Math 276
Calculus III

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Lesson 1

Numerical Computation and Graphics

Initialization

```
> restart;
  with(plots):
>
```

1.1 Numerical Computation

All arithmetic is exact, unless we explicitly ask for a decimal approximation using the **evalf** command.

Examples

Example 1.1.1

Rational numbers, large integers, trigonometric values and decimal approximations.

```
> n1:=(2/7)^4;
```

$$n1 := \frac{16}{2401} \tag{2.1.1.1}$$

```
> n2:=evalf(n1);
```

$$n2 := 0.006663890046 \tag{2.1.1.2}$$

```
> n3:=73491097^6;
```

$$n3 := 157546362627224319599041649399034062211350126929 \tag{2.1.1.3}$$

```
> n4:=cos(Pi/6);
```

$$n4 := \frac{1}{2}\sqrt{3} \tag{2.1.1.4}$$

```
> n5:=evalf(n4);
```

$$n5 := 0.8660254040 \tag{2.1.1.5}$$

```
>
```

Example 1.1.2

Decimal approximations of arbitrary length.

Decimal approximations of arbitrary length can be obtained by specifying the desired number of significant digits as an option in the **evalf** command. The default is ten significant digits. Here are the first 30 digits of π.

```
> n6:=evalf(Pi, 30);
```

$$n6 := 3.14159265358979323846264338328 \tag{2.1.2.1}$$

Example 1.1.3

Non-trivial trigonometric values.

Some non-trivial trigonometric values can be found by using the convert to radical routine.

```
> n7:=cos(Pi/24);
```

$$n7 := \cos\left(\frac{1}{24}\pi\right) \qquad (2.1.3.1)$$

```
> n8:=convert(n7, radical);
```

$$n8 := \frac{1}{4}\sqrt{8+2\sqrt{6}+2\sqrt{2}} \qquad (2.1.3.2)$$

```
>
```

1.2 Graphics

Maple contains an extensive array of plotting routines, most of which can be found in the **plots** package which is loaded using the

with(plots);

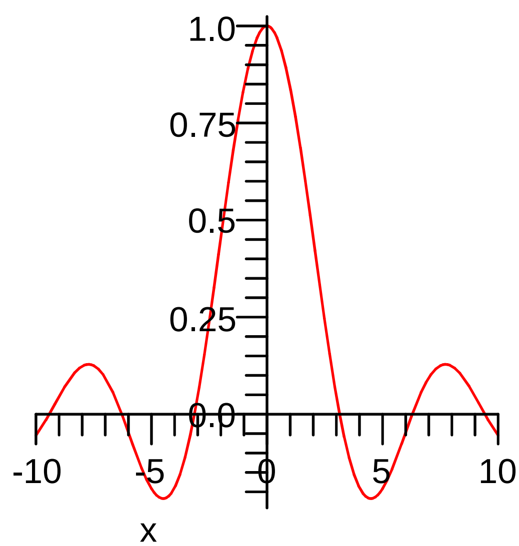
command. Only the basic **plot** and **plot3d** routines can be used without using loading the **plots** package.

Examples

Example 1.2.1

The **plot** command.

```
> plot(sin(x)/x, x=-10..10);
```



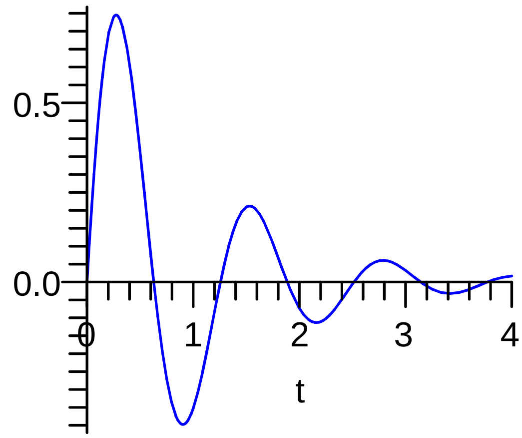

```
>
```

Example 1.2.2

Using the **color** option with the **plot** command.

We visualize a damped oscillation and color it blue.

```
> plot(exp(-t)*sin(5*t), t=0..4, color=blue);
```



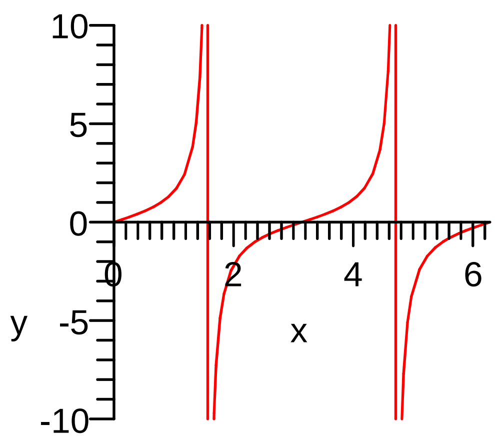
>

Example 1.2.3

Limiting the range of a plot.

Sometimes it is desirable to limit the range of a plot. This feature is particularly useful when vertical asymptotes lie within the domain of the graphic image.

```
> plot(tan(x), x=0..2*Pi, y=-10..10);
```



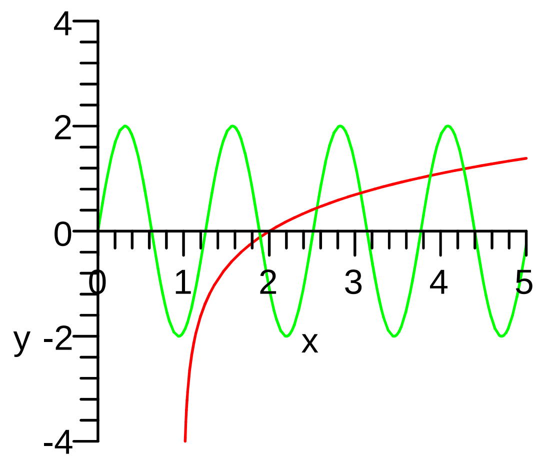
>

Example 1.2.4

Multiple plots in one picture.

We can create multiple plots within one frame by using Maple set notation **{ ... }** or list notation **[...]**.

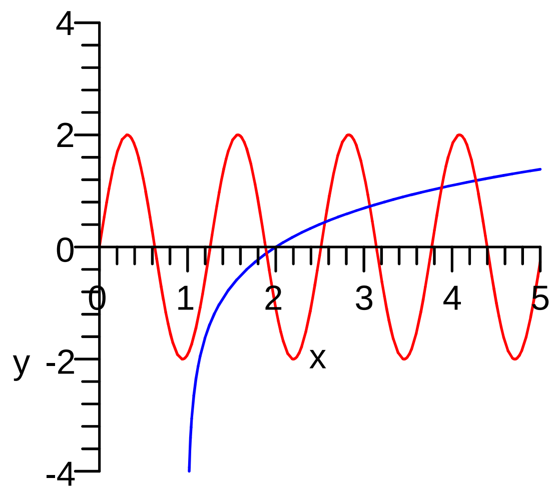
```
> plot({ln(x-1), 2*sin(5*x)}, x=0..5, y=-4..4);
```



Observe that the function $\ln(x-1)$ is only defined for $x > 1$.

The advantage of list notation is that it allows for control of the color of individual curves.

```
> plot([ln(x-1), 2*sin(5*x)], x=0..5, y=-4..4, color=[blue,
  red]);
```



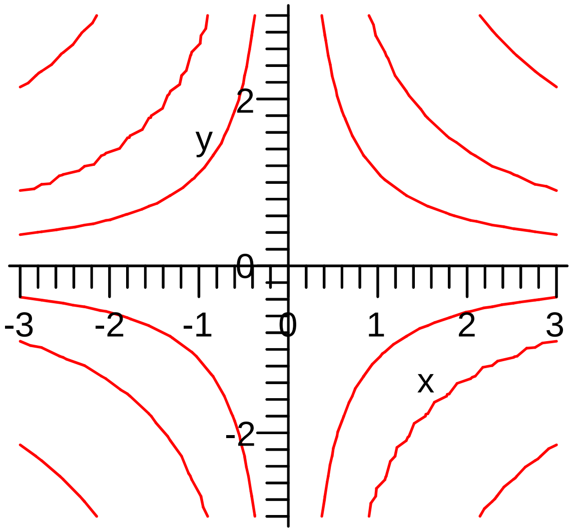

```
>
```

Example 1.2.5

The visualization of an implicitly defined curve.

The **implicitplot** routine is located in the **plots** package which must be loaded in advance. It is handy to include the **with(plots):** command in your initializations section.

```
> implicitplot(x*y*sin(x*y)=1, x=-3..3, y=-3..3);
```



>

Example 1.2.6

The visualization of a surface in three dimensional space.

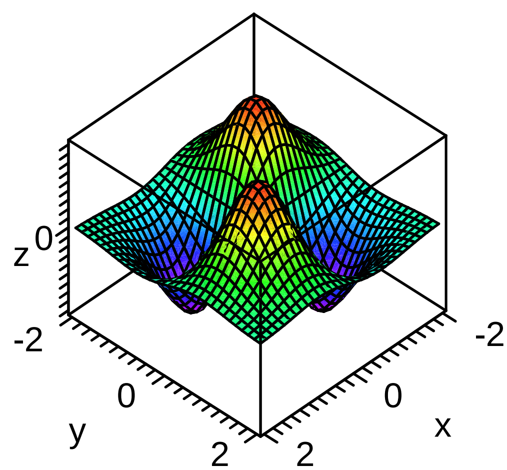
Maple is capable of creating images of surfaces in three space. This is a feature that will be used extensively later in the course. As an example we visualize the surface

$$z = x\,y\,\mathrm{e}^{-x^2 - y^2}$$

```
> f:=(x,y)->x*y*exp(-x^2-y^2);
```

$$f := (x, y) \rightarrow x\,y\,\mathrm{e}^{-x^2 - y^2} \qquad (3.1.6.1)$$

```
> plot3d(f(x, y), x=-2..2, y=-2..2, axes=boxed, labels=[x,y,
  z], numpoints=900, shading=ZHUE, orientation=[44,45]);
```



>