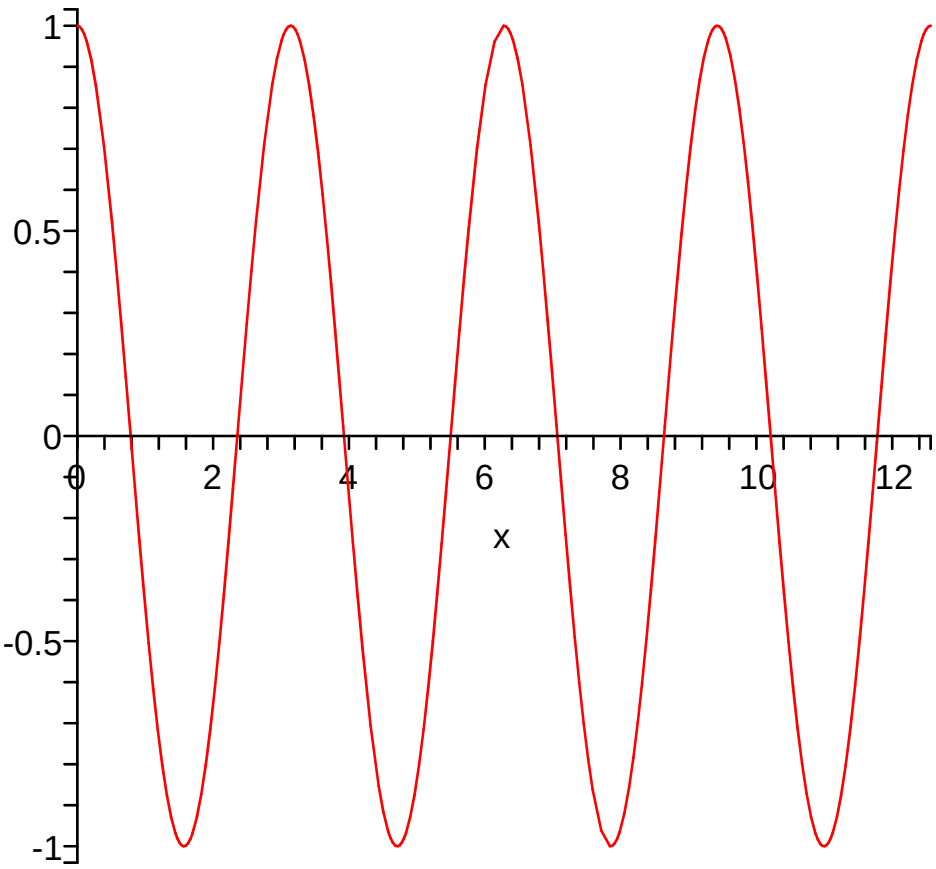
Short introduction to Maple plotting and the Differential Equation Package.

Plots:

```
> with(plots):
Warning, the name changecoords has been redefined
```

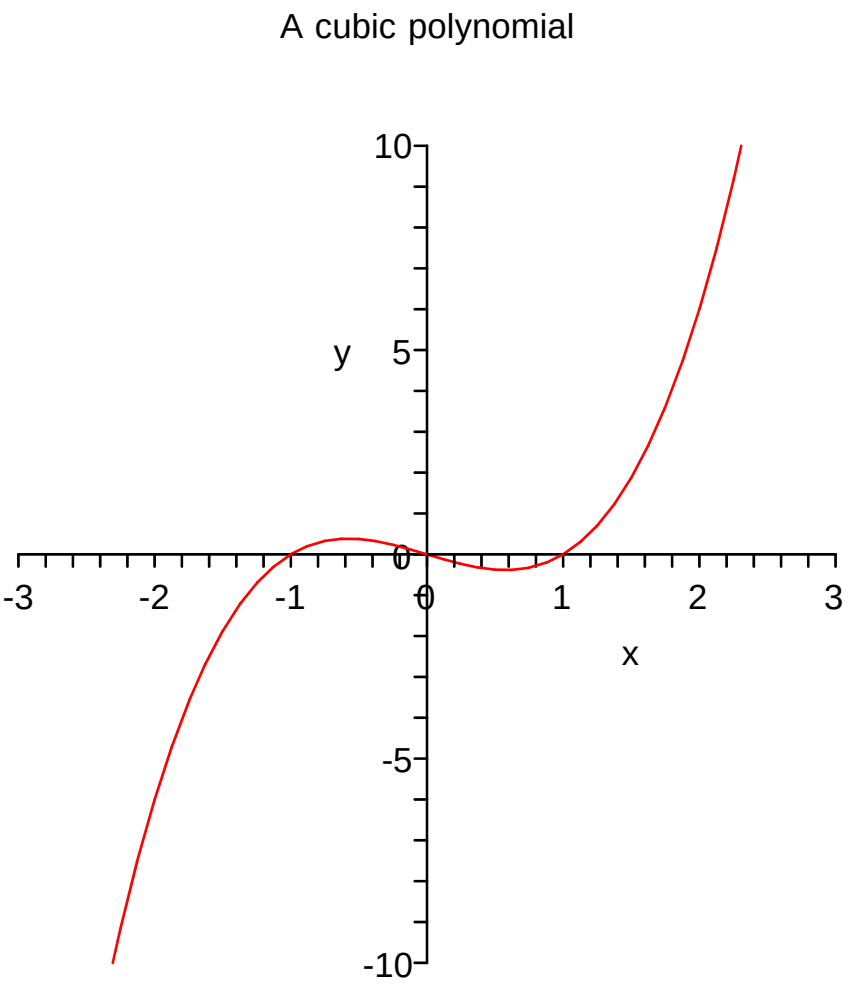
Here is a plot of a trigometric function

```
> plot(cos(2*x),x=0..4*Pi);
```



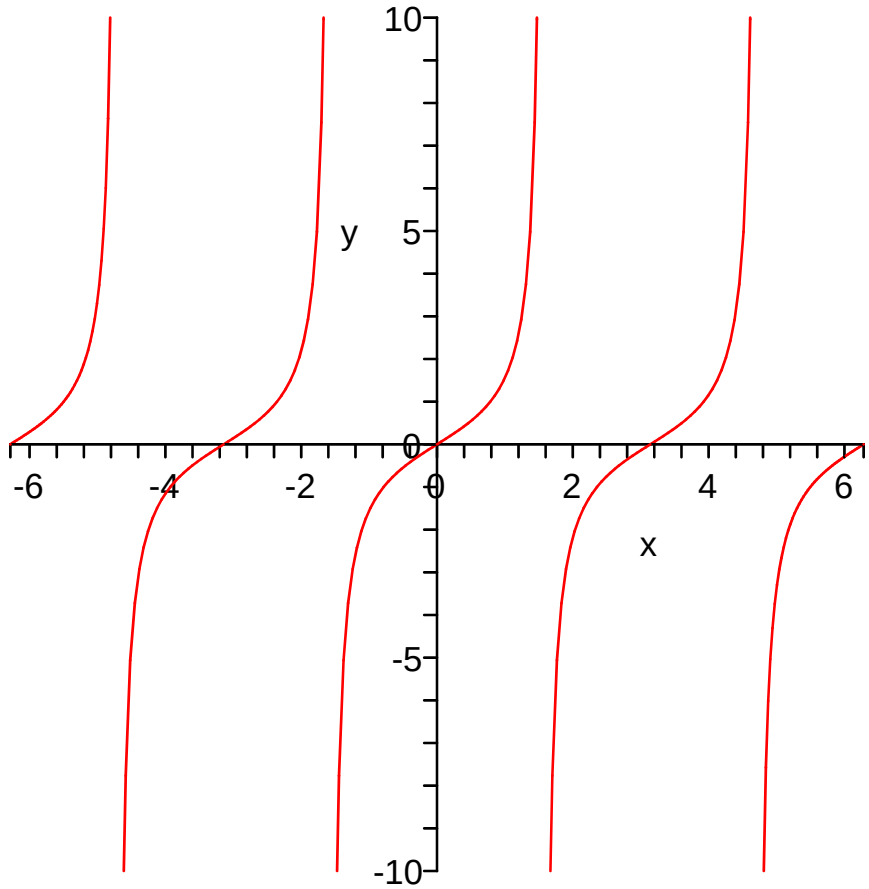
Here is a plot of a cubic polynomial with a title:

```
> plot(x*(x^2-1),x=-3..3,y=-10..10,title=`A cubic polynomial`);
```



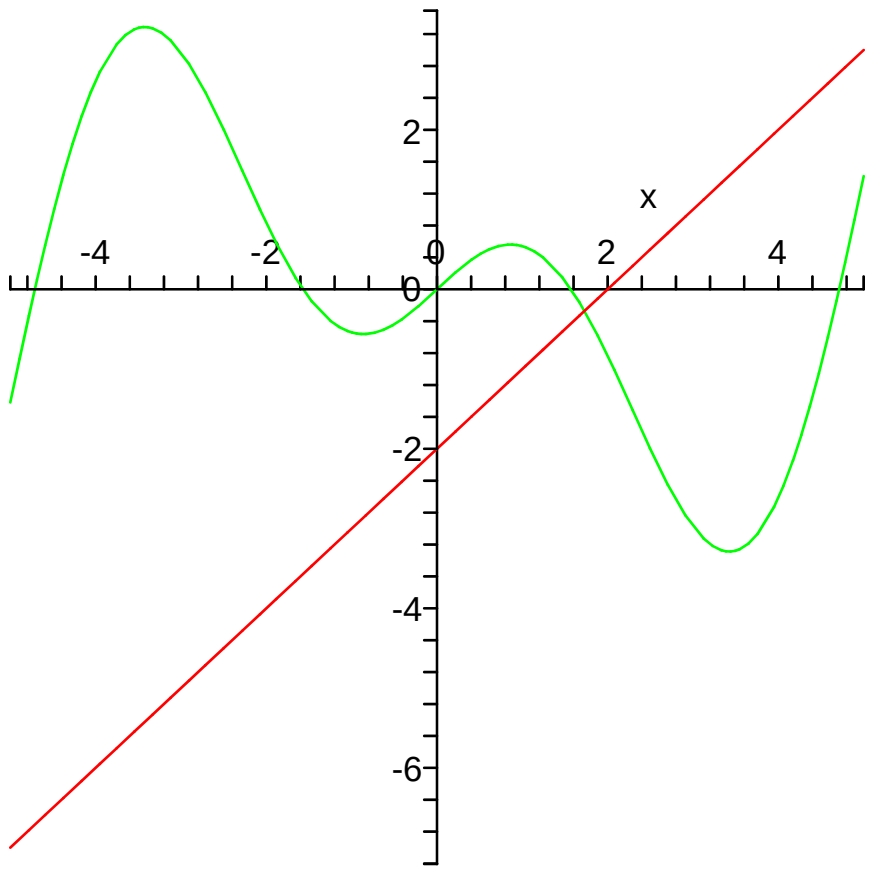
Here is a plot of a function with discontinuities:

```
> plot(tan(x),x=-2*Pi..2*Pi,y=-10..10,discont=true);
```



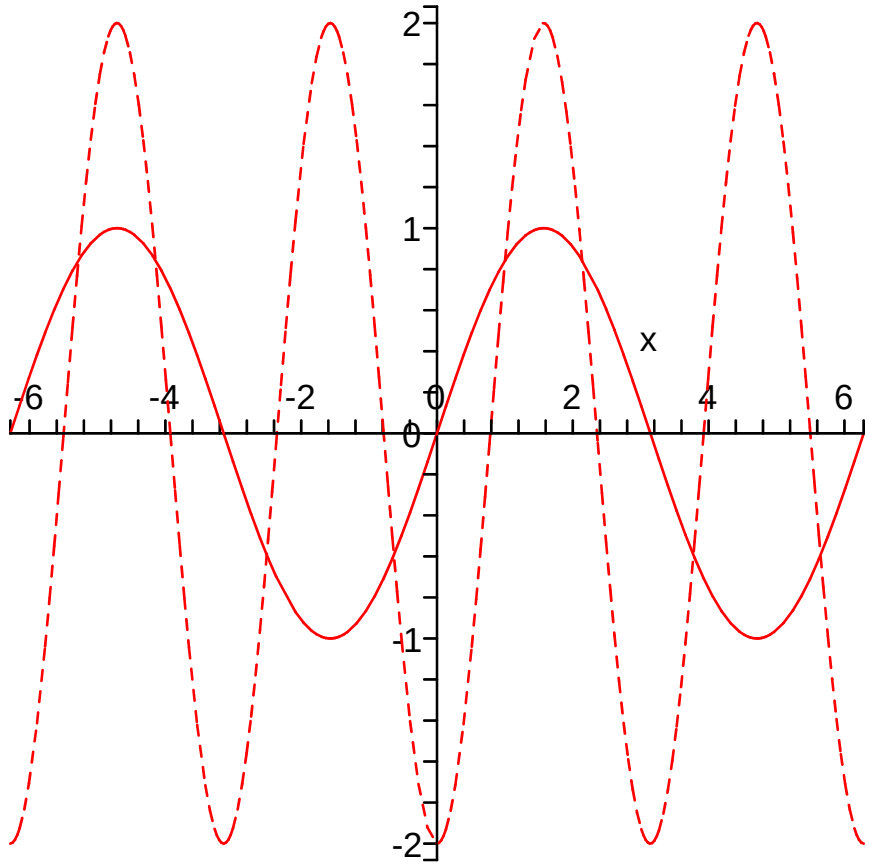
Here is an example of multiple plots:

```
> plot({x*cos(x),x-2},x=-5..5);
```



To have more control on the parameters of each plot, it is best to use the display command.

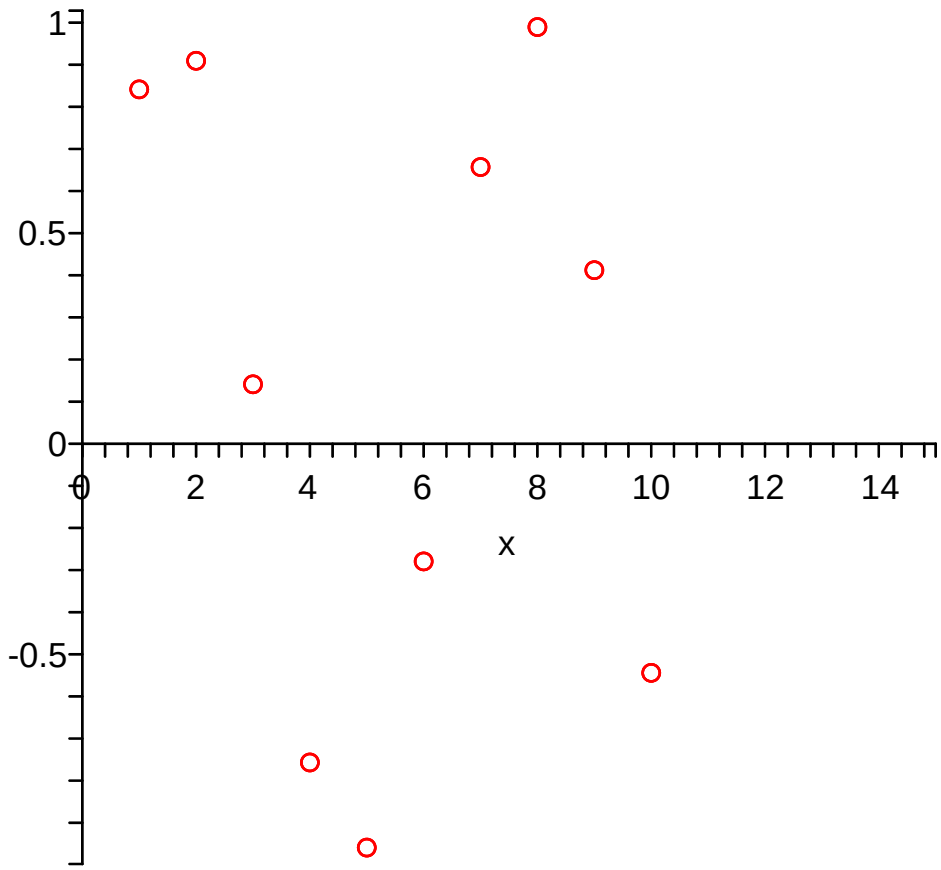
```
> C1:=plot(sin(x),x=-2*Pi..2*Pi,linestyle=1):
> C2:=plot(2*sin(2*x-Pi/2),x=-2*Pi..2*Pi,linestyle=3):
> display({C1,C2});
```



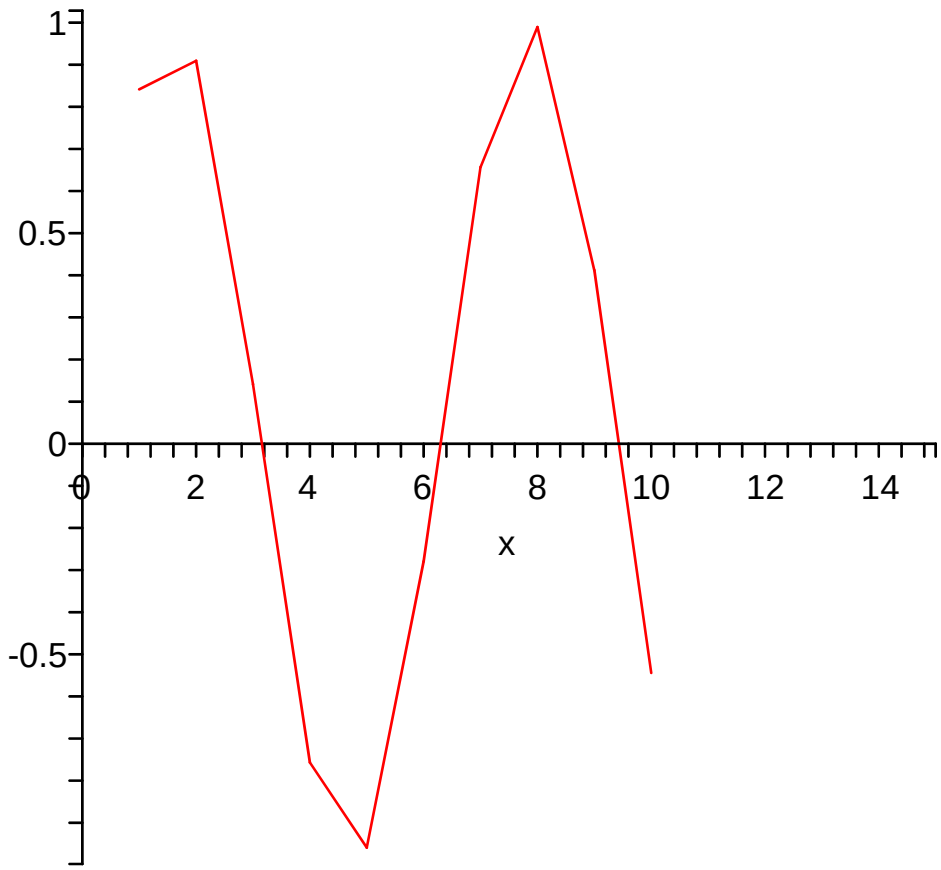
Here is a way to plot points and lines joining the points on two separate graphs

```
> points:=[[n,sin(n)]$n=1..10]:
```

```
> plot(points,x=0..15,style=point,symbol=circle);
```

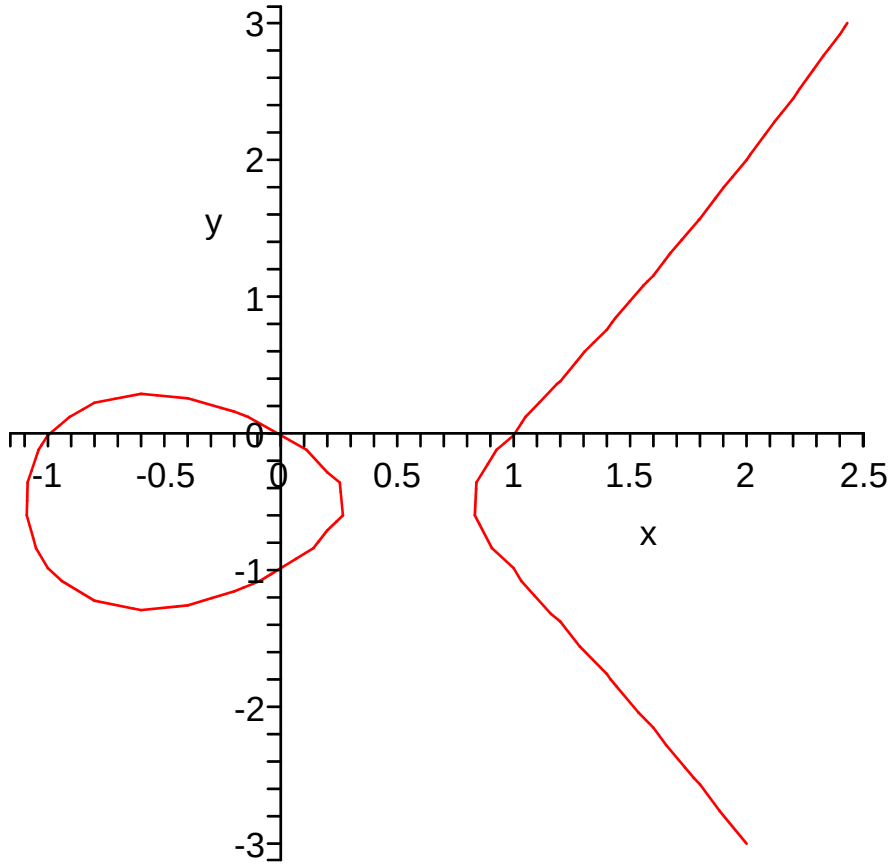



```
> plot(points,x=0..15,style=line);
```



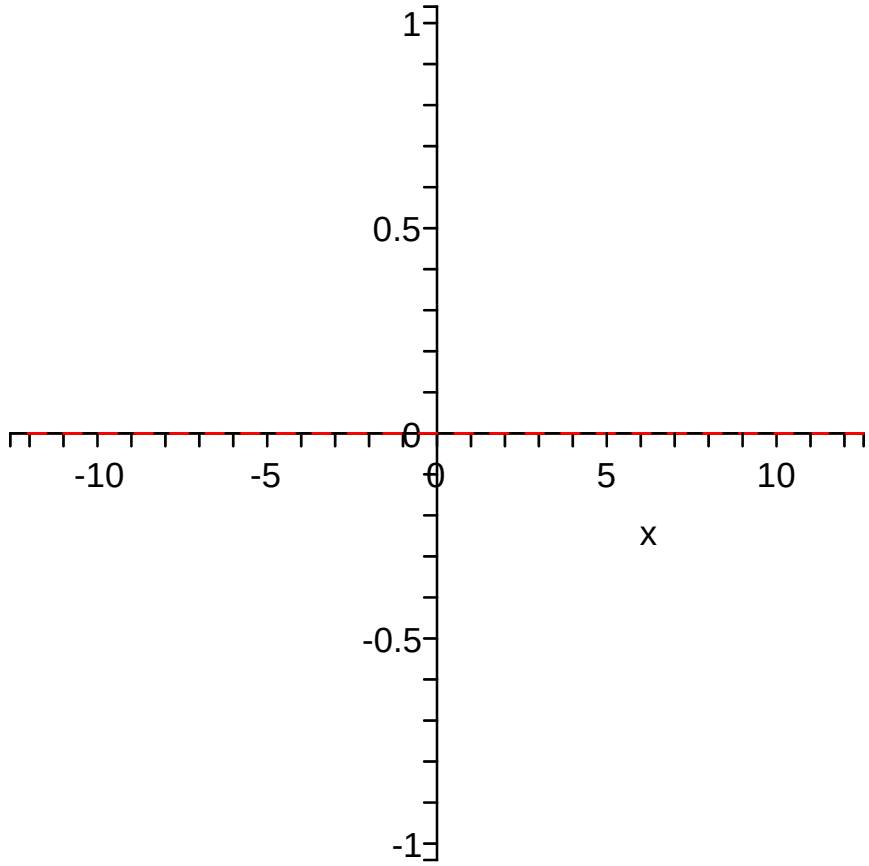
Here is an example of an implicit plot

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



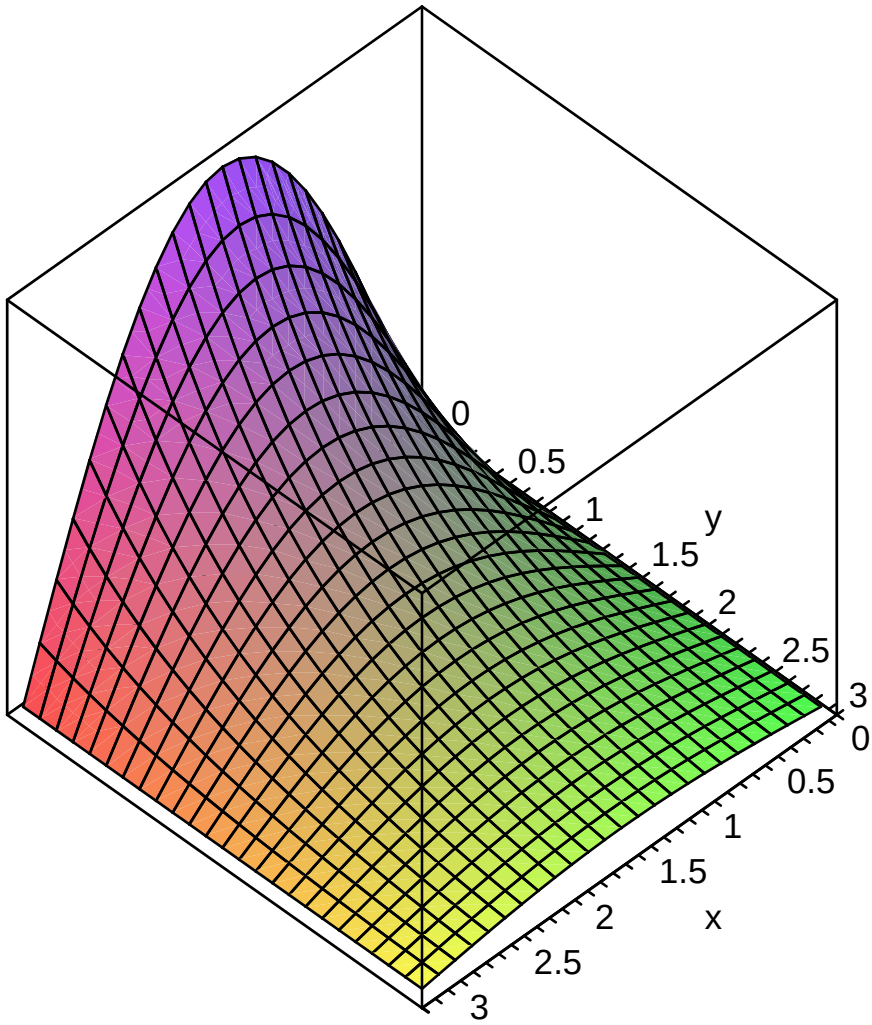
An example of animation

```
> animate(sin(x*t),x=-4*Pi..4*Pi,t=0..1,color=red);
```



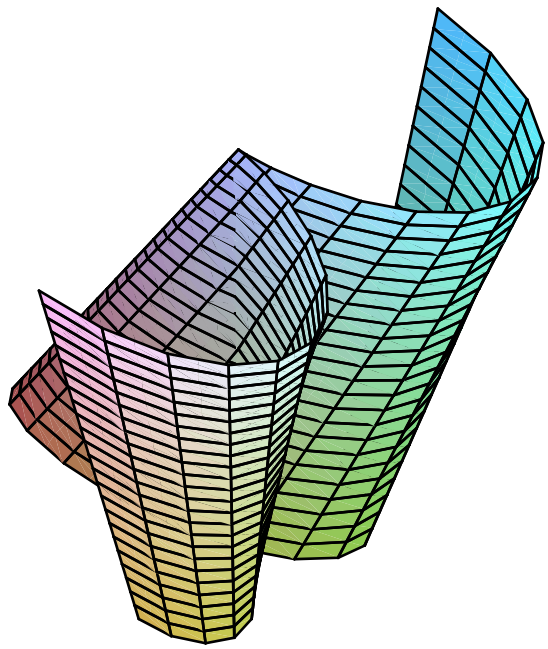
An example of a 3-D plot; You can rotate the figure with the left hand mouse

```
> plot3d(sin(x)*exp(-y),x=0..Pi,y=0..3,axes=boxed);
```



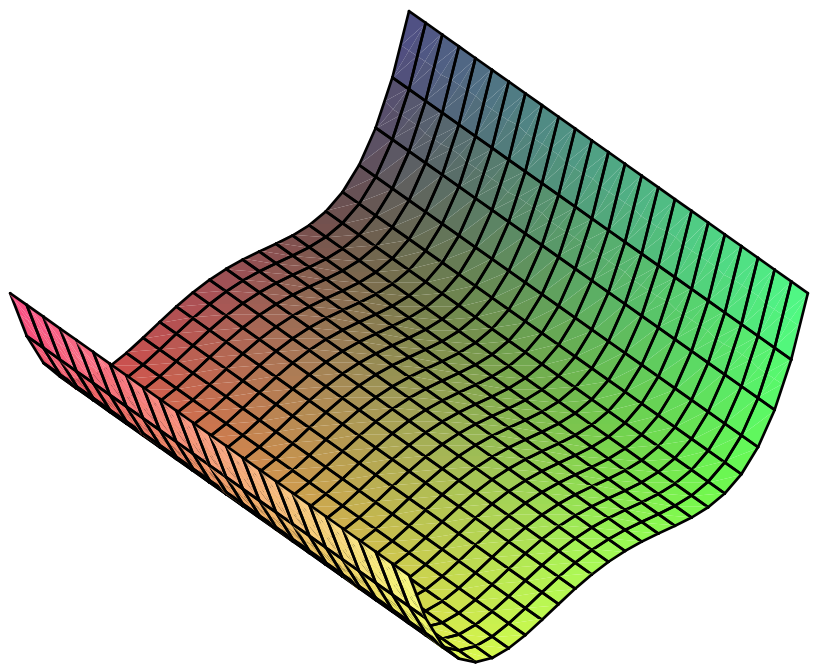
The plots package in Maple contain many other plotting commands. The only way to get to know some of them is to use the help system and play around with the examples provided. For example here is a plot given in cylindrical coordinates.

```
> cylinderplot(z+3*cos(2*theta),theta=0..Pi,z=0..3);
```



Another example of animation, but this one in 3-D.

```
> animate3d(t*y^2/2-x^2/2+x^4/4,x=-2..2,y=-2..2,t=0..2);
```



Now let us give some examples of solving certain differential equations and plotting slope fields using the differential equations package. For that you need to load the differential equations package into memory.

```
> with(DEtools):
```

Here is an example of solving the differential equation $\frac{d}{dx} y(x) = x$

```
> dsolve(diff(y(x),x)=x,y(x));
```

$$y(x) = \frac{1}{2} x^2 + \_C1$$

Here is an example of solving an initial value problem.

```
> dsolve({diff(v(t),t)+2*t=0,v(1)=5},v(t));
```

$$v(t) = -t^2 + 6$$

Here is an example of solving a second order linear differential equation.

```
> dsolve(diff(x(t),t$2)+8*diff(x(t),t)+25*x(t)=0,x(t));
```

$$x(t) = \_C1\, \mathbf{e}^{(-4\,t)} \sin(3\,t) + \_C2\, \mathbf{e}^{(-4\,t)} \cos(3\,t)$$

Another example

```
> dsolve(diff(x(t),t$2)+8*diff(x(t),t)+25*x(t)=t*exp(t),x(t));
```

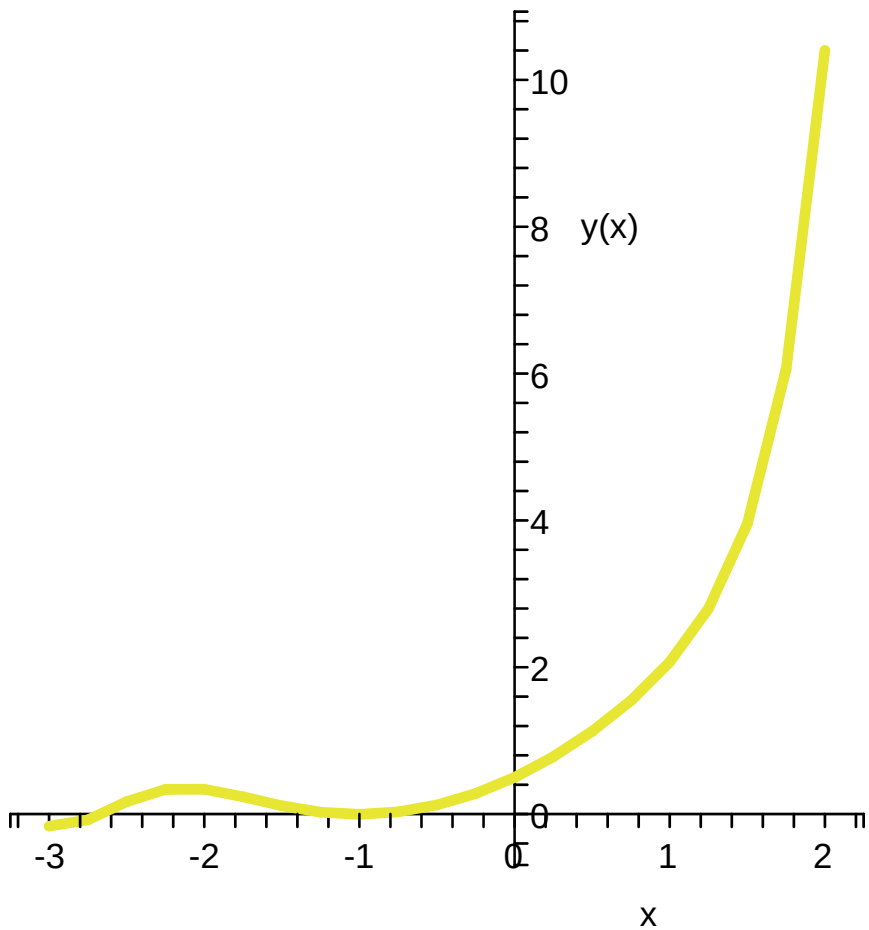
$$x(t) = \mathbf{e}^{(-4\,t)} \sin(3\,t)\, \_C2 + \mathbf{e}^{(-4\,t)} \cos(3\,t)\, \_C1 + \frac{1}{578} (-5 + 17\,t)\, \mathbf{e}^{t}$$

Now let us play around with the plots package. First we define differential equations then we use the DEplot command to plot certain solution curves and also slope fields and phase portraits.

```
> deqn:=diff(y(x),x$2)=x^3*y(x)+1;
```

$$deqn := \frac{d^2}{dx^2} y(x) = x^3\, y(x) + 1$$

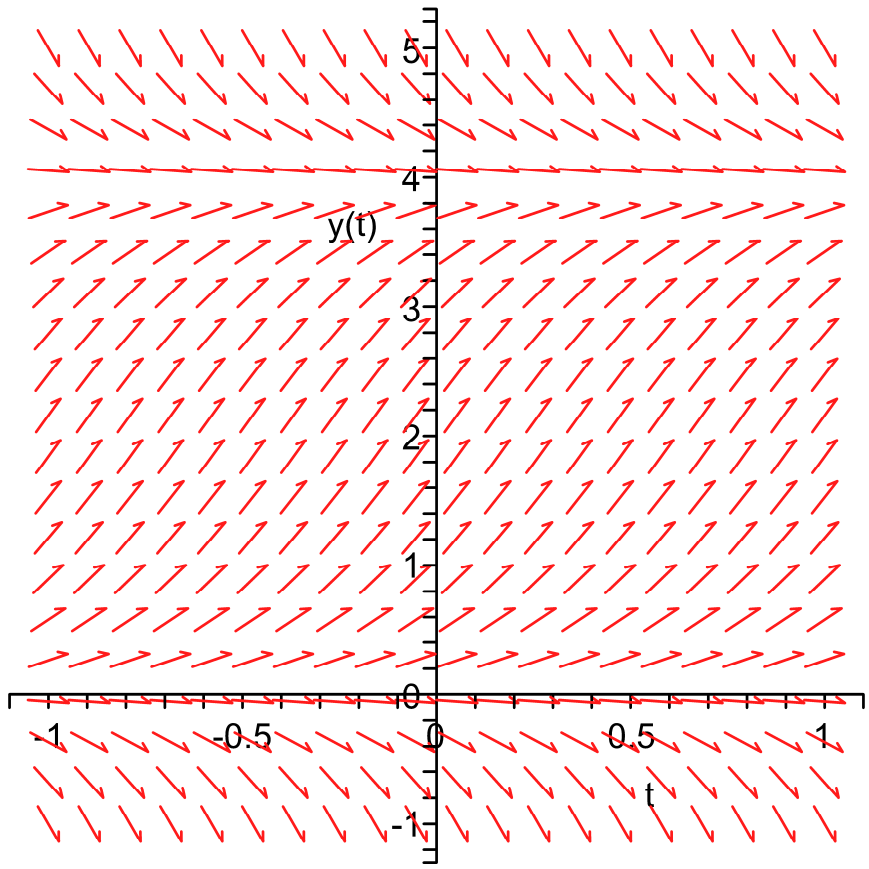
```
> DEplot(deqn,y(x),x=-3..2,[[y(0)=0.5,D(y)(0)=1]]);
```




```
> eq:=diff(y(t),t)=y(t)*(4-y(t));
```

$$eq := \frac{d}{dt}\, y(t) = y(t)\,(4 - y(t))$$

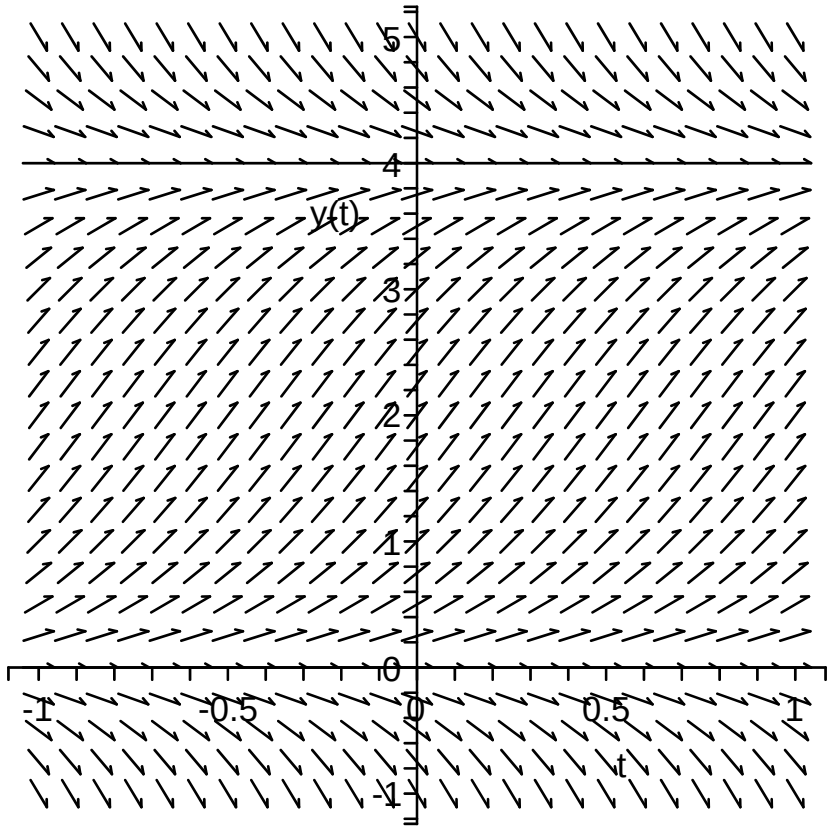
```
> DEplot(eq,y(t),t=-1..1,y=-1..5);
```



Here is the same command with more options

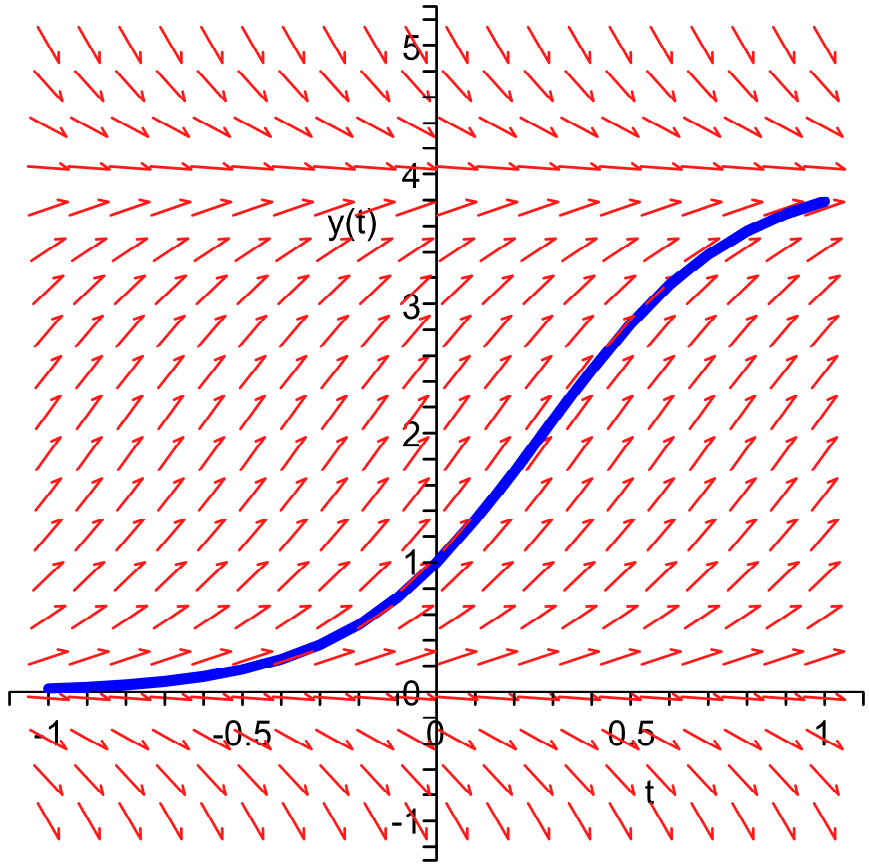
```
> DEplot(eq,y(t),t=-1..1,y=-1..5,title=`Direction
  Field`,color=black,dirgrid=[25,25]);
```

Direction Field



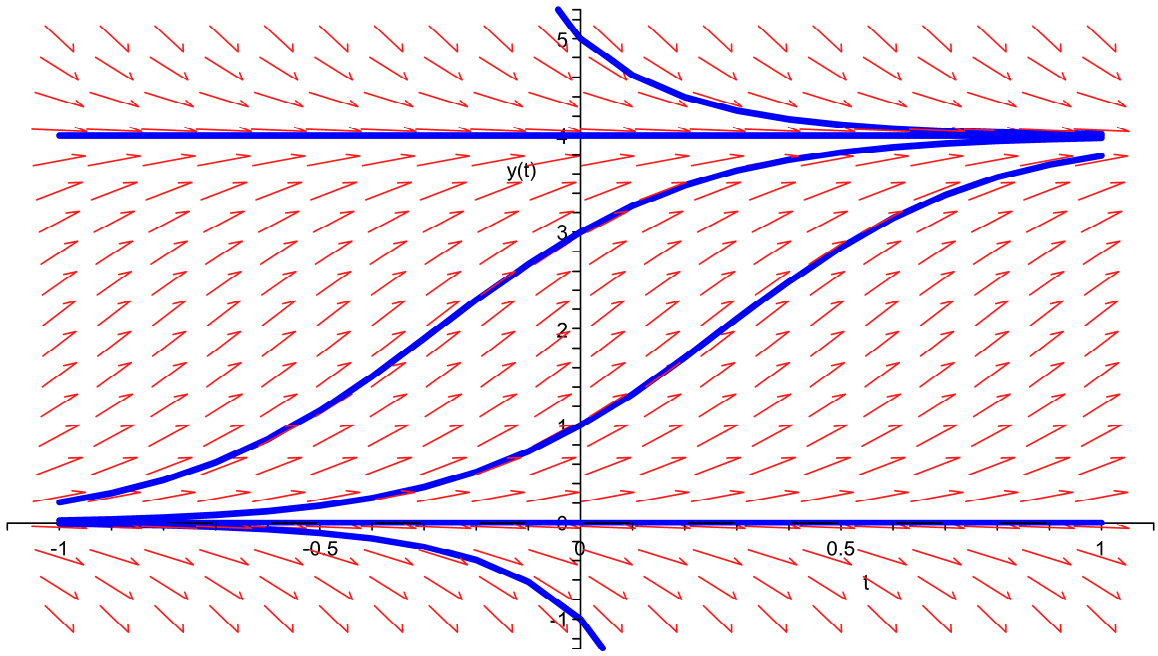
Let us add a solution curve to the direction field plot

```
> DEplot(eq,y(t),t=-1..1,[[y(0)=1]],y=-1..5,linecolor=blue);
```



Here is the same example with several solution curves plotted

```
> DEplot(eq,y(t),t=-1..1,[[y(0)=-1],[y(0)=0],[y(0)=1],[y(0)=3],[y(0)=4],[y(
  )=5]],y=-1..5,linecolor=blue);
```


y(t)
t
5
4
3
2
1
0
-1
-1
-0.5
0
0.5
1

>