

Math Software – Calculus

Limits

Maple has the ability to calculate limits. We can evaluate limits at either a point or at infinity. See the following examples The first is

$$\lim_{x \rightarrow 1} \frac{x^2 - 1}{x - 1}.$$

Here we would use the Maple command

```
[> limit((x^2 - 1)/(x - 1), x = 0);
```

in which maple would return

2.

The second is

$$\lim_{x \rightarrow \infty} \frac{e^x - 1}{e^x + 1}.$$

Here we would use the Maple command

```
[> limit((exp(x) - 1)/(exp(x) + 1), x = infinity);
```

in which maple would return

1.

Not all limits exists, for example consider

$$\lim_{x \rightarrow \infty} \frac{x^3 - 1}{x - 1}.$$

Here we would use the Maple command

```
[> limit((x^3 - 1)/(x - 1), x = infinity);
```

in which maple would return

∞ .

We can also approach from two different sides. For example, we could approach from the left or right. Here we would use the commands

[> *limit*(($x^3 + 1$)/($x - 1$)), $x = 1$, *left*);

[> *limit*(($x^3 + 1$)/($x - 1$)), $x = 1$, *right*);

in which Maple would give $-\infty$ and ∞ respectively.

Derivatives

Maple has the ability to calculate derivatives. The command is *diff*. For example

[> *diff*(x^2 , x);

maple gives

$$2x$$

or [> *diff*($\sin(x) * y$, x);

maple gives

$$\cos(x)y$$

For second and higher order derivatives (either ordinary or partial) we use the command

[> *diff*($x^3 * y^2 + 1/x/y^3$, x, y);

maple gives

$$6x^2y + \frac{3}{x^2y^4}$$

For higher order derivatives we can also use a \$ sign, i.e.

[> *diff*($f(x)$, $x\$4$);

maple gives

$$\frac{d^4}{dx^4}f(x)$$

Maple sometimes uses a D to denote derivatives. To convert to the *diff* format use the maple command *convert*. For example

[> *convert*($D[1](f)(x)$, *diff*);

maple gives

$$\frac{d}{dx}f(x)$$

Integrals

Maple can also integrate. Here we use the *int* command. For example, to calculate the indefinite integral

$$\int x^2 dx,$$

[> int(x², x);

maple gives

$$\frac{x^3}{3}.$$

Please note that maple doesn't include the constant of integration. This is something that you need to do manually. To calculate the definite integral

$$\int_0^3 x^2 dx,$$

[> int(x², x = 0..3);

maple gives

$$3.$$

For multiple integral, it is necessary to nest the *int* command. So to evaluate

$$\iint 4xy dx dy$$

we would type

[> int(int(4 * x * y, x), y);

maple gives

$$x^2y^2$$

with again, no constants of integration.

Problems

1. If $y = x^3 + 3 * x^2 + 4 * x - 3$, find (i) the derivative of y , (ii) the derivative of y at $x = 1$ and then (iii) the equation of the tangent at $x = 1$. Plot both the function and its tangent.
2. Graph the curve $y = x^3 - 4x$ and find the area under the curve on the interval $[-2, 2]$.
3. Integrate the function $y = x \sin x$ on the interval $[0, \pi]$ and in general.
4. Calculate $\frac{\partial^4 z}{\partial^3 x \partial y}$ where $z = x^4 y^2 - x^3 - y^4$.
5. Find the following double integral $\iint 6x^2y - 4x \cos x - 7ye^y dx dy$.