Lab1

Huong Phan

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#The objective of this lab is to get familiar with Sage and commands\
    and explore how it is applied into demonstrating various maths \
    concepts.
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#Basic 2D plots
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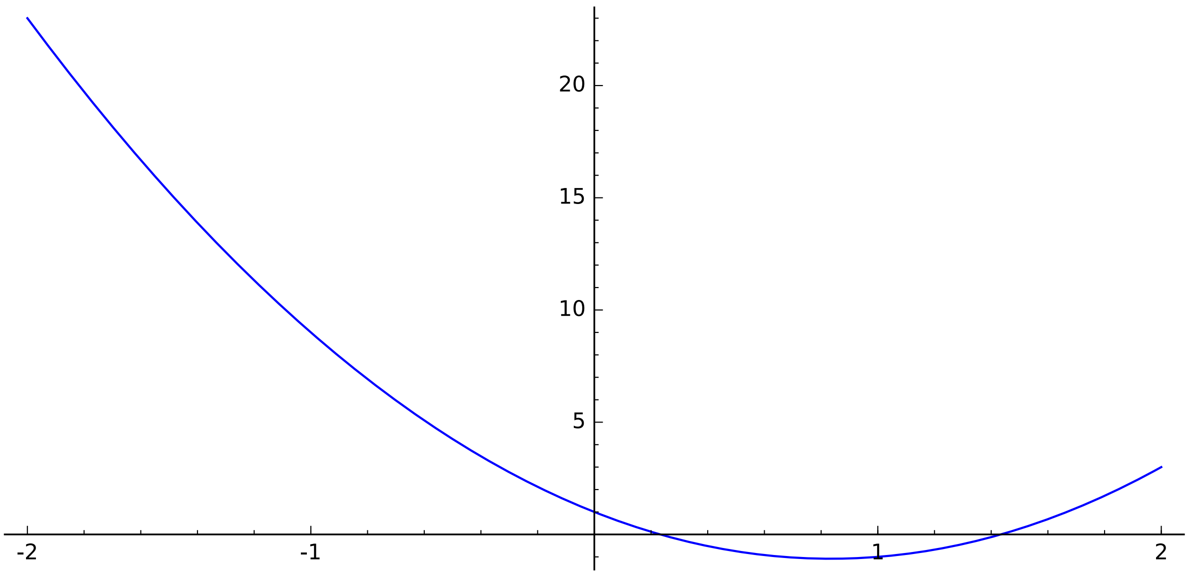
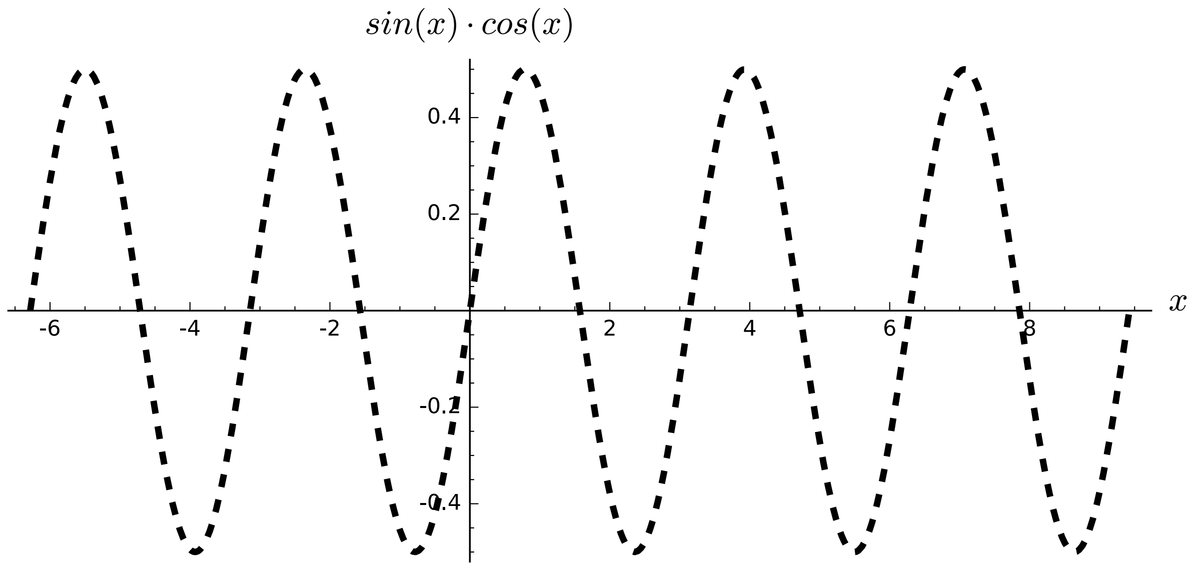
```
#Exercise 1
#1.
```

```
plot(3*x^2-5*x+1, (x, -2, 2))
```



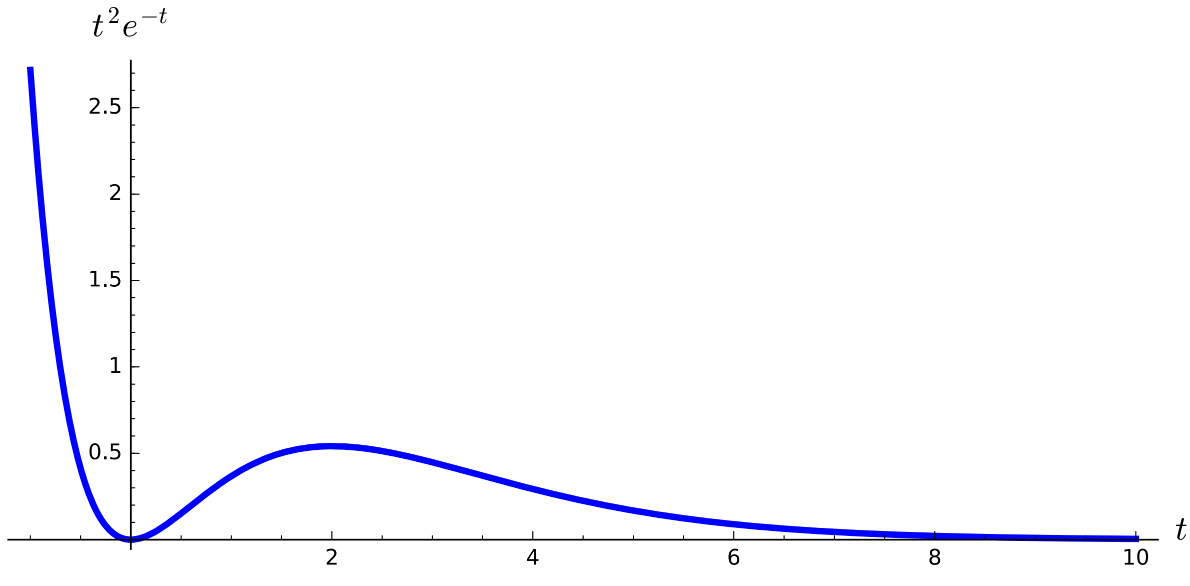

```
#2.
```

```
plot(sin(x)*cos(x), (x, -2*math.pi, 3*math.pi), axes_labels=['$x$', \
    '$sin(x) \cdot cos(x)$'], color='black', linestyle='--', \
    thickness=3)
```




```
#3. I used x in the command since x is the default variable defined \
    in Sage
```

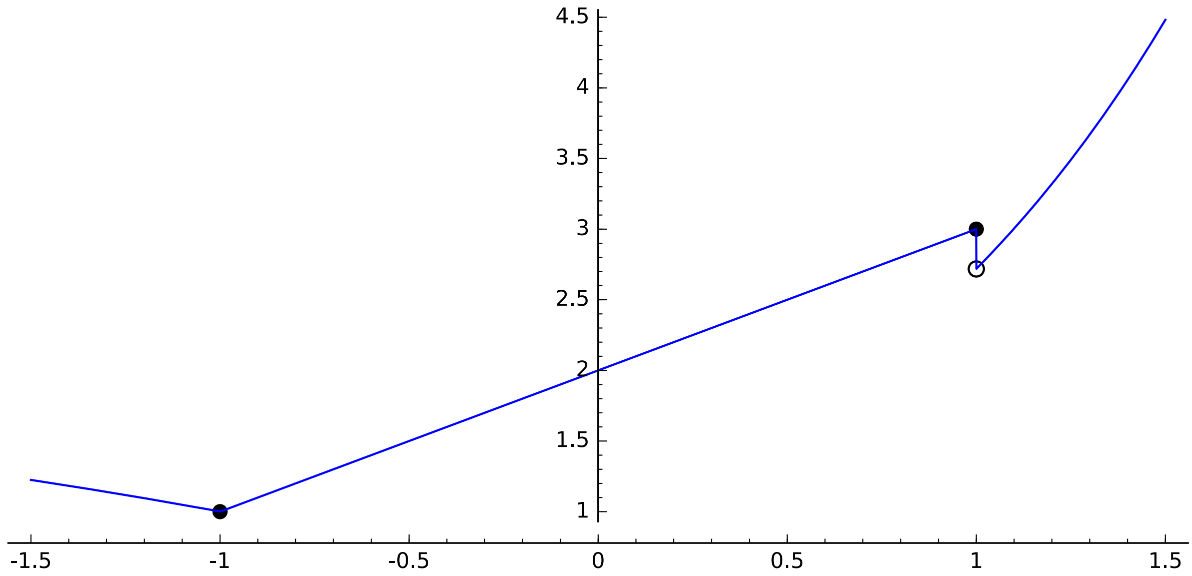
```
plot(x^2*exp(-x), (x, -1, 10), axes_labels=['$t$', '$t^2e^{-t}$'], \
    color='blue', linestyle='-', thickness=3)
```



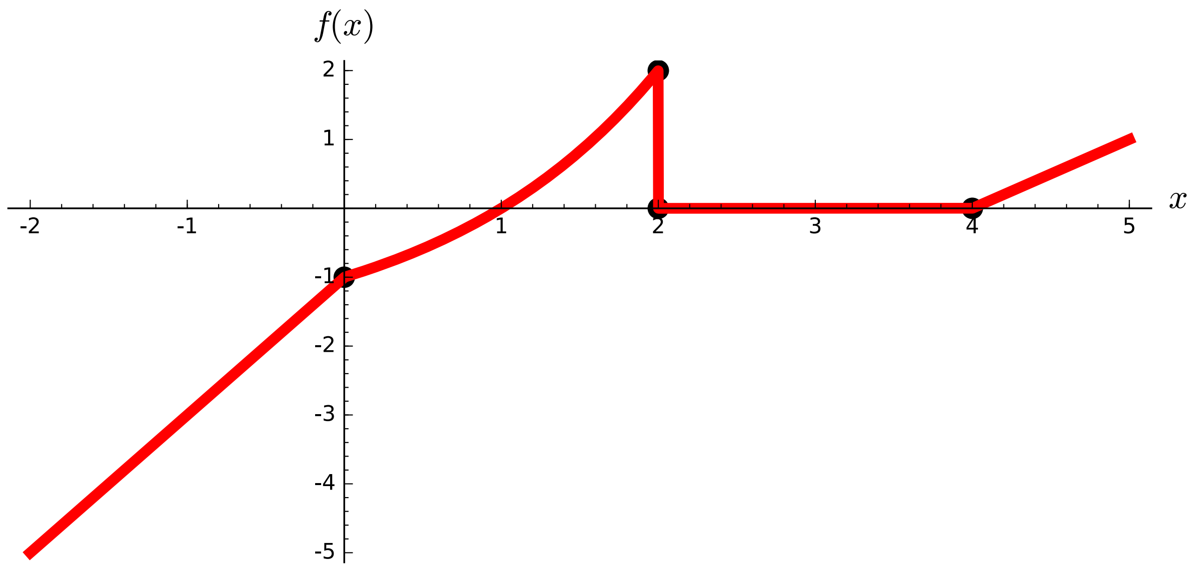

```
#Exercise 2
```

```
f1 = sqrt(-x)
f2 = 2+x
f3 = e^x
f = plot(piecewise([((-infinity, -1), f1), ((-1, 1), f2), ((1, \
    infinity), f3)]), (x, -1.5, 1.5))
pt1 = point([(1,3), (-1,1)], color='black', pointsize=50)
```

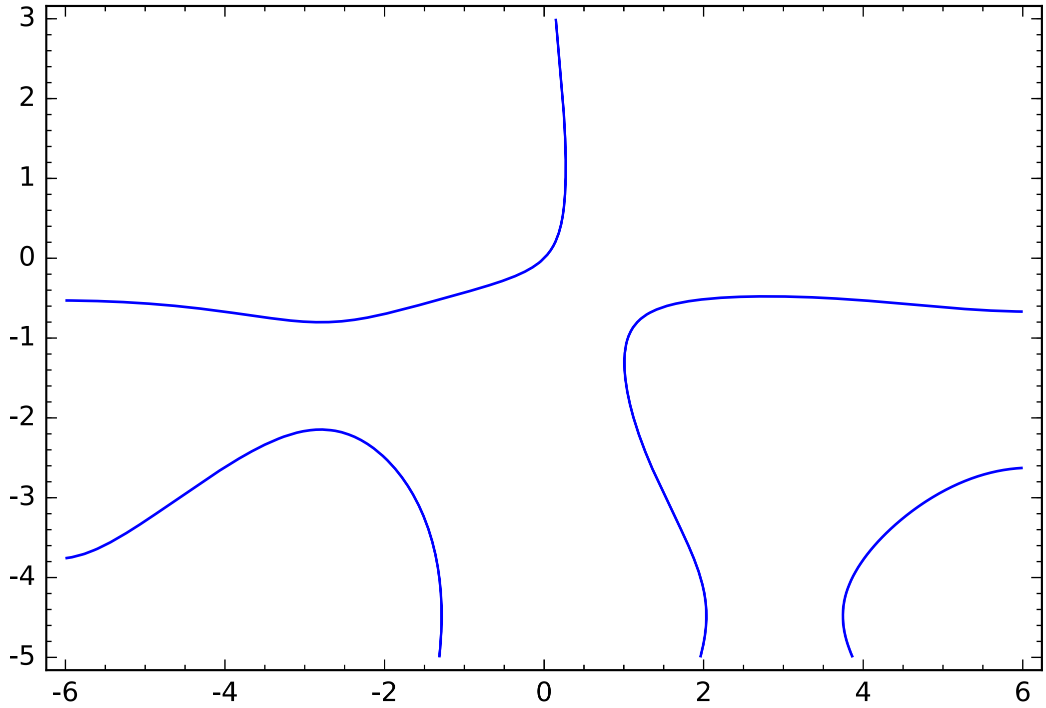
```
pt2 = point([(1,e^1)], color='white', pointsize=50, faceted = true)
(f+pt1+pt2).show()
```



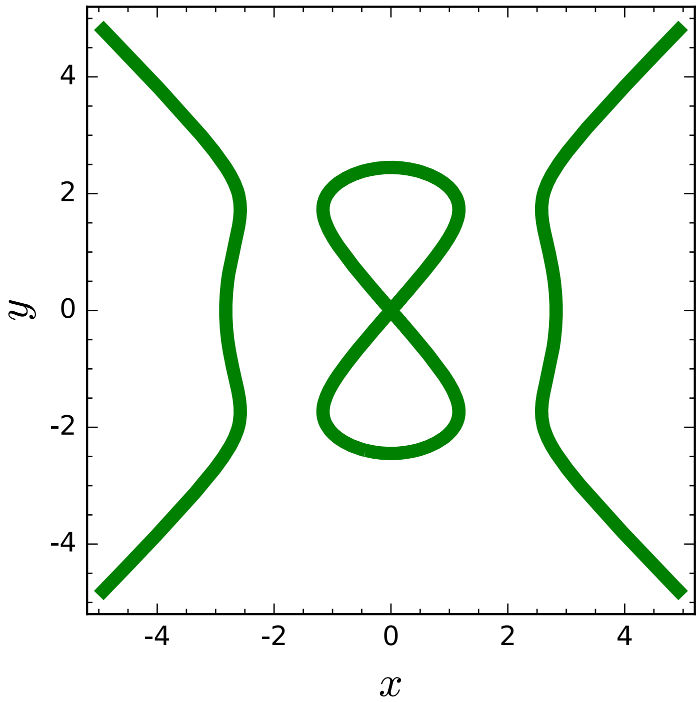

```
f1 = 2*x-1
f2 = 2^x-2
f3 = 0
f4 = x-4
f = plot(piecewise([((-infinity, 0), f1), ((0, 2), f2), ((2, 4), f3)\
    , ((4, infinity), f4)]), (x,-2,5), axes_labels=['$x$', '$f(x)$'],\
     color='red', thickness=5)
pt1 = point([(0,-1), (2,2), (2,0), (4,0)], color='black', pointsize\
    =100)
(f+pt1).show()
```



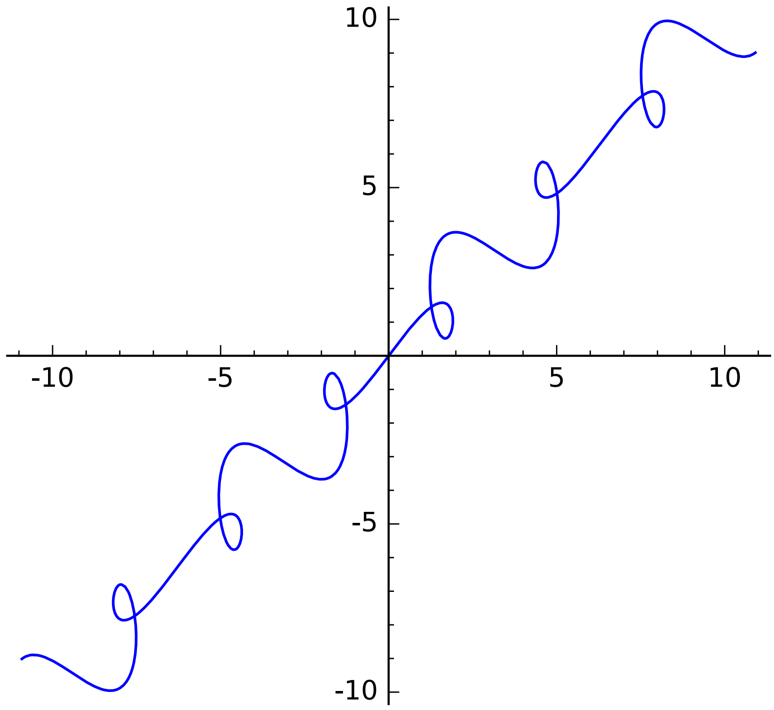
```
#Exercise 3
#1.
y = var('y')
implicit_plot(x*e^y==y*cos(x)-x*sin(y), (x,-6,6),(y,-5,3))
```



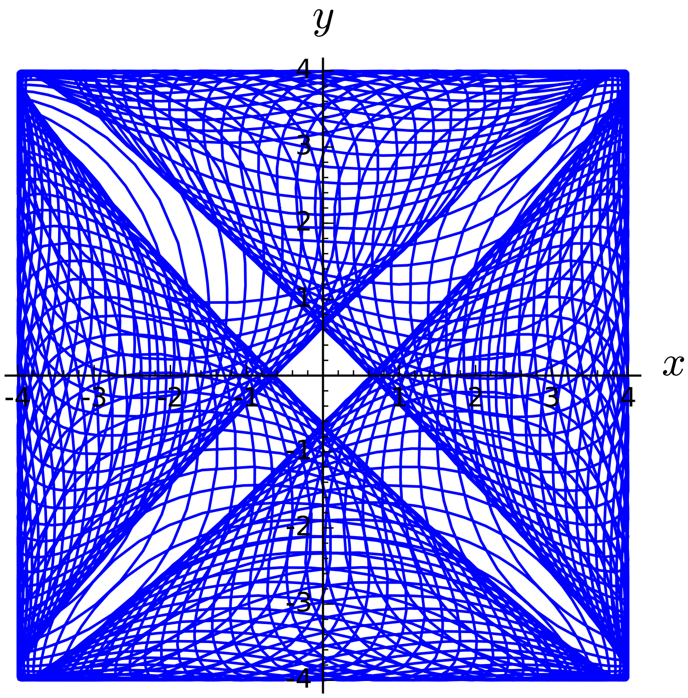

```
#2
implicit_plot(y^2*(y^2-6)==x^2*(x^2-8), (x, -5,5), (y,-5,5), \
    axes_labels=['$x$', '$y$'], color='green', linewidth=5)
```



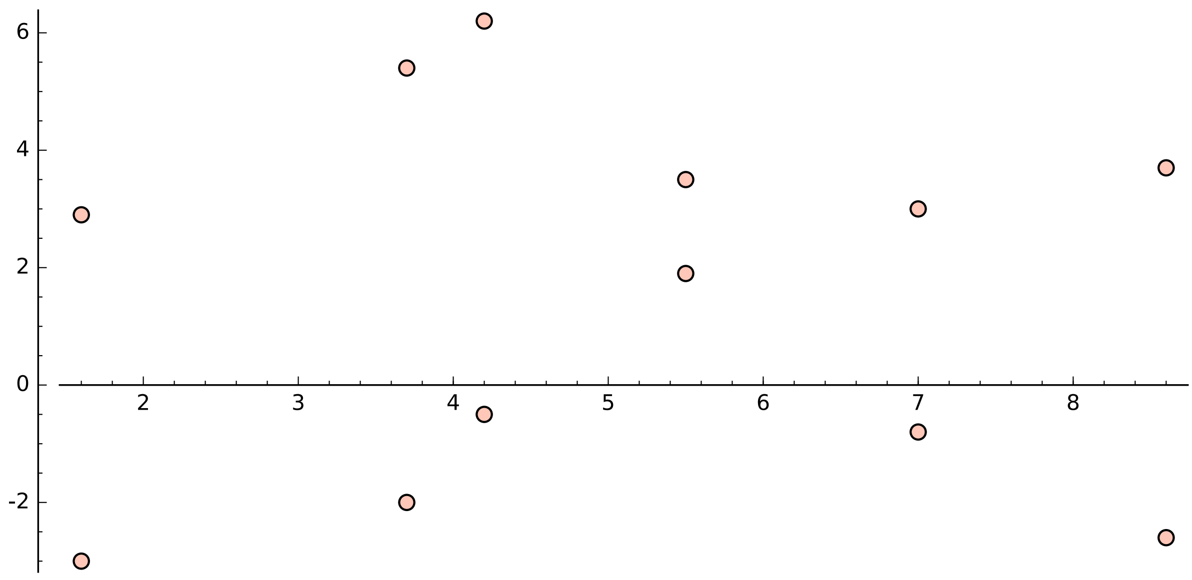

```
#Exercise 4
#1.
t = var('t')
parametric_plot((t + sin(2*t), t + sin(3*t)), (t,-10,10) )
```



```
parametric_plot((4*sin(t+cos(100*t)), 4*cos(t+sin(100*t))), (t, 0, \
    6), axes_labels=['$x$', '$y$'])
```




```
#Exercise 5
x = [1.6, 3.7, 4.2, 5.5,7.0,8.6]
f1 = [2.9, 5.4, 6.2, 3.5, -0.8, -2.6]
g1 = [-3.0, -2.0, -0.5, 1.9, 3.0, 3.7]
data1 = zip(x, f1)
data2 = zip(x, g1)
scatter_plot(data1)+scatter_plot(data2)
```



```
#Roller coaster design
```

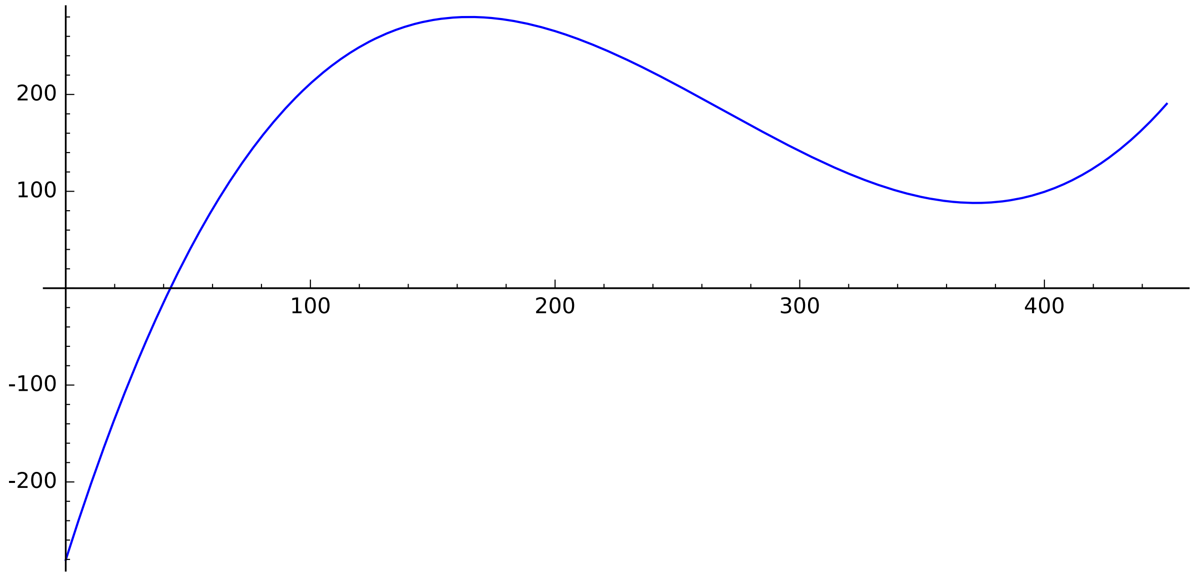
```
# Exercise:
# Colossus, Valencia, California.
a, b, c, d = var('a b c d')
f(x) = a*x^3 + b*x^2 + c*x + d
df = derivative(f,x)
results = solve([f(165) == 280, df(165) == 0, f(372) == 88, df(372) \
   == 0], (a, b, c, d), solution_dict=True)
plot( ((results[0][a])*x^3 + (results[0][b])*x^2 + (results[0][c])*x\
    + results[0][d]), (x,0,450))

f(x) = (results[0][a])*x^3 + (results[0][b])*x^2 + (results[0][c])*x\
    + results[0][d]
fp = derivative(f,x)
fpp = derivative(fp,x)
resultnew = solve([fpp == 0], x, solution_dict=True)

print "Critical point(s) of f' at: x =", resultnew[0][x]

thrill = arctan( abs( fp(resultnew[0][x]))) * (280-88)

print "thrill=", thrill.n()
```



Critical point(s) of f' at: x = 537/2
thrill= 181.938623397279

```
# Steel Dragon 2000, Nagashima, Japan.
a, b, c, d = var('a b c d')
f(x) = a*x^3 + b*x^2 + c*x + d
df = derivative(f,x)
results = solve([f(224) == 309, df(224) == 0, f(469) == 79, df(469) \
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    == 0], (a, b, c, d), solution_dict=True)
plot( ((results[0][a])*x^3 + (results[0][b])*x^2 + (results[0][c])*x\
     + results[0][d]), (x,0,500))

f(x) = (results[0][a])*x^3 + (results[0][b])*x^2 + (results[0][c])*x\
     + results[0][d]
fp = derivative(f,x)
fpp = derivative(fp,x)
resultnew = solve([fpp == 0], x, solution_dict=True)

print "Critical point(s) of f' at: x =", resultnew[0][x]

thrill = arctan( abs( fp(resultnew[0][x]))) * (309-79)

print "thrill=", thrill.n()
```

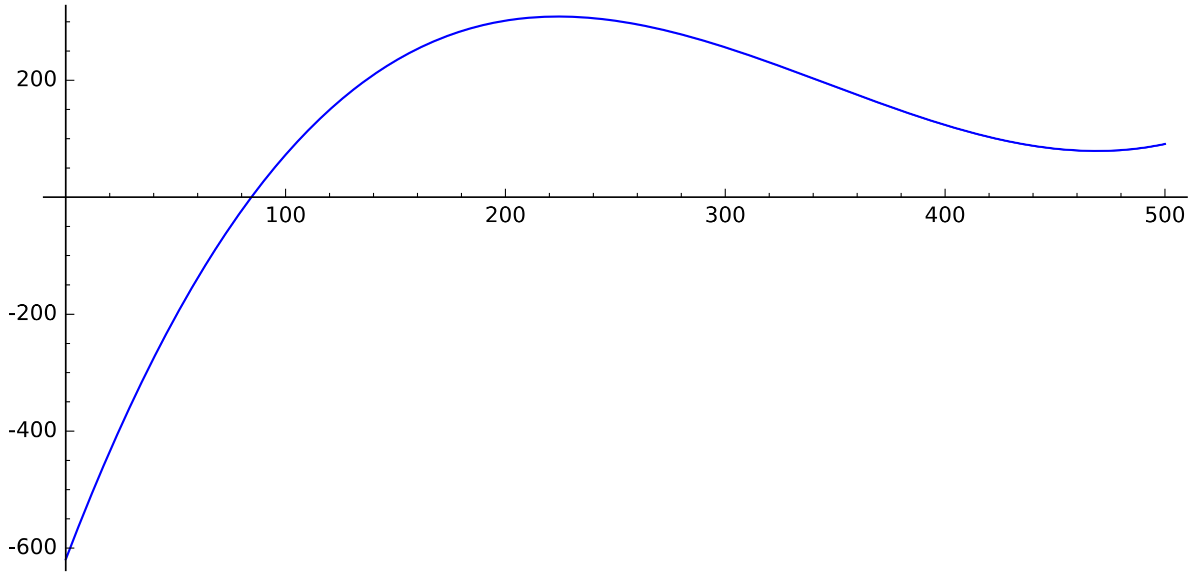

Critical point(s) of f' at: x = 693/2
thrill= 219.257639928999

```
# Since 219.26>181.94, the drop in Steel Dragon 2000 is more \
    thrilling than that in Colossus.
```