# 1. A brief Introduction to Maple

Here we give a selection of maple commands.

**assign**

If we type the following

$[> \ a := 1;$

maple returns

$$1$$

and every time we type

$[> \ a;$

maple returns

$$1$$

If we further type

$[> \ b := 2;$

maple returns

$$2$$

and if suppose we type

$[> \ a + b;$

maple returns

$$3$$

**unassign**

Sometimes we wish to then unassign variables. Here we use the command

$[> \ a :=' a ';$

(single quotes) then maple returns

$$a$$

and the variable $a$ has been unassigned. It should be noted that the maple command **restart** would also work but would unassign all variables (and undo all of your work!)

## *Expressions*

Sometimes we would like to group a bunch of terms. Here we can also use the assign command. For example

$[> \ expr := x * y + y^2;$

maple returns

$$expr := x\ y + y^2$$

and every time we type

$[> \ expr;$

maple returns

$$x\ y + y^2$$

and any operation with $expr$ would replace $expr$ with $x\ y + y^2$. So, for example

$[> \ expr^2 + x;$

maple returns

$$\left(x\ y + y^2\right)^2 + x$$

**expand**

Sometimes we wish to expand an expression. Here we us the following command.

$[> \ expand(expr^2 + x);$

were maple returns

$$x^2\ y^2 + 2\ x\ y^3 + y^4 + x$$

**factor**

Sometimes we wish to factor an expression. The command we use is

$[> \ factor(x^2 + 2x + 1);$

were maple returns

$$(x + 1)^2$$

**simplify**

Sometimes we wish to simplify expressions. The command here is.

$[> \ simplify(sin(x)^2 + cos(x)^2);$

were maple returns

$$1$$

This is especially helpful using trig functions.

**subs**

Sometimes we wish to make a substitution into an expression. For example, suppose we wish to substitute $x = 3$ into $expr$ above. If we were to assign $x = 3$, this would fix $x$. However we can use the **subs** command to make a single substitution with assigning $x$. This is done with the following command.

$[> \ subs(x = 3, expr);$

maple then returns

$$3\,y + y^2$$

and if we were to type $expr$, maple would return

$$x\,y + y^2$$

**collect**

Sometimes we wish to group terms in an expression according to a particular variable. For example, consider the following expression.

$$x\,y^3 + y^3 + y\,x^2 - 2\,x\,y + 6\,x$$

If we wanted to group the terms according to $x$ or $y$ we would use the **collect** command. To collect in terms of $x$

$[> \ collect(expr, x);$

maple then returns

$$y\,x^2 + (y^3 - 2\,y + 6)\,x + y^3$$

or to collect in terms of $y$

$[> \ collect(expr, y);$

then maple would return

$$(x + 1)\,y^3 + (x^2 - 2\,x)\,y + 6\,x$$

**op**

Sometimes we wish to extract a particular term from within an expression. For example consider

$$x^2\,y + x - 2\,y^4 - 3\,x^3$$

Suppose we wish to obtain the 3rd term. To do this we use the following command

$[> \ op(3, \%);$

maple then returns

$$-2\ y^4$$

noting that in maple, the symbol % means "the expression above"

**coeff**

Sometimes we wish to extract a particular group of terms from within an expression. For example, consider

$$expr := x^2\ y + x\ y - 2\ y^4 - 3\ x^3\ y^4 + x;$$

and we wanted the obtain the terms that multiply $y$. We could **collect** in terms of $y$, then use the **op** command to obtain the $y$ terms, then divide by $y$. However, we can use the **coeff** command to do this. i.e.

$[> \ coeff(expr, y);$

maple then returns

$$x^2 + x$$

or to obtain the terms multiply by $y^4$, we would use

$[> \ coeff(expr, y^4);$

maple then returns

$$-2 - 3\ x^3$$

If you want the answer in descending order, use the command

$[> \ sort(\%);$

where maple would return

$$-3\ x^3 - 2$$

**nops**

Sometimes we wish to determine the number of terms in an equation. For example, consider the following expression.

$[> \ expr := (x + y)^{15};$

$$expr := (x + y)^{15}$$

$[> \ expand(\%);$

$$x^{15} + 15yx^{14} + 105y^2x^{13} + 455y^3x^{12} + 1365y^4x^{11} + 3003y^5x^{10}$$
$$+5005y^6x^9 + 6435y^7x^8 + 6435y^8x^7 + 5005y^9x^6 + 3003y^{10}x^5$$
$$+1365y^{11}x^4 + 455y^{12}x^3 + 105y^{13}x^2 + 15y^{14}x + y^{15}$$

To have maple count the number of terms, we use

$[> \ nops(\%);$

in which maple would return

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This command is particularly useful if you have say, three large equations to solve and you'd like to choose the one with the least amount of terms.

## *Functions*

Maple has the standard functions. For example, the trig functions $sin(x)$,$cos(x)$, $tan(x)$, $cot(x)$, $sec(x)$ and $csc(x)$. It has all the inverse trig functions, $arcsin(x)$, $arccos(x)$, $arctan(x)$, $arccot(x)$, $arcsec(x)$ and $arccsc(x)$. It has $exp(x)$ and $ln(x)$. In fact there are so many, we won't list all of them here.

Sometimes we want to define a certain function. For example, $y = x^2$. In maple, we can use function notation and define the function as

$[> \ f := (x) - > x^2;$

in which maple would return

$$f := x \rightarrow x^2$$

Then, any time we type $f(x)$ maple returns $x^2$. So for example

$[> \ (f(x+h) - f(x))/h;$

maple gives

$$\frac{(x+h)^2 - x^2}{h}$$

If we want functions of more than one variable, say $x$ and $y$ then

$[> \ f := (x,y) - > x^2 * y + x + y;$

in which maple would return

$$f := (x,y) \rightarrow x^2\, y + x + y$$

## *Solving equations*

Maple can solve equations (and some systems). For example,

$[> \ solve(x^2 * y + 2 * y - x, y);$

would give

$$\frac{x}{x^2+2}$$

while

$[> \ solve(x^2 * y + 2 * y - x, x);$

would give

$$\frac{1 \ + \ \sqrt{1-8\,y^2}}{2\,y}, -\frac{-1 \ + \ \sqrt{1-8\,y^2}}{2\,y}$$

For systems, we use the same command. Suppose we wish to solve the system of equations

$$\begin{aligned} 4x + 3y &= 10 \\ 3x - y &= 1 \end{aligned}$$

then we would use the command

$[> \ solve(\{4x + 3y = 10, 3x - y = 1\}, \{x, y\});$

would give

$$\{x = 1, y = 2\}$$

We could have achieved the same result by the command

$[> \ solve(\{4x + 3y - 10, 3x - y - 1\}, \{x, y\});$

where maple would assume that each equation is set to zero.

If we were to assign these values, we would use the **assign** command

$[> \ assign(\%);$

To unassign we could use the **unassign** command

$[> \ unassign(`x`, `y`);$

Sometimes it is necessary to solve equations numerically. This is done with the command **fsolve** a floating point solver. For example,

$[> \ fsolve(x - \cos(x) = 0, x);$

would give

.7390851332.

If there is more than one solution, we can give the range. For example,

$[>\ \ fsolve(x^5 - 3 * x^3 - 1 = 0, x = 1..\ 2);$

would give

$$1.782308780.$$

If we used just **fsolve** it would give us all three.

**Assignment**

1. Factor $x^4 - 2\,x^3 - 13\,x^2 + 14\,x + 24$.
2. Expand $(x + 2y)^{18}$ and find the coefficient of the term $x^{10}y^8$.
3. Solve $x^3 + x - 1 = 0$ numerically for $x$.
4. Collect the following according to $t$

$$x^2yt^3 + 2tx + 6y + 4xt^2 - 6t^3 + zt - 7yt^2 + z^3$$

5. Solve the following system for $x, y$ and $z$

$$\begin{aligned} x + y + z &= 2, \\ 2x - y + z &= 7, \\ x - 3y + z &= 10. \end{aligned}$$