**Getting Started with Maple**

In Calculus I - Math 111, we will be using Maple for our lab assignments. Maple is a technical computing and documentation software package used in education, research, and industry so knowledge of Maple is a marketable skill. We will use Maple to perform operations in algebra and calculus. As you advance to other courses, Maple will provide many useful visual approaches to problem solving.

This introduction document is not meant to be an all-inclusive guide to Maple but rather a quick start for you. As with any software package, you should “play around” to find ways on your own to use it. If you get stuck, google is your friend!

**Some General Comments:**

* Before we get started, it is important to familiarize yourself with the extensive help that is available through Maple. The Maple Portal has video tutorials on many different aspects of utilizing the software. If you get stuck on something look for Maple help or visit the Maple Portal. The labs will be designed to walk you step by step but **you may need to troubleshoot at times so use the resource**!Quick ways to get help:
  + From the input prompt line type ?command which will return the help section for that the command. Try it for the solve command which is a very useful algebraic command, ?solve. Maple will return the help pages relating to the solve command.
  + Click to activate the window put your cursor over a keyword (ex. Solve) and Press F2. Try this method of getting help for the following maple instruction:  You should see the same help pages pop up.
* Save your Maple Worksheet periodically just as you would while working with any document. **Click the file tab and select Save As…** so that you can specify the directory that you want to save your work. The files created by Maple will have a .mw extension. If you want to return to a particular .mw file just double click and Maple will open and populate the worksheet with your work.
* Maple can work in both Text Mode and Math Mode so you will be preparing your lab reports directly in Maple. You can click back and forth between modes by simply selecting text (when documenting) and math (when working math problems) on the tool bar. A shortcut is to use the F5 key to toggle between the two modes. This feature will allow you to imbed mathematical equations and mathematical work directly in a text document which at best is cumbersome in word processing software.
* Since the Maple file contains your math problems/solutions embedded directly in your text. **This is what you will turn in as the hardcopy for your lab report, no need for a word document.** Please be sure to spell check your document, much of the functionality that you have with Microsoft Word is available in Maple so explore Maple’s documenting capabilities. Before printing your documents, access the print preview by pulling down from the file tab and selecting print preview. Your document should be readable before printing it! Add page breaks to enhance the readability. There is more information on lab reports at the end of this introduction manual.
* Maple has both a document and worksheet mode. From the file pull down, select new and you will be given the option to select worksheet mode or document mode. The worksheet mode is the more traditional usage of Maple, however the document mode produces a bit more elegant documents. Use of the worksheet mode is easier for quick computational work but when you are producing your lab reports, document mode is preferable. You will notice a difference in command prompts between the two modes.

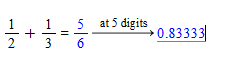
1. **Basics with Maple:**
2. When you launch Maple you start with a blank document, with menus and toolbars at the top and palettes on the side. Explore each of the palettes by expanding them. At the cursor, you can start typing a math statement. Press **Enter** to see the result. *Be sure you are in Math mode.*
   * Type in 3 + 2 **Enter**
   * The result is returned on the next line with a label (1) that increments with each command. You can access the results to use in other computations by typing Ctrl L and enter the number of the equation label.
   * For lab reporting purposes, it is better to have the answer returned on the same line. Type in 3 + 2 **Ctrl =** there is no label associated with in-line results.
3. Entering Numerical Expressions:

*Exponents:*

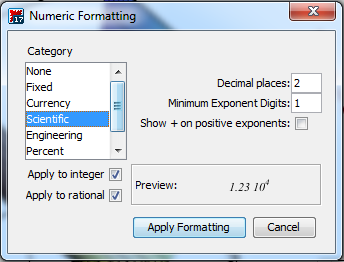
* + Type in x^2 **you will be in the** **exponent mode until you select the right arrow key 🡪**;
  + Type in +3 -7 Ctrl = will return the following **** = 

*Fractions and Formatting:*

* + Maple calculates exact answers so fractions remain as fractions as well as e and throughout all calculations to reduce errors due to approximations in multi-step problems. On a new line, **enter 1/2 + 1/3**; typing a ‘/’ automatically moves you to the denominator. The right arrow will take you out so you will need to type 1/2 🡪 + 1/3. Press Enter for the result of 5/6.
  + Right click on the 5/6 and select **Approximate** from the context menu. Select accuracy of 5 digits. The following should display:



* If your problem already uses decimals then Maple keeps to the same format. However, you can apply different formatting to numeric results by right-clicking on 5/6 and select **Numeric Formatting…** the following dialog box appears, under Category you can select **Scientific**, then press **Apply Formatting**.



* The following answer will appear in your Maple Worksheet.



*Symbols such as PI, e, Square root:*

* You can access from the Common Symbols Palette and and e from the Expressions Palette. An alternative way to access these symbols/commands are through Maple’s command completion where you type the first few characters of the symbol and press **Esc**. Maple returns a list of possible symbols/commands and you select the one that you want from the list.
* The constant “π”:Now, type in 5/6 + Pi; and press Enter. You should have an output of 5/6 + π. It is important to use a capital letter P here, since Maple will not understand “pi”. Typing in evalf(%) and pressing Enter will give you a decimal approximation of 5/6 + π.
* The constant “e”: Old versions of Maple used E for the constant we call “e”. This is no longer the case. If you need this constant, type in e := exp(1);and press enter. Maple will now understand that the letter e represents the constant “e”. What we have done is the following. The command “:=” tells Maple to assign a certain value to the expression on the left-hand side. In this case, we are giving the symbol “e” a value. Namely, we are giving it the value “exp(1)”, the exponential of 1, or, as we normally write,. Type in evalf(e); and press Enter to get a decimal approximation of the constant “e”.

***DO NOT USE THE KEYBOARD “e” !!***

* Square roots: In Maple, there are two ways to take square roots. We may raise our expression to the ½ power, or we may use the sqrt() command. For example, type in sqrt(25); and press Enter. You should have an output of 5.

*Multiplication:*

* Multiplication in Maple is done using the \* symbol. For example, type in 3\*2; and press Enter. You should receive and output of 6. You should always use \* to multiply things together, including functions, numbers, constants, expressions, etc. to avoid confusion. There are exceptions to this rule, but they lead to confusion for beginners.

1. Entering Algebraic Expressions:

* Expressions with variables: In Maple, you may enter all sorts of expressions with variables having any name you choose. For example, type in f:= (x+2\*y)^3; and press Enter. You have now entered the expression (x+2\*y)^3 and saved it in a variable named f. Type in f; and press Enter. Notice that Maple does not automatically expand these expressions for you! Type in expand(f); and press Enter. Maple will now output the expression you gave it, but expanded. Note that this expanded expression is not saved to the variable “f”. Maple will still think “f” is the non-expanded expression you gave it. You can save the expanded expression to a variable called “g” by typing g := expand(f); and pressing Enter. We may also factor expressions using the factor command. Type in factor(g); and press Enter to factor g.
* Substituting into an expression: Oftentimes, we want to substitute numbers into our variables. Notice that since “f” is an expression, we can’t simply write something like f(1,2) to substitute values into it. To substitute numbers into an expression, we use the “subs()” command. Type in subs(x=1,y=2,f); and press Enter. You have just told Maple to

substitute 1 for x and 2 for y in the expression f. You should have an output of 125. Note that this does not set the variables x and y to be 1 and 2, respectively, for the remainder of the worksheet. If we had typed in x:=1; and pressed Enter, it would have set x to be 1

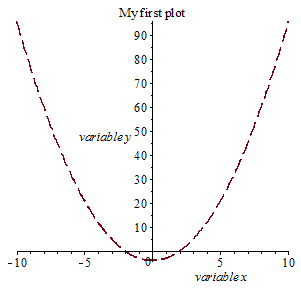
for the remainder of the worksheet, which is often not desirable!

* Graphing expressions: Type in plot(x^2-4); and press Enter. Maple will display a graph of x^2-4 and will pick a domain for you. We can change the domain if we wish to view a different part of x^2-4. Type in plot(x^2-4, x=0..15); and press Enter. This will show you the graph of x^2-4 from x=0 to x=15.

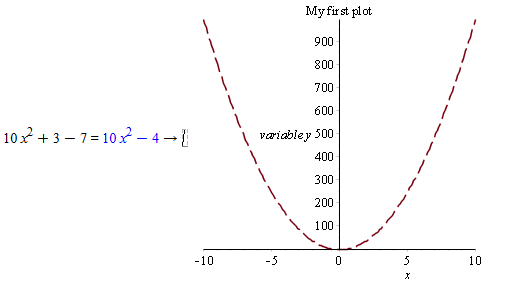
1. Entering Functions:

* Functions: You may also input functions into Maple. Recall that we may think of a function as a rule that takes a number as input and returns a number as output. Type in h:=x -> x^2+5; and press Enter. We have just defined a function, called h, which takes a number (or expression!) as input, squares it, adds 5 to it, and then returns that value. For example, typing in h(3); and pressing enter will return 14. Typing in h(Pi); and pressing Enter will return π^2 + 5. Typing h(f); and pressing enter will square the expression f we defined earlier and then add 5 to it! We can get the expression x^2 + 5 by simply typing h(x); and pressing Enter.
* Trigonometric functions and Natural Logarithm: Maple will, by default, understand trigonometric functions and will expect their input to be in radians. For example, typing in cos(Pi); and pressing Enter will return an output of -1. Maple will also understand the natural logarithm function. For example, typing in ln(1); and pressing Enter will return 0.
* Graphing functions: We may graph functions in Maple by converting them into expressions. Type in h:= x -> x^2 – 3; and press Enter. Now, to graph h(x) from x=0 to x=15, type plot(h(x),x=0..15); and press Enter. This will give the desired graph.

1. Using Maple’s context-sensitive menus:
   * Type in the expression x2 – 4, hover over this expression and right click. The context-sensitive menu offers several operations that you can perform on the current expression: factor, simplify, solve, differentiate, integrate and plots to name a few that you will use this semester. Maple is smart enough to only offer operations that applies to this expression.
   * To plot the current expression select **Plots>2-D Plot** from the context-sensitive menu.
   * Modify the plot after it has been created by clicking on the plot; a blue box appears around the plot. You can expand it or shrink it by dragging the corners. Right click on the plot itself and use the context-sensitive menus to modify the line type, color of the graph, label the axes, add a title to the graph, add a legend etc. Play around with these options as you will need to label all graphs and “make them pretty” to submit for your labs. Notice the context-sensitive menu appears only with graphing options.



1. Changing a problem in Maple:
   * Mathematics in a Maple document are live so you can go back to make changes and re-execute the problem to obtain a new result.
   * Go back to the very first thing you entered 3 + 2 and change the 2 to a 8; Press Enter to obtain a new result of 11
   * Go back to x2 – 4, change the x2 to 10x2. Highlight the entire line including the plot then click the execute button  found at the top of the Maple worksheet. All selected calculations are updated. Notice the updated graph.



1. **Algebraic Calculations:**
2. Solving Equations using context sensitive menus:

*Solving for a variable:*

* + To represent an equation in Maple, use the = sign for equality.
  + Type Remember you need to explicitly define the multiplication or Maple will see ‘ax’ as a variable instead of ‘a’ times ‘x’.
  + Right click on the equation to get the context menu. Select **Solve>Solve for Variable>x**
  + The quadratic equation will be returned.

*Solving for exact solutions:*

* + By default, Maple will find the exact solution for an equation.
  + Type
  + Right click on the equation to get the context menu. Select **Solve>Solve**.
  + The following result appears:

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*Solving for numeric solutions:*

* + Type
  + Right click on the equation to get the context menu. Select **Solve>Numerically Solve**.
  + The following result appears:



1. Solving Equations using Maple Commands:

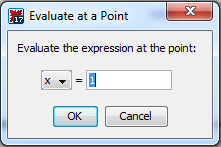
Solving one equation in one variable:

* Type in solve(x^2-2=0,x); and press Enter. The output will be the two solutions to the equation x^2-2=0. The “solve()” command takes two inputs here: the equation we wish to solve and the variable we wish to solve for. Notice, as usual, Maple does NOT give us a decimal answer.
* To obtain this, we may type evalf(solve(x^2-2=0,x); and press Enter.

Solving systems of equations:

* Type solve({x^2\*y^2=0, x-y=1, x!=0}); and press Enter. You should obtain {x=1,y=0} as output, which is the solution of this system. Here is an explanation of what we have done. By using curly braces { and }, we have given Maple a list of equations. We have told Maple that the equations we wish to simultaneously solve are x^2\*y^2 = 0, x-y = 1, and x is not equal to 0. Here, the symbol != means “not equal to” (this is fairly standard in programming in general).

1. Evaluating Expressions:
   * An expression in x written as h:=sin(x) is not a function. Maple interprets this as assignment of an expression to the name h.
   * To find the value of an expression at a given value of x, you evaluate the expression at the point.
   * Type
   * To evaluate at x=1: right click on the expression to bring up the context menu. Select **Evaluate at a Point**. The following dialog box appears:



* + The result returned is 5.
  + You could also evaluate this expression with a direct call to the Maple command eval(h,x=1)
  + Or selecting the evaluate symbol from the Expression palette

 use the tab button with the expression palette to fill in the necessary information. The following result appears:

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1. More on Defining and Evaluating Functions (Palette Option):
   * Mathematical functions in Maple are represented as operators with the operator notation an arrow.
   * Define a function using the Expression Palette. From the palette, choose Type F, then press Tab. Type x, press Tab. Type x^2. Press Enter to evaluate this line, thus making the function definition. The following result appears:

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* To find the value of F at a particular value of x, call the function F with an argument. Type F(3) and try F(y). The following results appears:











1. Factoring:
   * We will use the simple version of the Maple factor command. The factor function computes the factorization of a polynomial with calling sequence “factor(a)” where a is a polynomial.
   * Type factor(x3 + y3) Press Enter, and the traditional formula will be returned.
   * Type factor(
   * The result should appear: 6(x+4)(x–1)
   * Alternatively, you could enter an expression, right-click on it and use the context menu select **Factor.**
2. Simplify:
   * Maple’s simplify command uses the basic algebraic rules to simplify expressions.
   * Type simplify()
   * The result should appear: 
   * Alternatively, you could enter an expression, right-click on it and use the context menu select **Simplify>Simplify**
3. Expand:
   * The expand command distributes products over sums. This is done for all polynomials.
   * Type expand(
   * The result should appear: 
   * Type expand(sin(x + y))
   * The result should appear: 
4. **General Guidelines for Lab Reports:**

* Although each student should be working individually on a Maple file you will submit only **one hardcopy report** per group the day the lab is due. Be sure to include a cover sheet listing both names, Lab #, Date.
* **Each group** will submit a Maple .mw file via Canvas. The title of your electronic version should include both lab partner names & Lab # for ex., “Taylor Swift and Ella O’Connor Lab #1”.
* Answer all questions with complete sentences in Maple. Clearly identify each question. You will use the text and math modes as described in this manual to create a readable document with grammatically correct language. It is essential to communicate effectively using the appropriate mathematical language.
* Label all graphs, axes, and explain your plots!
* Add any additional observations and comments that you may have.
* Please make sure that your report is readable to a person not literate in Mathematics. Remember, someday you will be working in industry or academia and will need to effectively communicate your findings to your peers.