Introduction: The purpose of this lab is to introduce you to some of the basic plotting commands in Maple, and to use Maple to investigate the behavior of some polynomial and exponential functions. You will work in groups of two. Each group will turn in a single lab report with answers to the Exercises below. The lab report will consist of a printout of your Maple worksheet. Please place the exercises in numerical order, and type the exercises number at the beginning of your answer. Also, please write in complete sentences. Lab reports are due Wednesday September 21.

Instructions: First, find a partner, log on to a computer and start up Maple. See the Introduction to Maple handout or call me over if you have any difficulty. *Be sure to actually log on with your Novell username and password, so that you can save your worksheet. Do* **not** *select Workstation Only.*

Plotting in Maple: The command to plot the graph of a function is `plot`. For example, to plot the function $f(x) = (x-2)^2 - 1$ over the domain $0 \le x \le 4$, type

```
plot((x-2)^2-1,x=0..4);
```

To plot more than one function on the same set of axes, use square brackets and separate the functions by commas. For example, to plot the functions x^2, x^3 and x^4 on the domain $0 \le x \le 1$, type

```
plot([x^2,x^3,x^4],x=0..1,color=[red,blue,yellow]);
```

The optional statement `color=[red,blue,yellow]` tells Maple to plot x^2 in red, x^3 in blue and x^4 in yellow. This allows you to identify the graphs. It is often useful to restrict the range that Maple plots. For instance, to plot the portion of the graph of $f(x) = \frac{1}{x}$ which lies within the rectangle $0 \le x \le 2$, $0 \le y \le 5$, type

```
plot(1/x,x=0..2,y=0..5);
```

See what happens if you leave out the `y=0..5` statement. Sometimes, when making multiple references to the same function, it is useful to give that function a name. For instance, to define a function $f(x) = x^2 + 2x - 2$, type

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

Be sure to always use `*` for multiplication – there is no "implied multiplication" in Maple. Now if you wanted to plot this function together with $f(x-2)$ and $f(x)+7$ over say $-4 \le x \le 4$, you would type

```
plot([f(x),f(x-2),f(x)+7],x=-4..4,color=[red, blue, yellow]);
```

This is far easier than typing the formula for f three times!

Exercises. Answer each of the following questions.

1. Plot the graphs of $x^{1/2}$, x, x^2 and x^3 on the domain $0 \le x \le 2$.

   (a) Looking only at the portions of the graphs over $0 \le x \le 1$, put these functions in increasing order.

   (b) Do the same for the portions over $1 \le x \le 2$.

2. Plot the graph of the polynomial $p(x) = 2x^4 - 14x^3 + 34x^2 - 34x + 12$ over the domain $0 \le x \le 4$. What is the factored form of this polynomial?

3. Plot the functions $f(x) = 2^x$ and $g(x) = x^3$ over the domain $0 \le x \le 3$. If you now click on a point in the figure, the coordinates of that point will appear in the upper left hand corner of the Maple window.

   (a) Determine the coordinates of the point where the graphs cross.

   (b) Now change the domain to $0 \le x \le 12$. The graphs appear to cross a second time. Find the coordinates of the second crossing.

   (c) Repeat parts (a) and (b) for $f(x) = 2^x$ and $g(x) = x^4$. (You may need to extend the domain further.)

4. For the following rational functions, use Maple to define and plot the function on a suitable domain and range. What happens to the values of $s(x)$ as $x \to \infty$ and as $x \to -\infty$? Find the equations of the vertical and horizontal asymptotes.

   (a) $s(x) = \dfrac{4x^4 - x^3 - 10x^2 + 1}{x^4 - 2x^2 - 1}$

   (b) $s(x) = \dfrac{x^5 - 3x^3 + 2x}{x^4 - x^3 - 7x^2}$

   (c) $s(x) = \dfrac{x^6 + 10x^4 - 10x^3 + 5}{x^7 - 1}$

5. Plot the graph of the function $p(x) = (\sin x)^2$ for $-2\pi \le x \le 2\pi$. What is its amplitude and period? Assuming that this function is equivalent to a function of the form

$$A \cos(Bx) + C,$$

what must A, B and C be? Now plot $p(x)$ together with the graph of $y = A \cos(Bx) + C$ (with the values of A, B and C that you found) to verify your answer. The graphs should perfectly overlap.