MATH 131, Sections 02 and 04, Fall 2005

Computer Lab #1

Using MAPLE to Visualize Functions

DUE DATE: Monday, Sept. 19th, in class.

The goal of this lab project is for you to become familiar with the software package MAPLE and to understand how new functions can easily be generated from old ones (via shifting, stretching, reflecting, etc.) Before beginning, please read the *Introduction to MAPLE Computer Labs* handout. The lab is designed to explore material from Section 1.3 of the course text.

It is **required** that you work in a group of two or three people. Any help you receive from a source other than your lab partner(s) should be acknowledged in your report. For example, a textbook, web site, another student, etc. should all be appropriately referenced. Please turn in one report per group, listing the names of the groups members at the top of your report. Be sure to answer all of the questions carefully **writing in complete sentences.** You should type your answers, leaving space for mathematical calculations or graphs. You may also include calculations and graphs in an appendix at the end of your report.

You should turn in your answers on separate sheets of paper. There are **four graphs** to be turned in for this report. You should not turn in any other graphs unless they significantly contribute to the explanation of an answer. For example, it is ok to say, "By plotting the graph of $f(x) + 2$, we see that adding 2 to the function shifts the graph upward 2 units," without actually turning in the graph.

1. Use MAPLE to define the polynomial $f(x) = x^3 - 8x - 3$ and then plot it over the domain $-5 \leq x \leq 5$. The commands for this are listed below. Be sure to type them in exactly as shown.

```
f := x -> x^3 - 8*x - 3;
plot(f, -5..5);
```

   (a) Print out and turn in a graph of $f(x)$ over the domain $-5 \leq x \leq 5$.

   (b) Find all the **roots** (zeroes) of $f(x)$. By adjusting the plot range, zoom in on your graph to estimate the roots as best as you can using MAPLE. What are the *exact* values of the roots? *Hint:* If r is a root, then $x - r$ is a factor of $f(x)$.

   (c) Use MAPLE to find the number of digits of $f(1000000)$.

   (d) Define a new function $g(x) = f(x + 3)$ using MAPLE with the command

   ```
   g := x -> f(x+3);
   ```

   How does the graph of g differ from the graph of f? In general, what effect does replacing x by $x + c$ have on the graph of f?

   (e) Define a new function $h(x) = f(x - 3)$ using MAPLE with the command

   ```
   h := x -> f(x-3);
   ```

   How does the graph of h differ from the graph of f? In general, what effect does replacing x by $x - c$ have on the graph of f?

(f) Plot all three functions f, g, h on the same set of axes choosing an appropriate range for the x- and y-axis. (Be an artist!) See the *Introduction to MAPLE Computer Labs* handout on how to plot multiple functions. Print out your plot and make sure to label each graph.

2. Use MAPLE to define the functions $f(x) = 4\cos(2x) - x^2$, $g(x) = f(x) + 5$ and $h(x) = f(x) - 5$. (See the syntax from the previous problem. Remember to include a `*` sign between the 4 and `cos` and between the 2 and `x`.) Plot these functions over the range $-\pi \leq x \leq \pi$. (Type `Pi` to obtain the number π.)

   (a) How does the graph of g differ from the graph of f? In general, what effect does adding a positive constant c to $f(x)$ have on the graph of f?

   (b) How does the graph of h differ from the graph of f? In general, what effect does subtracting a positive constant c from $f(x)$ have on the graph of f?

   (c) Plot all three functions f, g, h on the same set of axes choosing an appropriate range for the x- and y-axis. Print out your plot and make sure to label each graph.

3. Use MAPLE to define the functions $f(x) = 0.4x^2$, $g(x) = 3f(x)$ and $h(x) = (1/3)f(x)$.

   (a) How does the graph of g differ from the graph of f? In general, what effect does multiplying $f(x)$ by a positive constant $c > 1$ have on the graph of f?

   (b) How does the graph of h differ from the graph of f? In general, what effect does dividing $f(x)$ by a positive constant $c > 1$ have on the graph of f?

   (c) Plot all three functions f, g, h on the same set of axes choosing an appropriate range for the x- and y-axis. Print out your plot and make sure to label each graph.

4. Use MAPLE to define the functions $f(x) = x^2 - 3x + \sin x$, $g(x) = f(-x)$ and $h(x) = -f(x)$.

   (a) How does the graph of g differ from the graph of f? In general, what effect does replacing x by $-x$ have on the graph of f?

   (b) How does the graph of h differ from the graph of f? In general, what effect does replacing $f(x)$ by $-f(x)$ have on the graph of f?

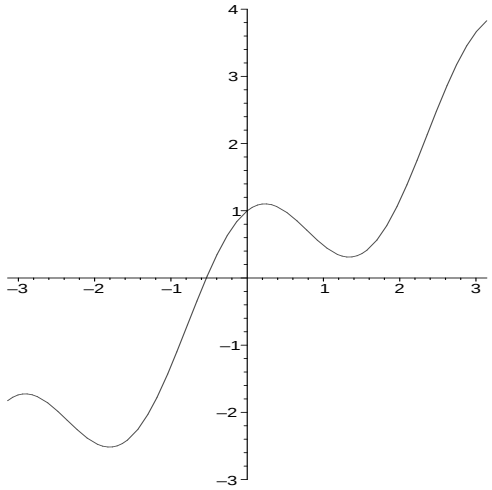

Figure 1: The graph of $f(x) = \cos(2x) + 0.9x$.

5. **What's the function?**

The graph of $f(x) = \cos(2x) + 0.9x$ is shown above in Figure 1 plotted over the domain $-\pi \leq x \leq \pi$. Using your knowledge on shifting, stretching and reflecting functions, find formulas for the functions $g(x)$ and $h(x)$ shown in Figure 2. Express your answers in terms of $f(x)$ (for example, $g(x) = 100f(\pi x - \ln(3))$ is a possible answer.) NO graphs need to be turned in for this question.

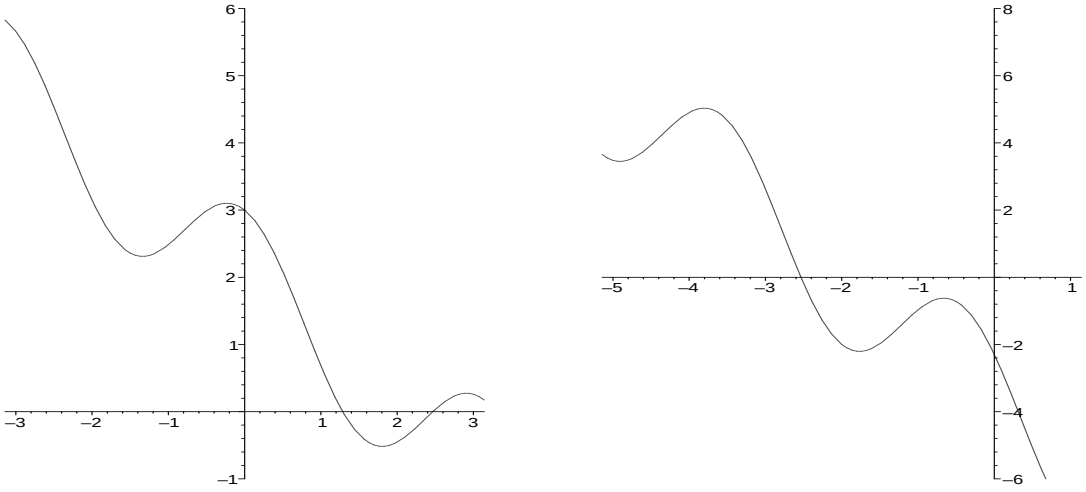

Figure 2: The graphs of $g(x)$ (left) and $h(x)$ (right).