Lab #1: Using a Graphing Program
Calculus 1, Professor Samuels

please type your answers and turn it in or email it
(you may write equations by hand)

how to use it

1. let's draw a graph
   input a function for $f_1(x)$...try *3cos(x)+2*
   hit 'enter' OR click 'graph'
   that was easy, right?

2. let's find values on that graph
   find the green dot, it should be on the graph at x=0
   use your **mouse** to drag the dot...it stays on the graph
   look to the right of the graph: "c=" has the x-value; "$f_1(x)$=" has the y-value
   a) what is cos(1.8) ? (to 2 decimal places)
   you can also **type** in a value
   b) what is cos(2.7698) ? (to 5 decimal places)

3. you can draw two graphs
   make $f_1(x)= x^2 - 4x + 2$ ... type it as *x^2-4x+2*
   make $f_2(x) = -x^2 + 6x - 1$ ... type it as *-x^2+6x-1*
   there are little boxes next to f(x), click on them to put a check in both
   click 'graph'
   a) how many times do these graphs intersect?

4. typing in different functions
   graph $y=e^{2x}$ ... type *e^(2x)*
   a) if you do not include the parentheses, what does it graph?
   graph $y=\sqrt{x}$ ...*type sqrt(x)*
   graph $y=\sqrt[3]{x+1}$ ... type *nrt(3,x+1)*
   graph y=sin(x) ... type *sin(x)*
   graph y=xsin(x) ... type *x*sin(x)*
   note that here you must include the * for multiplication
   graph $y=\sin^2(x)$ ... this is the same as $(\sin(x))^2$, so type *(sin(x))^2*

5. The viewing window is the range of x-values and y-values you graph. They are typically denoted {xmin, xmax, ymin, ymax}.
   enter a function (try $y=x^3-x$)
   click 'bounds'
   change the values and see what happens
   click 'square' to make x-lengths the same as y-lengths
   click 'std' (standard) to make the window {xmin=-10, xmax=10, ymin=-10, ymax=10}
   click 'ok'
   click 'zoom in', then click a point on the graph to zoom in on

click 'zoom out', then click a point on the graph to zoom out on
click 'mouse', then put the mouse over the graph. You can see the coordinates of the mouse. Click it again to turn it off.

<u>possible problems</u>

Several strange things can happen with the grapher's picture

6. Misleading viewing window
   graph $y=x+x^{-2}$ ... type *x+x^(-2)*
   a) describe what you see.
   b) now type {xmin=-100, xmax=100, ymin=-100, ymax=100} ... describe what you see in this viewing window.
   c) type in {ymin=3, ymax=9} ... describe what you see in this viewing window.
   d) which one is correct? Explain.

7. scale
   a) for the graph *y=x*, describe in words what you expect to see.
   type in $f_1(x)=x$
   b) describe what you actually see.
   c) how can you fix this?

8. shape of the graph
   a) Graph the polynomials $y= 3x^5 - 5x^3 + 2$ and $y = 3x^5$ on the same screen, first using the viewing window: {xmin=-4, xmax=4, ymin=-4, ymax=4} and then the window: {xmin=-10, xmax=10, ymin=-1000, ymax=1000}.
   a) how do the graphs compare in the first viewing window? How do they compare in the second viewing window?
   Click 'clear'
   b) graph $y = x^3 - 60x$ Describe what you see.
   c) now graph it with viewing window {xmin=-10, xmax=10, ymin=-1000, ymax=1000} Describe what you see.

9. wiggliness
   click 'clear'
   a) graph $f_1(x)=\sin(x)+.02*\sin(60x)$ describe what the graph looks like.
   b) now 'zoom in' twice [remember that after you click 'zoom', you click somewhere on the graph and that is where it zooms in]
   describe what the graph looks like now.
   If you think this might be a problem with the computer screen, then graph $f_2(x)=\cos(x)$ and compare

10. ghost asymptotes and lines
    click 'clear'
    first, graph $f_1=(x-1)^{-1}$ ... type it as (x-1)^(-1)

a) Describe what you see.
b) click 'zoom out' [then click in the center of the graph] describe what you see.
this happens because most graphing programs calculate lots of values and then try to 'connect the dots'
Next, graph the piecewise-defined function:
y=2 if x<1, y=3 everywhere else ... for f_1 type in *x<1?2:3*
c) describe what should happen to the graph at x=1
d) describe what the grapher draws.
Next, what happens when a function "goes to infinity"?
Click 'clear'
Graph y= $\frac{1}{x^3-1}$ ... type *1/(x^3-1)*
e) the graph is supposed to go very high ("go to infinity"), but what happens?

11. pixellation
a) describe what you expect the graph of y=.3x to look like.
b) graph $f_1(x)=.3x$ describe the graph of the function.
(did you lean in to the screen really close?)
this happens because the screen is made up of tiny squares called pixels, so the picture can never be perfectly smooth (some are worse than others)

12. sampling
consider $f_1(x)=\sin(x)$ and $f_2(x)=\sin(100x)$
a) how do you expect the graph of sin(100x) to look, compared to sin(x) ?
b) now graph them. Describe what you see:
c) Click 'zoom in' and click near the center of the graph. Describe what you see.
d) Again, Click 'zoom in', click near the center of the graph. Describe what you see.
This happens because the program calculates about 200 graph points, and the graph is wiggling so fast that the program misses the wiggles...until you zoom in. (keep zooming in, the pictures are interesting)

13. endpoints
click 'clear'
recall that for $y=\sqrt{x}$ the function is undefined for negative x, so the graph stops
graph $f_1(x)=\sqrt{x-4}+1$ ...type it as sqrt(x-4)+1
a) you can see where the graph ends. How does it draw the endpoint?
b) Is it supposed to include the endpoint? (yes/no)
most graphing programs do not have a circle at an endpoint to indicate if it is included or not

<u>Part C: why the grapher is very useful</u>
(activities that would take very long by hand)

14. finding an approximate intersection

graph $f_1(x)=x$ and $f_2(x)=cos(x)$

a) how many solutions does the equation $x = cos(x)$ have?

b) what are they, to two decimal places:

c) use a graph to show that the equation $.3x = cos(x)$ has three solutions and find their values correct to two decimal places.

d) Find an approximate value of m such that the equation $mx = cos(x)$ has exactly two solutions.

[hint: we have seen one solution, we have seen three solutions. try a couple different values for m ...where does the line have to be to give two solutions?]

Part D: other tricks

15. how do you draw a graph which is not a function?

Lets try to draw the circle centered at the origin with radius 5 ... $x^2+y^2=25$

a) the graphing program asks for f(x), so try to solve for y ... y = ?

b) but this can be broken into two parts which are functions: y_1 = ? and y_2= ? type these in for $f_1(x)$ and $f_2(x)$, click 'graph'

c) describe what the program draws.

16. comparing similar functions

graph $f_1(x)=\sin(x)$ ... type sin(x)

graph $f_2(x)=\sin(x^2)$ ... type sin(x^2)

a) what is similar about the graphs?

b) what is different about the graphs?

for more free graphers, on the course web page, click "resources"