Section 6: More on Graphing

```
> restart;
```

Parametric Equations

Maple's **plot** command can also be used to graph curves described by parametric equations.

To graph the parametric curve corresponding to the pair of parametric equations: $x = f(t)$ and $y = g(t)$ on the parameter interval $[a, b]$ use the command:

plot([f(t), g(t), t = a..b], x = xmin..xmax, y = ymin..ymax);

There are two things to take careful note of here. First note that there are three entries in the square brackets : the two parametric expressions for x and y and the parameter domain. Also note that the viewing window for the plot is separately specified by the x- and y-ranges (i.e., **x = xmin. .xmax, y = ymin..ymax**).

```
>
```

Example 1

Plot the parametric curve determined by $x = t^2 - t$ and $y = 2t - t^3$ over the t-interval [-2, 2] .

```
> plot([t^2-t,2*t-t^3,t=-2..2],x=-2..5,y=-5..5);
```

```
>
```

Exercise 6.1

Plot the parametric curve defined $x = \sin(3t)$ and $y = \sin(4t)$ over the t-interval $[0, 2\pi]$. For a viewing window let x and y range between -2 and 2 .

Student Workspace 6.1

```
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```

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Answer 6.1

```
> plot([sin(3*t),sin(4*t),t=0..2*Pi],x=-2..2,y=-2..2);
```

```
>
```

Implicit Plots

Maple can plot curves that are implicitly defined by an equation in the variables x and y.

Example 1

To plot the graph of the hyperbola given by the equation: $\frac{x^2}{4} - \frac{y^2}{9} = 1$ use the **implicitplot** command. To use this command we must first load the "plots" package using the "with" command.

```
> with(plots):
>
```

Note the syntax for this command on the next line.

```
> implicitplot(x^2/4-y^2/4=1,x=-5..5,y=-5..5);
>
```

Example 2

Graph the equation $\frac{x^2}{25} + \frac{y^2}{9} = 1$ using the **implicitplot** command.

Recall that this is the equation of an ellipse with the lengths of major and minor axes equal to 10 and 6 respectively.

Our first attempt at getting the expected graph comes up short !

```
> implicitplot(x^2/25+y^2/9=1,x=-5..5,y=-5..5);
>
```

Why did we get a circle instead of an ellipse ?

The problem here is that the x- and y-scales are not equal. To force equal scaling add "scaling=constrained" or click on the graph to expose the graphing toolbar, and select the button marked 1:1.

The graph then appears as seen in the following figure.

```
> implicitplot(x^2/25+y^2/9=1,x=-5..5,y=-5..5,scaling=
  constrained);
>
```

Exercise 6.2

Graph the equation $x^2 + 4\,y^2 = 4$

Student Workspace 6.2

```
>
>
>
>
>
>
```

Answer 6.2

```
> implicitplot(x^2+4*y^2=4,x=-3..3,y=-2..2,scaling=
  constrained);
>
```

Polar Graphs (optional)

Graphs of polar equations $r = f(\theta)$ are handled by the **polarplot** command, which is part of the plots package accessed using with(plots).

Here are some examples. Note that we include the option *scaling = constrained* to get geometric perspective.

```
> polarplot(1+cos(theta),theta=-Pi..Pi,scaling=constrained);
>
> polarplot(sin(3*theta),theta=-Pi..Pi,scaling=constrained);
>
```

Another way of graph polar graphs is to use the plot option **coords=polar** and graph the curve using parametric equations. The general form of the command is:

plot([r(s), theta(s), s=a..b], coords=polar);

If the parameter *s* is actually the angle θ, the command becomes

plot([r(theta), theta, theta=a..b], coords=polar);

For example, to graph 1+cos(θ) in polar coordinates using the **plot** command, type:

```
> plot([1+cos(theta),theta,theta=-Pi..Pi],coords=polar);
>
```

The **coords=polar** option can be applied to **implicitplot** command as well.

For example, to graph the lemniscate $r^2 = 4\cos(2\theta)$ over the θ interval $-\pi..\pi$, type:

```
> implicitplot(r^2=4*cos(2*theta), r=0..2, theta=0..2*Pi,coords=
  polar, scaling=constrained, grid=[50,50]);
>
```

Plot Options

There are many options available when you use the **plot** command. To see a list, execute the next line to go directly to Maple's Help Page on this command. Skip this if you wish.

```
> ?plot[options];
>
```