A Maple Primer

```
to run maple in unity type
```
add maple
xmaple &

you will get window called Untitled(1) - [Server 1] or similar. This is where you type maple commands.

a comment starts with a

all commands must end with a semicolon or a colon. Expressions are assigned to names with the symbol := Don't forget the colon! Here is an example

```
> f := sin(x);
```

$$f := \sin(x)$$

typing f; again shows what it is:

```
> f;
```

$$\sin(x)$$

let's do another

```
> g := exp(-x*x);
```

$$g := \mathbf{e}^{(-x^2)}$$

ok, let's manipulate them

```
> h := f+g;
```

$$h := \sin(x) + \mathbf{e}^{(-x^2)}$$

```
> h2 := f/g;
```

$$h2 := \frac{\sin(x)}{\mathbf{e}^{(-x^2)}}$$

```
> h3 := sqrt(f)*g;
```

$$h3 := \sqrt{\sin(x)}\, \mathbf{e}^{(-x^2)}$$

to differentiate use diff(fcn,argument). Eg

```
> diff(h3,x);
```

$$\frac{1}{2} \frac{\mathbf{e}^{(-x^2)} \cos(x)}{\sqrt{\sin(x)}} - 2 \sqrt{\sin(x)}\, x\, \mathbf{e}^{(-x^2)}$$

sometimes the command simplify() helps. Note that it you forget to assign

a name to an expression (as I just did) you can still refer to it with "

```
> simplify(");
```

$$-\frac{1}{2}\frac{\mathbf{e}^{(-x^2)}(-\cos(x)+4\sin(x)x)}{\sqrt{\sin(x)}}$$

ever wonder what 40 factorial is?

```
> 40!;
>
```

$$815915283247897734345611269596115894272000000000$$

how about the 40'th digit in pi?

```
> evalf(Pi,40);
```

$$3.141592653589793238462643383279502884197$$

notice that the number pi is refered to as Pi. The function evalf() returns
actual numbers instead of symbolic expressions.

```
>
```

say that you have been asked by a perverse professor to evaluate the integral
of exp(-x*sin(x)) between 0 and 8. Maple to the rescue!

```
>
```

lets call the expression f to save typing

```
> f := exp(-x*sin(x));
```

$$f := \mathbf{e}^{(-\sin(x)\,x)}$$

#let's try to integrate it. This is done in maple with the int(expr,argument=lower limit .. upper limit) command.

```
> int(f,x=0..8);
```

$$\int_0^8 \mathbf{e}^{(-\sin(x)\,x)}\,dx$$

when maple comes back with what you entered, it means maple couldn't do
the integral. We need to work some more. But before we do let's make sure
that integrating actually works

```
>
> int(sin(x),x);
```

$$-\cos(x)$$

```
> int(sin(x),x=0..a);
```

$$-\cos(a)+1$$

the parameter 'a' above is general and so the integral is not evaluated

```
>
> int(sin(x),x=0..2);
```

$$-\cos(2)+1$$

#still not evaluated. You need to use evalf():

```
> evalf(");
```

$$1.416146837$$

a harder example

```
> int(x^3/(1+x+x*x),x);
```

$$-x+\frac{1}{2}x^2+\frac{2}{3}\sqrt{3}\ \arctan\left(\frac{1}{3}(2x+1)\sqrt{3}\right)$$

starting to look good! Back to our example. If maple chokes and you are
interested in a numerical answer you can have maple numerically
calculate the integral!

```
> g:= int(f,x=0..8);
```

$$g := \int_0^8 \mathbf{e}^{(-\sin(x)\,x)}\,dx$$

```
> evalf(g);
```

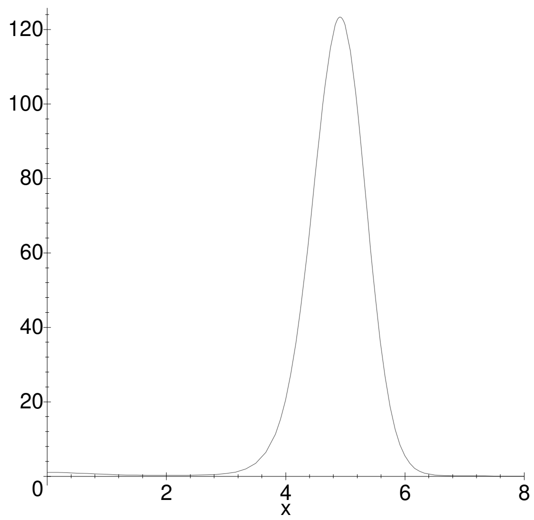
141.6516070

so its 141.65

```
>
```

let's see if that is reasonable by plotting the integrand

```
> plot(f,x=0..8);
```



doesn't look bad (Note: the function get's huge bumps at half integer
multiples of pi where sin(x) = -1 so that exp(-xsin(x)) gets very large there!

```
>
```

say you wanted something more analytical. We could try making a Talyor
expansion of f about x=0 and integrating that:

```
> h := series(f,x=0,8);
```

$$h := 1-x^2+\frac{2}{3}x^4-\frac{41}{120}x^6+\mathrm{O}(x^8)$$

the 8 means get the series up to O(x^8)
Now integrate that

```
> h2 := int(h,x);
>
```

$$h2 := x - \frac{1}{3}x^3 + \frac{2}{15}x^5 - \frac{41}{840}x^7 + O(x^9)$$

```
>
```

and evaluate this between 0 and 8. The "O(x^9)" wrecks things so you
have to convert the series to a polynomial first

```
> h3 := convert(h2,polynom);
```

$$h3 := x - \frac{1}{3}x^3 + \frac{2}{15}x^5 - \frac{41}{840}x^7$$

now substitute x=8 in the expresion (you could also just type x:=8, but this
is more general)

```
> subs(x=8,h3);
```

$$\frac{-10306232}{105}$$

```
> evalf(");
```

$$-98154.59048$$

Well that sure didn't work. But is not too surprising given how the function looks!

a few other things of use before finishing are forming a series solution to
a differential equation and solving a system of equations

say you want to solve y' = sin(x)y for small x and a boundary condition y(0)=1. The following does this for you

```
> g := convert(series(sin(x),x=0,8),polynom);
```

$$g := x - \frac{1}{6}x^3 + \frac{1}{120}x^5 - \frac{1}{5040}x^7$$

```
> with(powseries):
> a := powsolve(diff(y(x),x)=g*y(x),y(0)=1):
> tpsform(a,x);
```

$$1 + \frac{1}{2}x^2 + \frac{1}{12}x^4 + O(x^6)$$

note that we had to put the series expansion of sin into the differential
equation. Looks like a maple bug to me.... Also I ended the above commands
with a colon. This means don't print the results to the screen.
lets check the answer

```
> series(exp(-cos(x)+1),x=0);
```

$$1 + \frac{1}{2}x^2 + \frac{1}{12}x^4 + O(x^6)$$

OK!
>
lastly one often has a rather large linear set of equations to solve which
#can be tedious
#
say we want to solve   3x + 5y = 10
and -2x + 14 y = 12
for x and y.

```
> s := solve({3*x+5*y=10,-2*x+14*y=12},{x,y});
```

$$s := \{ y = \frac{14}{13}, x = \frac{20}{13} \}$$

```
> assign(s);
> x;
```

$$\frac{20}{13}$$

```
> y;
```

$$\frac{14}{13}$$

and there you have it!
Note we should really check that the problem is invertible (although I am
sure that maple would complain if it weren't)

```
> A := linalg[matrix](2,2,[3,5,-2,14]);
```

$$A := \begin{bmatrix} 3 & 5 \\ -2 & 14 \end{bmatrix}$$

```
> det(A);
```

$$52$$

```
>
>
```

Maple is a huge programming environment and you can do many more things
with it (like make 3d plots, animate functions, solve difference equations,
analytically evaluate sums, and write procedures). But this
should be enough to get you started (with plenty of assistance from the
Help button).