Using *Mathematica* in Calculus

To start a *Mathematica* session when you are at a UNIX level you type "Mathematica" (without the quotes). If you have the software installed on your own machine you probably just click on the *Mathematica* icon. Here are some examples from calculus

Differentiation: Suppose you want to differentiate the function $\sin x$ with respect to x. In *Mathematica* you type

```
D[Sin[x],x]
```

and hit the return button. Note that the sine function begins with a capital letter and the dependence on x is given with square brackets. Here is what it looks like in a *Mathematica* session

```
In[1]:= D[Sin[x], x]

Out[1]= Cos[x]
```

Suppose we want to define a more complicated function, say

$$f(x) = e^{-2x}\cos(3x) + a\,e^{-x}\sin(x)$$

and differentiate it with respect to x treating the number a as a constant. Here is how it is done in *Mathematica*

```
In[2]:= f[x_] := Exp[-2*x]*Cos[3*x] + a*Exp[-x]*Sin[x]

In[3]:= D[f[x], x]

Out[3]= a E^(-x) Cos[x] - 2 E^(-2 x) Cos[3 x] - a E^(-x) Sin[x] - 3 E^(-2 x) Sin[3 x]
```

except it looks better on my screen. Note how the function $f(x)$ is defined in *Mathematica* . Here is another example of defining a function now of the two variables x and y: Suppose

$$f(x,y) = \sin(x)\cos(y) + x^2 + \sqrt{y}$$

In *Mathematica* we type

```
f[x_, y_] := Sin[x]*Cos[y] + x^2 + Sqrt[y];
```

Integration: Suppose we want to do the integral

$$\int_0^\infty \frac{1}{1+x^2}\,dx$$

We type

```
In[5]:= Integrate[1/(1 + x^2), {x, 0, Infinity}]
```

Hitting the return key we get $\frac{\pi}{2}$ as output. Suppose instead we wanted

$$\int_0^\infty \frac{1}{1+x^{100}}\,dx$$

Then we simply change the *Mathematica* input to

```
Integrate[1/(1+x^100),{x,0,Infinity}]
```

and *Mathematica* returns the result

$$\frac{\pi}{100}\,\csc(\frac{\pi}{100})$$

Mathematica can do the general case

$$\int_0^\infty \frac{1}{1+x^a}\,dx$$

but we have to tell it that $a > 1$:

```
Integrate[1/(1 + x^a), {x, 0, Infinity}, Assumptions -> {a > 1}]
```

Mathematica returns the result

$$\frac{\pi}{a}\csc\left(\frac{\pi}{a}\right)$$

Taylor (Power) Series: Suppose we are asked to write the Taylor (power) series for

$$f(x) = \sqrt{\frac{\sin x}{x}}$$

about $x = 0$ to order x^5. In *Mathematica* we type and get the result

```
In[11]:= Series[Sqrt[Sin[x]/x],{x,0,5}]
Out[11]= 1-x^2/12+x^4/1440+O[x]^6
```

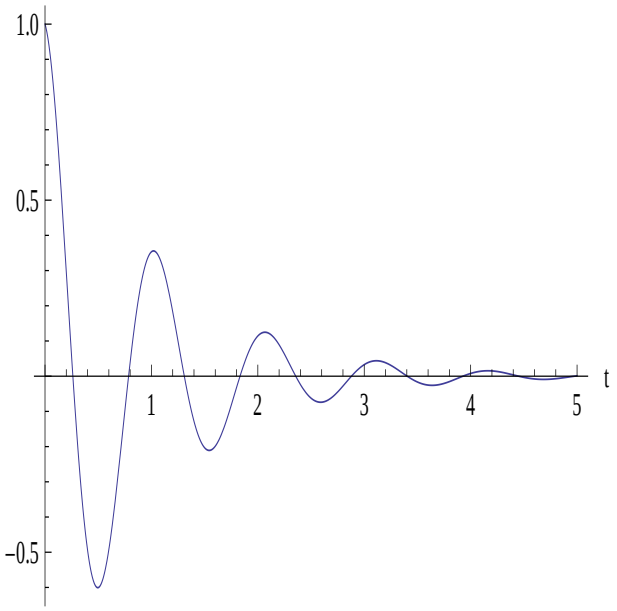

Figure 1: This is what *Mathematica* returned when plotting $e^{-t}\cos(6t)$.

Graphing Suppose we wish to graph the function

$$f(t) = e^{-t}\cos(6t)$$

as a function of t in the interval $0 \leq t \leq 5$. In *Mathematica* one writes

```
Plot[Exp[-t]*Cos[6t],{t,0,5},PlotRange->All]
```

Then the plot returned is shown at the top of this page.