact</i> value (not a decimal approximation). <code>value( )</code> can be combined with other expressions like <code>Diff( )</code> to find a value.
<code>evalf(3*sqrt(Pi) )</code>	Returns a decimal approximation of $3\sqrt{\pi}$ using 10 significant digits. <code>evalf</code> stands for "evaluate to floating point".
<code>evalf(3*sqrt(Pi), 20)</code>	Returns a decimal approximation using 20 significant digits.
<code>%</code>	The output from the last executed statement.
<code>simplify( sin(x)^2 + cos(x)^2 )</code>	Simplifies the expression. In this case, the result is 1.
<code>solve(x^2+3*x+1)</code>	Solves the equation $x^2 + 3x + 1 = 0$ .
<code>solve(t*x^2+3*x*t+1, t)</code>	Solves the equation $tx^2 + 3xt + 1 = 0$ for $t$ .

**THE BASICS OF GRAPHING:**

<code>plot(sin(x)+Pi/2, x=-2..Pi, color=blue)</code>	Generates a plot of $y = \sin(x) + \pi/2$ from $x = -2$ to $x = \pi$ in blue. You can leave out the color if you want.
<code>plot( [x^2, cos(x)], x=0..2*Pi, color=[blue,red])</code>	Plots the two functions $y = x^2$ and $y = \cos(x)$ on the same set of axes. The color is useful for distinguishing the plots.
<code>plot(L, x=0..5)</code>	If you have defined $L$ to a list of points (see above) whose $x$ coordinates are all between 0 and 5, this command will plot these points and draw lines connecting them.

Command	Description
<b>SINGLE-VARIABLE CALCULUS COMMANDS:</b>	
<code>Diff(x^3+sin(x), x)</code>  <code>value(%)</code>	<p>Returns the expression <math>\frac{\partial}{\partial x}(x^3 + \sin(x))</math>. This allows you to check whether you've entered everything correctly.</p> <p>If you follow the command <code>Diff(x^3+sin(x),x)</code> immediately with this one, it will return the derivative of <math>x^3 + \sin(x)</math> with respect to <math>x</math>.</p>
<code>dif( x^3 + sin(x), x)</code>	Returns the derivative of $x^3 + \sin(x)$ with respect to $x$ , $3x^2 + \cos(x)$ . Once you feel comfortable both with Maple and with differentiation, you can use this command rather than the previous one.
<code>dif(f(x),x)</code>	Returns the derivative of a function you have already entered, see top of page 2.
<code>dif(x^{3}+sin(x),x\$2)</code>	Returns the second derivative of $x^3 + \sin(x)$ with respect to $x$ , $6x - \sin(x)$ . You can also do second derivatives as above, where the expression is returned first, by simply capitalizing the "d" in <code>dif</code> .
<code>Int(x^3+sin(x),x)</code>  <code>value(%)</code>	<p>Returns the expression <math>\int x^3 + \sin(x) dx</math>.</p> <p>If you follow the above command with this one, Maple will return the indefinite integral (i.e. the antiderivative) of <math>x^3 + \sin(x)</math>.</p>
<code>int( x^3 + sin(x), x)</code>	Returns the indefinite integral, or antiderivative, of $x^3 + \sin(x)$ , $\frac{1}{4}x^4 - \cos(x)$ .
<code>int(f(x),x)</code>	Returns the antiderivative (indefinite integral) of a function you've already entered (see top of page 2).
<code>int(x^{3}+sin(x),x=2..5)</code>	Returns the definite integral of $x^3 + \sin(x)$ from 2 to 5. If you capitalize the "i" in "into", it will return the expression $\int_2^5 x^3 + \sin(x) dx$ . To get the value, you would then enter <code>value(%)</code> .
<code>Sum( j^2, j=1..300)</code>	This creates the sum $\sum_{j=1}^{300} j^2$ , but does not evaluate it. You'll need to use <code>value(%)</code> to get a numeric value.
<code>sum(j^{2}, j=1..300)</code>	This returns the value of the sum directly.

Command	Description
<b>CALCULUS GRAPHING COMMANDS:</b>	
Tools -Load Package- Student Calculus 1	Loads the student package. You must load this package before you can use <code>RiemannSum( )</code> , command.
<code>RiemannSum(x^2, x=0..3, partition=10, method=left, output=sum)</code>	Generates the leftsum approximation of $\int_0^3 x^2 dx$ using 10 equal subintervals. You need to use <code>evalf( )</code> to get the decimal approximation. Replace “left” with “right” or “middle”, and “sum” with “plot” or even “animation”.
Tools-Load Package- Plots	Loads the plots package. You must load this package before you can use the <code>display</code> or <code>tubeplot()</code> command.
<code>plot1:=plot3d(7-x^2/9+y^2/16, x=-5..5,y=-5..5): plot2:=plot3d(x+y/2+3,x=-5..5, y=-3..4): display(plot1,plot2);</code>	Allows you to display multiple plots structures (that may have been defined over different domains) on the same set of axes. Notice the colon at the end of the first two lines, to suppress the output from these commands.
<code>tubeplot( [x, 0, 0], x=0..4*Pi, radius =sin(x)+ 2)</code>	This will draw the surface obtained by rotating the graph of $y = \sin(x) + 2$ about the $x$ -axis from $x = 0$ to $x = 4\pi$ . For all of our plots, you should not change the <code>[x,0,0]</code> part of the command.

### MULTIVARIABLE CALCULUS COMMANDS:

<code>f := (x,y) -&gt; 3*x^2 + 2*x*y</code>	Defines a function of <i>two</i> variables
<code>Diff(3*x^2+2*x*y,x)'</code>	Returns the expression $\frac{\partial}{\partial x}(3x^2 - 2xy)$ so you can check if you've entered everything correctly. To actually find what the partial derivative with respect to $x$ is, you can follow up with <code>value(%)</code> .
<code>diff(3x^2+2*x*y,x)'</code>	Using the lower case $d$ in <i>diff</i> tells Maple to actually find the partial derivative, just as is true with derivatives of functions in one variable.

Command	Description
<b>MULTIVARIABLE GRAPHING COMMANDS:</b>	
<code>plot3d(x^2-cos(y), x=-5..5, y=-7..7);</code>	Generates a graph of the surface $z = x^2 - \cos(y)$ over the domain $-5 \leq x \leq 5$ and $-7 \leq y \leq 7$ .
<code>Tools -Load Package-Plots</code>	The plots package allows you to use the commands below.
<code>implicitplot(x^2-y^2/9=1, x=-10..10, y=-4..4);</code>	Returns a 2D plot of this implicitly defined curve. Notice that you must give bounds for both $x$ and $y$ . To change the colors, the tickmarks on the axes, or anything else, investigate <code>plot[options]</code> in Maple Help.
<code>implicitplot3d(x^2+y^2/9+z^2/4=1, x=-2..2, y=-4..4, z=-2..2);</code>	Returns a 3D plot of this implicitly defined surface – without any axes. To add axes, change the color, etc, investigate <code>plot3d[options]</code> in Maple Help.
<code>plot1:=plot3d(7-x^2/9+y^2/16, x=-5..5, y=-5..5): plot2:=plot3d(x+y/2+3, x=-5..5, y=-3..4): display(plot1, plot2);</code>	Allows you to display multiple plots structures (that may have been defined over different domains) on the same set of axes. Notice the colon at the end of the first two lines, to suppress the output from these commands.
<code>contourplot(x^2-y^2, x=-5..5, y=-5..5);</code>	Returns a contour plot of the surface $z = x^2 - y^2$ . Try the <code>filled=true</code> and/or <code>coloring=[blue, red]</code> options.
<code>polarplot(sin(2*theta), theta=0..2*Pi);</code>	Generates a graph of the polar equation $r = \sin(2\theta)$ , $0 \leq \theta \leq 2\pi$ .