Names: _____

With your partner(s), read through the instructions and do the activities described. Only one report should be submitted from each group. This report is due Monday.

Introductory Remarks

In this lab we will explore the graphs of the trigonometric functions. Recall that in *Mathematica* the names of functions and mathematical constants always start with a capital letter, so to find $\sin\left(\frac{\pi}{4}\right)$, we use the command `Sin[Pi/4]`. (*Mathematica* always assumes that the input is in radians.)

Notice that *Mathematica* returns an exact result for $\sin\left(\frac{\pi}{4}\right)$. To get a numerical answer, use `N[Sin[Pi/4]]`.

When plotting trigonometric functions, it may be convenient to specify the tick marks on the axes. You can do that using the `Ticks` option with the `Plot` command:

```
Plot[Sin[x], {x, 0, 10}, Ticks -> {{0, Pi, 2 Pi, 3 Pi}, {-1, 1}}]
```

Explorations

1. **Zeros and Asymptotes**:

   (a) Plot $y = \sin x$ using *Mathematica*, and sketch a nice graph below, with clearly labeled tick marks on your axes. Make sure to show at least two full cycles.

   What are the zeros of $y = \sin x$? (Notice that $y = \sin x$ has infinitely many zeros. You need to determine how to indicate, in a concise way, what all the zeros are.)

   (b) Sketch $y = \cos x$, and find all zeros.

(c) Sketch a graph of $y = \tan x$.

What are the zeros of $y = \tan x$? Explain how you could determine the zeros of $y = \tan x$ without graphing $y = \tan x$, just using your results from (a) or (b).

What are the x-asymptotes of $y = \tan x$? Again, explain how you could determine these asymptotes without graphing $y = \tan x$.

2. **Graphical Transformations and Solving Equations** In each of the following exercises, you will plot a function in *Mathematica*. Print a copy of the graph, and clearly mark one cycle of the function.

   (a) Plot $y = 2\sin x$ and $y = 3\sin x$ in *Mathematica*. Describe how each of these graphs compares to the graph of $y = \sin x$.

Find all solutions to the equations $2\sin x = 0$ and $3\sin x = 0$.

(b) Plot $y = \sin(2x)$ and $y = \sin(3x)$ in *Mathematica*. Describe how each of these graphs compares to the graph of $y = \sin x$.

Find all solutions to the equations $\sin(2x) = 0$ and $\sin(3x) = 0$.

(c) Plot $y = \sin(x + 2)$ and $y = \sin(x - 3)$ in *Mathematica*. Describe how each of these graphs compares to the graph of $y = \sin x$.

Find all solutions to the equations $\sin(x + 2) = 0$ and $\sin(x - 3) = 0$.

3. **Symmetry**

(a) Plot $y = \sin x$ and $y = \sin(-x)$ in *Mathematica*. Describe how the graphs are related.

Use an equation involving $\sin(x)$ and $\sin(-x)$ to express the relation you noticed.

(b) Plot $y = \cos x$ and $y = \cos(-x)$ in *Mathematica*. Describe how the graphs are related.

Use an equation involving $\cos(x)$ and $\cos(-x)$ to express the relation you noticed.