Basic Maple Tutorial

The purpose of this document is to introduce some basic Maple commands, syntax, and programming concepts for Maple V Release 9.5.

1 Some Basic Maple Commands

After you log on to your terminal and access Maple, you will get a window containing a ”prompt” > where you can immediately begin entering Maple commands. If you wanted to multiply the numbers 247 and 3756, you would enter

```
> 247*3756;
```

$$927732$$

NOTE: Every Maple V command must end with either a semicolon or a colon. If a command is ended with a colon then the calculation will be made but no output will be printed. When a semicolon is used the calculation will be made and the result will be printed.

If a colon were used on the previous command, the result would look like the following:

```
> 247*3756:
```

If the semicolon or colon is omitted from a command, the command will not execute. Maple will respond as follows:

```
> 247*3756


Warning, premature end of input
```

However, because Maple allows full screen editing, you can go back to the line where the problem occurred and correct it.

2 Arithmetic

The basic arithmetic operations of addition, multiplication, division, and exponentiation are recognized in Maple V by the following symbols:

+ and -	add and subtract
* and /	multiply and divide
^ or **	raise to a power

You can easily add two numbers

```
> 253+7775;
```

$$8028$$

or add two fractions.

```
> 25/27 + 3/51;
```

$$\frac{452}{459}$$

Operations can be performed on previous results by using the percent symbol %. The next calculation multiplies the previous result by 23.

```
> 23 * %;
```

$$\frac{10396}{459}$$

Double percent marks refers to the next to last result.

```
> 23 * %%;
```

$$\frac{10396}{459}$$

You can raise a number to a power as follows.

```
> 3^7;
```

$$2187$$

```
> 3**7;
```

$$2187$$

Like other computer algebra systems, Maple uses exact arithmetic. For example, if you divide two integers Maple V will return the exact answer.

```
> 3235/7478;
```

$$\frac{3235}{7478}$$

The Maple function **evalf** will give the following decimal representation.

```
> evalf(%);
```

$$0.4326023001$$

3 Defining Variables and Functions

You can assign a value or a function to a variable by using the colon-equal notation "**:=**"

```
> y := 5;
```

$$y := 5$$

This means that the variable "y" has been assigned the value 5 and will have this value throughout the session until it is assigned another value or its value is unassigned. To display the current contents of a variable, we enter the variable's name followed by a semicolon.

```
> y;
```

$$5$$

We can perform basic calculations with the unassigned variable such as

```
> 4*y + 5;
```

$$25$$

Assigning a variable to itself enclosed in single quotes unassigns the variable.

```
> y := 'y';
```

$$y := y$$

```
> y;
```

$$y$$

There are two ways to define and work with functions. One way is to define the function as an expression. For the function $\mathrm{f}(x) = x^2$, this would be done by entering

```
> f := x^2;
```

$$f := x^2$$

This definition can be checked by entering:

```
> f;
```

$$x^2$$

The Maple V procedure **subs** allows expressions such as this to be evaluated.

```
> subs(x=5,f);
```

$$25$$

The problem with defining functions as expressions is that standard functional notation, such as *f(5)*, is not understood by Maple V and results in nonsense.

```
> f(x);
```

$$\mathrm{x}(x)^2$$

```
> f(5);
```

$$\mathrm{x}(5)^2$$

If you wish to use standard functional notation, you must enter the function using the minus-greater than notation "**->**", made by typing the "minus sign" followed by the "greater than" sign. For example:

```
> f := x -> x^2;
```

$$f := x \rightarrow x^2$$

```
> f(x);
```

$$x^2$$

```
> f(5);
```

$$25$$

4 Case Sensitivity

Maple is case sensitive - it distinguishes between upper and lower case characters. If you want to factor the polynomial $x^2 + 2\,x + 3$, you would enter

```
> factor(x^2 - 2*x - 3);
```

$$(x+1)\,(x-3)$$

However, the following command results in nonsense.

```
> FACTOR(x^2 - 2*x - 3);
```

$$\mathrm{FACTOR}(x^2 - 2\,x - 3)$$

Even one letter not being the correct case returns nonsense.

```
> Factor(x^2 - 2*x - 3);
```

$$\mathrm{Factor}(x^2 - 2\,x - 3)$$

5 Modular Arithmetic and the Greatest Common Divisor

You can easily perform modular arithmetic in Maple using the **mod** function. The **mod** function in Maple is always entered in lower case, not in the upper case MOD form that your textbook uses. The following commands illustrates how this command works:

```
> 25 mod 7;
```

$$4$$

```
> 23451 mod 4344;
```

$$1731$$

```
> -131 mod 31;
```

$$24$$

```
> 1357015327903875075l2805098775 mod 342190873420982300274 31;
```

$$2734771084593461288729 8$$

This command would produce and error, since **mod** is not in lower case.

```
> 25 MOD 7;

Error, missing operator or `;`
```

We can also quickly compute multiplicative inverses in modular arithmetic. Suppose we want to compute the multiplicative inverse of 15 mod 26, that is, compute, 15^{-1} mod 26. We enter

```
> 15^(-1) mod 26;
```

$$7$$

This command illustrates that the last answer, 7, is the inverse of 15 mod 26.

```
> (15*7) mod 26;
```

$$1$$

If the greatest common divisor (gcd) of the number and the modulus is not 1, then Maple will report this as and error as the next answer illustrates:

```
> 4^(-1) mod 26;

Error, the modular inverse does not exist
```

The **gcd** command can be used to check if the **gcd** of two numbers equals 1 before attempting to calculate the multiplicative inverse. The following commands illustrates it use:

```
> gcd(15, 26);
```

$$1$$

```
> gcd(144, 264);
```

$$24$$

```
> gcd(132133244323, 2470327403427374230);
```

$$1$$

Since the gcd of the the last two numbers is not equal to 1, we can compute 132133244323^{-1} mod 2470327403427374230 and check the result.

```
> 132133244323^(-1) mod 2470327403427374230;
```

$$1620922020081868497$$

```
> (132133244323 * 1620922020081868497) mod 2470327403427374230;
```

$$1$$

6 Representing Messages: Strings

In this class, when we enter sentences to be encrypted or decrypted, we will normally enter them as strings. Strings are always enclosed in double quotes "". For example, to store the sentence "MAPLE IS NOT THAT HARD TO USE", we would enter:

```
> sentence := "MAPLE IS NOT THAT HARD TO USE";
```

sentence := "MAPLE IS NOT THAT HARD TO USE"

7 Algebra

Here are some of the important Maple V algebra commands:

Maple Command	**What it does**
expand	Expands expressions
simplify	Simplifies expressions
factor	Factors expressions
solve	solves equations

Some examples of these commands follow:

```
> expand( (x^2 + 1) * (x + 1) * (x + 3) );
```

$$x^4 + 4\,x^3 + 4\,x^2 + 4\,x + 3$$

```
> factor(%);
```

$$(x^2 + 1)\,(x + 1)\,(x + 3)$$

```
> sol := solve( x^3 - 9*x^2 + 20*x = 0, x);
```

$$sol := 0,\ 5,\ 4$$

The last equation has 3 roots, and we can pick a particular one by entering

```
> sol[1];
```

$$0$$

or

```
> sol[3];
```

$$4$$

8 Graphing

Maple has the ability the graph functions and equations. The **plot** command is the basic command used for plotting graphs. To demonstrate, suppose we enter the function

```
> f := x^2;
```

$$f := x^2$$

The following command will graph this function (note the quotes around the sentence in the title option).

```
> plot(f, x = -3..3, y = -5..10, title = "Graph of y = x^2");
```

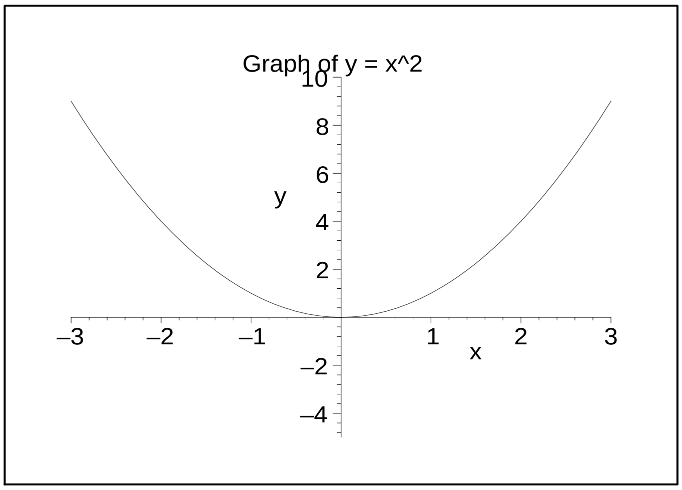

Figure 1: Maple graph of $y = x^2$

In the previous statement, the first parameter is the function that will be graphed. The second and third parameters are the ranges on the x and y axis over which we want our graph to be plotted.

Maple has the ability to graph multiple graphs. Suppose we enter the function

```
> g := x^3;
```

$$g := x^3$$

The following commands set up and store the plots for these graphs in the variables p1 and p2. An important fact to remember is to end these commands with a **colon :.** If you end the command with a semicolon, all the data points generated to plot the graph will be displayed.

```
> p1 := plot(f, x = -3..3, y = -9..9, color = blue):
> p2 := plot(g, x = -3..3, y = -9..9, color = green):
```

Using the **display** command, we can graph both functions. The **display** is in a package of routines called plots, which we read into the session by entering

```
> with(plots);
```

```
Warning, the name changecoords has been redefined
```

$[animate, animate3d, animatecurve, arrow, changecoords, complexplot, complexplot3d, conformal, conformal3d, contourplot, contourplot3d, coordplot, coordplot3d, cylinderplot, densityplot, display, display3d, fieldplot, fieldplot3d, gradplot, gradplot3d, graphplot3d, implicitplot, implicitplot3d, inequal, interactive, listcontplot, listcontplot3d, listdensityplot, listplot, listplot3d, loglogplot, logplot, matrixplot, odeplot, pareto, plotcompare, pointplot, pointplot3d, polarplot, polygonplot, polygonplot3d, polyhedra\_supported, polyhedraplot, replot, rootlocus, semilogplot, setoptions, setoptions3d, spacecurve, sparsematrixplot, sphereplot, surfdata, textplot, textplot3d, tubeplot]$

This command now plots both graphs on the same axes.

```
> display([p1, p2], title = "Graphs of y = x^2 and y = x^3");
```

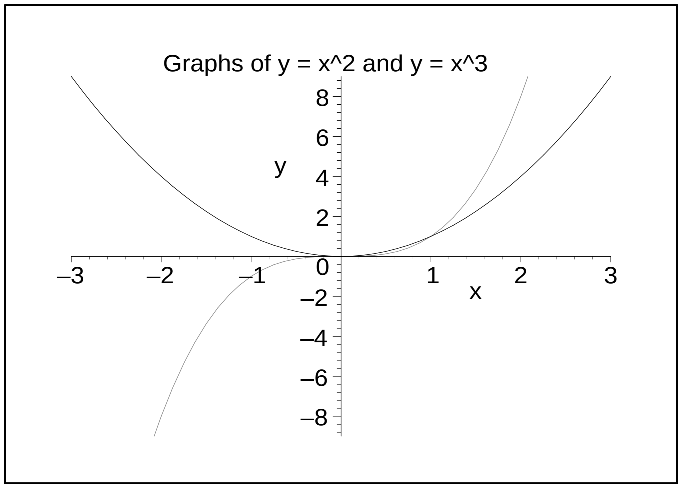

Figure 2: Maple graphs of $y = x^2$ and $y = x^3$

9 Help File

You can obtain the help file regarding most Maple functions and statements by entering **?** ***name*** where name is the function or statement you desire help on. To see help on factor, you can enter:

```
> ? factor
```

Help can also be obtain using the help option on the toolbar.