Lab 2: Parametric Curves and Maple

Objectives: Learn to use Maple to plot parametric curves, to find intersections of parametric cuves with various lines, and to find slopes and self-intersections of parametric curves. In LaTeXwe introduce how to include figures in your lab write up.

Maple help pages that will come in handy:

`?plot,parametric`, `?textplot`, `?fsolve`

Sample Maple Commands

Try the following commands. This creates two parametric *functions*, then creates the plot in two dimensions, $(x(t), y(t))$:

```
xt:= cos(t);  yt:= sin(t);
plot([xt,yt, t=0..2*Pi]);
```

The following comands plot points, and puts some text in the plot:

```
with(plots):
P:=plot([[1,0],[2,1],[0,2],[3,0]], style=point, symbol=diamond, symbolsize=24);
T:=textplot([2, 1, "   (2,1)"], align={ABOVE, RIGHT}):
display([P,T],view=[-1..4,-1..3]);
```

Here, we want to find the solutions to:

$$x + \cos(x) = 2\sin(x)$$

We solve this by first getting a graph, then call Maple to find numerical approximations to the solutions:

```
f:=x+cos(x);  g:=2*sin(x);
plot({f,g},x=-5..6);  %Three solutions- Take note of where they are.
fsolve(f=g,x=-2..-1);
fsolve(f=g,x=0.5..1.5);
fsolve(f=g,x=2..3);
```

To solve a system of two equations in two unknowns, use the following syntax:

```
fsolve({ s-3*t=0, s*t=5}, {s=3..6,t=1..2});
```

What does the following set of Maple commands do?

```
with(plots):  %If you didn't already type this earlier
G:=t->t^2-1;
P := [seq([i,G(i)], i = -1 .. 2, 0.3)];
pointplot(P);
```

Another way to do something similar is to use the `map` command. For example, what does adding this line do?

```
tt:=[0.1, 0.2, 0.3, 0.4];
map(G,tt);
```

Lab 2 Questions

Answer each of the following in your write up for Lab 2. In this lab, you may make an enumerated list and incorporate Maple plots into your answers where appropriate. Given the curve:

$$x(t) = 3\sin(2\pi t) - 2\cos^5(t) \quad y(t) = \cos(2\pi t) - 3\sin(2\pi t) \qquad 0 \le t \le 1$$

1. Plot the curve. Plot the points on the curve where $t = 0, 0.1, 0.2, \cdots, 0.9, 1$. Combine the two plots into one using `display`.

2. Determine the points (x, y) where the curve crosses the line $x = 1$. HINT: You'll have to find the values of t which make the $x-$coordinate equal to 1 by using `fsolve`- A plot may be useful. In your write up, describe how you solved this problem, and include plots that you used.

3. Determine the points (x, y) where the curve crosses the line $y = 2x$.

4. Find the point(s) (x, y) where the tangent line is horizontal. Plot one tangent line together with the curve to illustrate your solution.

5. Find the point(s) (x, y) where the tangent line is has slope $-2/3$. Plot one tangent line together with the curve to illustrate your solution.

6. Find the point(s) (x, y) where the curve crosses itself. Find the angle in degrees between the two branches of the curve. HINT: This is the angle between the vectors that are pointing in the direction of each derivative.