Math 171 Tutorial

Limit at finite number

```
var("s")
f(s) = (exp(3*s)-1)/sin(4*s)
flim = limit(f(s), s=0); show(flim)
```

$$\frac{3}{4}$$

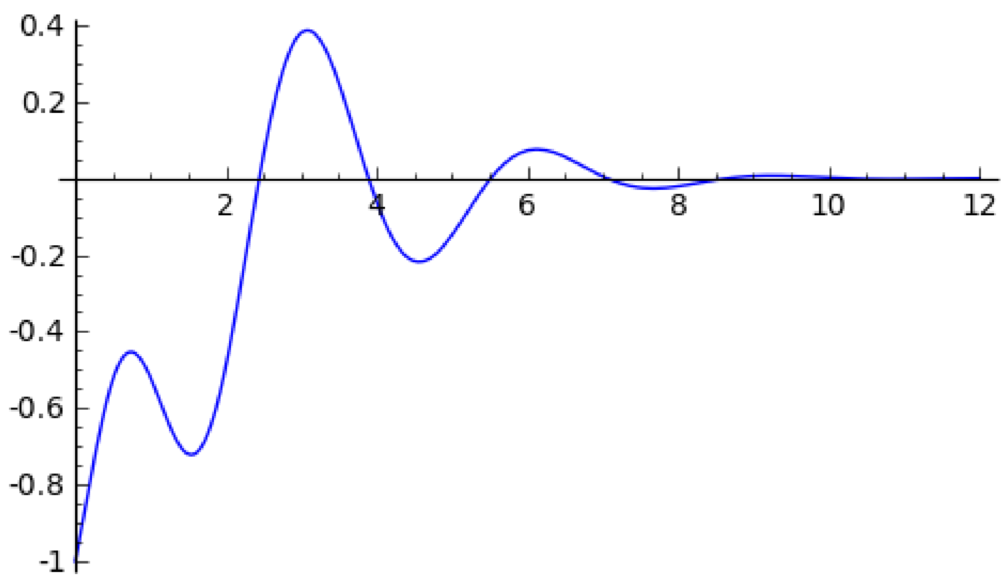
Limit at infinity

```
var("t")
g(t) = (t^3-3*t^2+6*t)/(7*t^3+9)
glim = limit(g(t), t=infinity); show(glim)
```

$$\frac{1}{7}$$

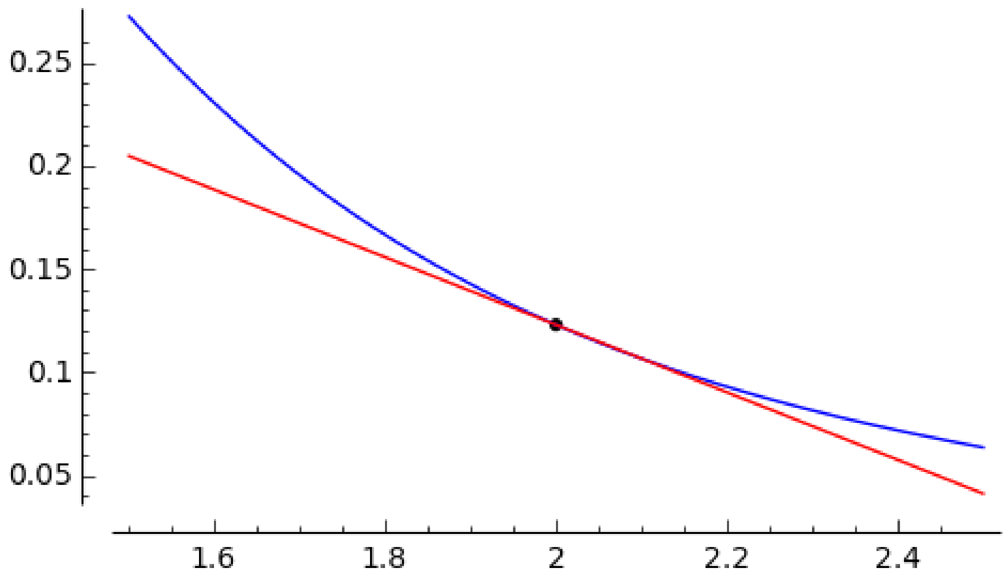
Plot function

```
var("x")
f(x) = (x^2*cos(2*x)-1)*exp(-x)
plotf = plot(f(x), (x,0,12), color='blue', linestyle='-', thickness=1)
show(plotf, figsize=[5,3])
```



Secant line

```
var("x,a,h")
a = 2; h = 0.1
g(x) = x^3/(1+x^6)
m = (g(a+h)-g(a))/h
gs(x) = g(a) + m*(x-a)
plotg = plot(g(x), (x,a-0.5,a+0.5), color='blue', linestyle='-',
thickness=1)
plotgs = plot(gs(x), (x,a-0.5,a+0.5), color='red', linestyle='-',
thickness=1)
plotpt = point((a, g(a)), color='black', size=20)
plotall = plotg + plotgs + plotpt
show(plotall, figsize=[5,3])
```



Differentiation - 1st derivative

```
var("x")
f(x) = x^3*cos(4*exp(9*x))
fp(x) = diff(f(x),x); show(fp(x))
```

$$-36\,x^3 e^{(9\,x)} \sin\left(4\,e^{(9\,x)}\right) + 3\,x^2 \cos\left(4\,e^{(9\,x)}\right)$$

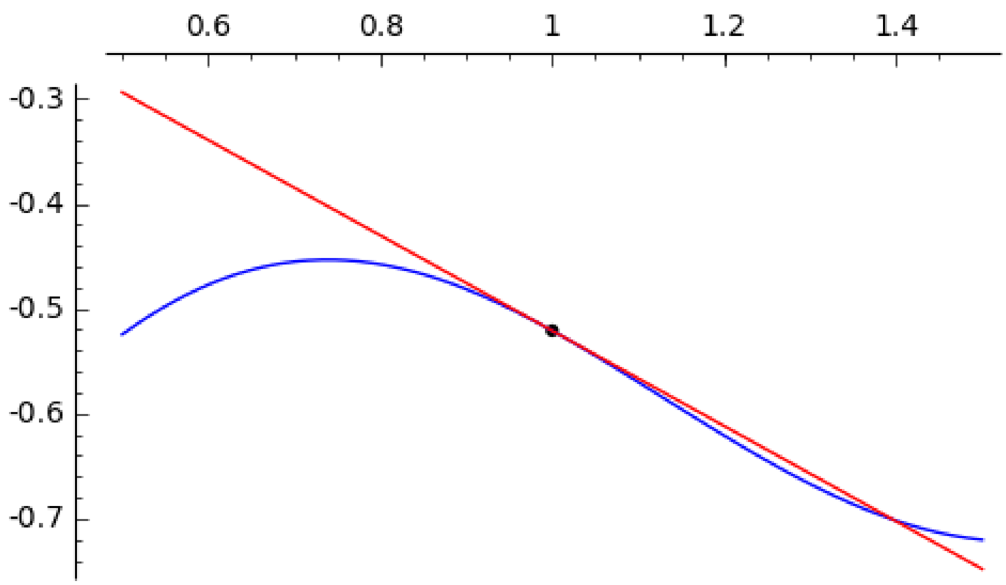
Differentiation - 2nd derivative

```
var("x")
f(x) = x/(1+x^2)
fp2(x) = diff(f(x),x,2)
fp2s(x) = factor(fp2(x)); show(fp2s(x))
```

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

Tangent line

```
var("x")
f(x) = (x^2*cos(2*x)-1)*exp(-x)
x0 = 1
y0 = f(x0)
fp(x) = diff(f(x),x); m = fp(x0)
tline(x) = y0 + m*(x-x0)
plotf = plot(f(x), (x,x0-0.5,x0+0.5), color='blue', linestyle='-',
thickness=1)
plottline = plot(tline(x), (x,x0-0.5,x0+0.5), color='red', linestyle='-',
thickness=1)
plotpt = point((x0, y0), color='black', size=20)
plotall = plotf + plottline + plotpt
show(plotall, figsize=[5,3])
```



Integration

```
var("t")
a(t) = -exp(-3*t)*sin(2*t)
A(t) = integral(a(t),t); show(A(t))
```

$$\frac{1}{13}\left(2\cos\left(2t\right) + 3\sin\left(2t\right)\right)e^{\left(-3t\right)}$$

Definite integral

```
var("t")
a(t) = -exp(-3*t)*sin(2*t)
A(t) = integral(a(t),t)
Alim1 = integral(a(t),t,0,4*pi); show (Alim1)
```

$$\frac{2}{13}\,e^{\left(-12\,\pi\right)} - \frac{2}{13}$$

Improper integral

```
var("t")
a(t) = t^2/(1+t^4)
A(t) = integral(a(t),t)
Alim2 = integral(a(t),t,0,infinity); show (Alim2)
```

$$\frac{1}{4}\,\sqrt{2}\pi$$