SHRI RAMDEOBABA COLLEGE OF ENGINNERING AND MANAGEMENT

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BATCH:C3

ROLL N0:65

EXPERIMENT NO:5

Experiment 5:DIfferential Calculus and its Application

Aim:to learn calculus with sagemath

1. LIMITS

PROBLEM:Find the limit of lim x->0 x/|x|

In [2]:
```
f(x)=x/abs(x)
show(f(x))
```

$$\frac{x}{|x|}$$

In [4]:
```
limit(f(x),x=0)
```

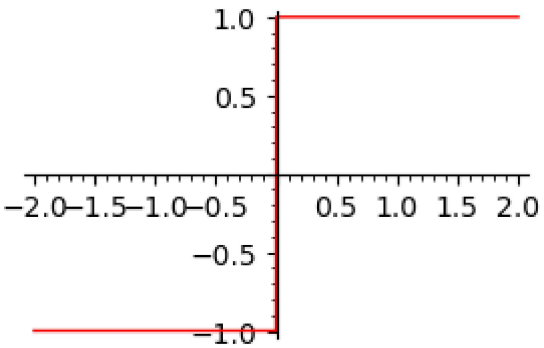
Out[4]: und

In [5]:
```
limit(f(x),x=0,dir='+')
```

Out[5]: 1

In [5]:
```
f.plot(-2,2,figsize=3,color='red')
```

Out[5]:



PROBLEM:Find the limit of lim x->2 (x^2-4)/(x-2)

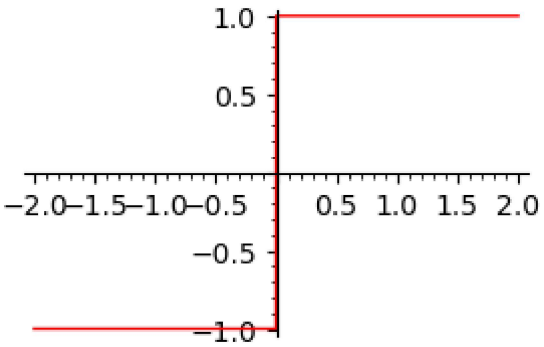
In [6]:
```
limit((x^2-4)/(x-2),x=2)
```

Out[6]: 4

In [7]:
```

```

Out[7]:



PROBLEM: Evaluate lim x->inf x^a for various values of a

In [7]:
```
var('a')
assume(a>0)
```

In [18]:
```
limit(x^a,x=infinity)
```

Out[18]: +Infinity

In [21]:
```
forget() #Assumption for 'a' are delete
```

In [ ]:
```
assume(a<0)
```

In [8]:
```
limit(x^a,x=infinity)
```

Out[8]: +Infinity

2.Derivative

In [1]:
```
f(x)=x^4
show(f(x))
```

$$x^4$$

In [2]:
```
show(f(x).diff())
```

$$4\,x^3$$

In [3]:
```
show(diff(f(x)))
```

$$4\,x^3$$

In [4]:
```
show(diff(f(x),x))
```

$$4\,x^3$$

In [5]:
```
show(diff(f(x),2))  #double derivative
```

$$12\,x^2$$

In [6]:
```
show(f(x).diff(2))
```

$$12\,x^2$$

In [7]:
```
diff(f(x))(x=4)
```

Out[7]: 256

In [8]:
```
show(diff(f(x),3)) #triple derivative
```

$$24\,x$$

In [9]:
```
diff(x^4,x,4)         #four times derivative
```

Out[9]: 24

In [10]:
```
show(diff(f(x),x,x,x))      #triple derivative
```

$$24\,x$$

In [11]:
```
var('x,y')
f(x,y)=x^3*y+(sin(y))*(cos(x))^2
show(f(x,y))
```

$$x^3 y + \cos\left(x\right)^2 \sin(y)$$

In [12]:
```
show(diff(f,x),x)   #partially with resp to x
```

$$(x, y) \mapsto 3\,x^2y - 2\,\cos(x)\sin(x)\sin(y)x$$

In [13]:
```
show(diff(f,x),y)          #partially with resp to y
```

$$(x, y) \mapsto 3\,x^2y - 2\,\cos(x)\sin(x)\sin(y)y$$

In [14]:
```
show(diff(f,x),x,y)             #partially with resp to x then wrt y
```

$$(x, y) \mapsto 3\,x^2y - 2\,\cos(x)\sin(x)\sin(y)xy$$

In [15]:
```
show(diff(f,x),y,x)               #partially with resp to y then wrt x
```

$$(x, y) \mapsto 3\,x^2y - 2\,\cos(x)\sin(x)\sin(y)yx$$

In [16]:
```
show(diff(f,x),y,y)             ##partially with resp to y twice
```

$$(x, y) \mapsto 3\,x^2y - 2\,\cos(x)\sin(x)\sin(y)yy$$

In [17]:
```
show(diff(f,x),x,3,y,2)
```

$$(x, y) \mapsto 3\,x^2y - 2\,\cos(x)\sin(x)\sin(y)x3y2$$

In [18]:
```
show(diff(f,x)(x=1,y=-1))
```

$$2\,\cos(1)\sin\left(1\right)^2 - 3$$

In [19]:
```
show(diff(f,x,2,y,3)(x=1,y=-1))
```

$$2\,\cos\left(1\right)^3 - 2\,\cos(1)\sin\left(1\right)^2$$

In [20]:
```
show(diff(f,x,5))            #partially with resp to x ---5 times
```

$$(x, y) \mapsto -32\,\cos(x)\sin(x)\sin(y)$$

In [ ]:
```
=x^3          #g for continous differential function
for i in range(0,3)
show(g.diff(i))
```

Implicit Derivative

find the slope formula for the folium of Descartes implicitly defined by X^3+y^3=6*xy*. (Find dy/dx)

In [26]:
```
var('x,y')
f(x,y)= (x^3)+(y^3)-6*x*y
```

In [27]:
```
x=var('x')
y=var('y')
f(x,y)=x^3+y^3-6*x*y
y=function('y')(x)          #  y is function of x
a=diff(f(x,y))
show(a)
```

$$3\,y(x)^2\frac{\partial}{\partial x}y\left(x\right)+3\,x^2-6\,x\frac{\partial}{\partial x}y\left(x\right)-6\,y\left(x\right)$$

In [28]:
```
solve(a,diff(y))
show(solve(a,diff(y)))
```

$$\left[\frac{\partial}{\partial x}y\left(x\right)=-\frac{x^2-2\,y\left(x\right)}{y(x)^2-2\,x}\right]$$

In [29]:
```
g(x,y)=x^3+y^3-6*x*y
show(-diff(g,x)/diff(g,y))
```

$$(x,y)\mapsto-\frac{x^2-2\,y}{y^2-2\,x}$$

Local maxima and minimum

In [30]:
```
var('f')
```

Out[30]: f

In [31]:
```
f(x)=exp(-x/2)+exp(-2*x^2)
show(f(x))
```

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

In [ ]:
```
plot(f(x),-2,2,figsize=3)
```

In [ ]:
```
   f.find_local_maximum(-1,0.5)
```

In [ ]:
```
f.find_local_minimum(-2,4)
```

In [ ]:
```
var('x,y')
f(x)=2*x^3-9*x^2+12*x-3
p1=plot(f,0,3,figsize=3,color='red')
show(p1)
```

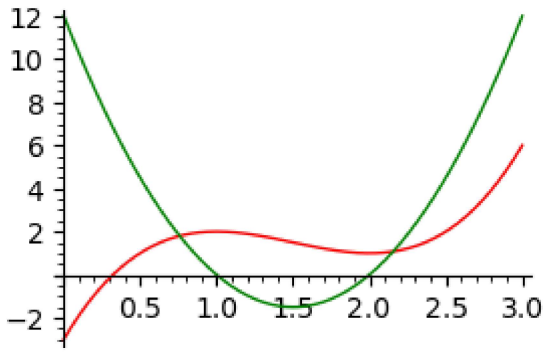
find intervals on which f is increasing or decreasing

In [ ]:
```
g(x)=f.diff()
show(g(x))
```

In [ ]:
```
p2=plot(g,0,3,figsize=3,color='green')
show(p2)
```

In [33]:
```
p1+p2
```

Out[33]:



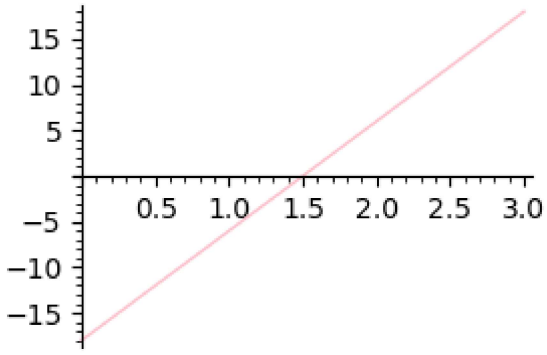
In [34]:
```
solve(g(x),x)
```

Out[34]:
```
[x == 1, x == 2]
```

In [35]:
```
c=1
d=2
```

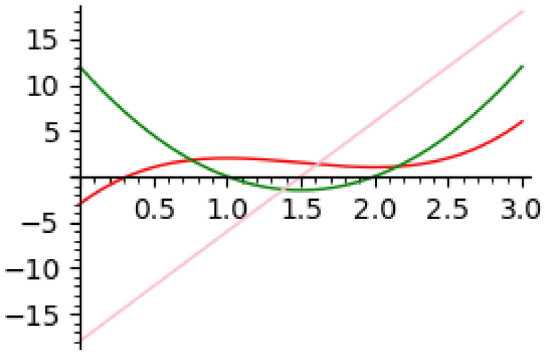
Therefor fun is increasing in the interval(0,1) and (2,3) as derivative is positive in these intervals.Function is decreasing in these intervals. Function is decresing in the interval (1,2) as derivative is negative in this interval.

In [43]:
```
h(x)=f.diff(2)
p3=plot(h,0,3,figsize=3,color='pink')
show(p3)
```



In [44]:
```
p1+p2+p3
```

Out[44]:

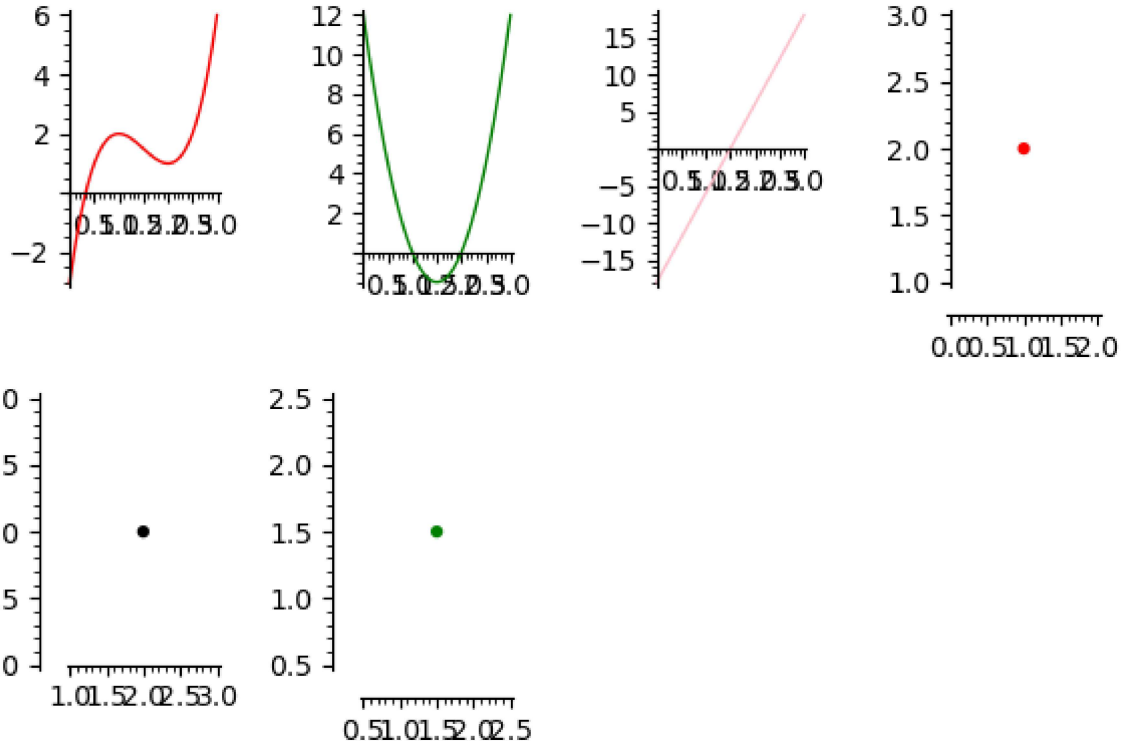


In [45]:
```
solve(h(x),x)
```

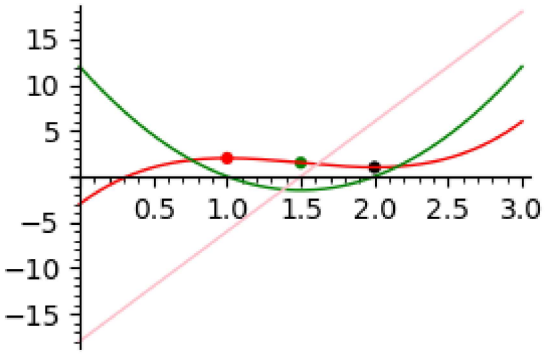
Out[45]:
```
[x == (3/2)]
```

In [46]:
```
e=3/2
```

In [48]:
```
p4=point((c,f(c)),color='red',size=20)
p5=point((d,f(d)),color='black',size=20)
p6=point((e,f(e)),color='green',size=20)
show(p1,p2,p3,p4,p5,p6)
```



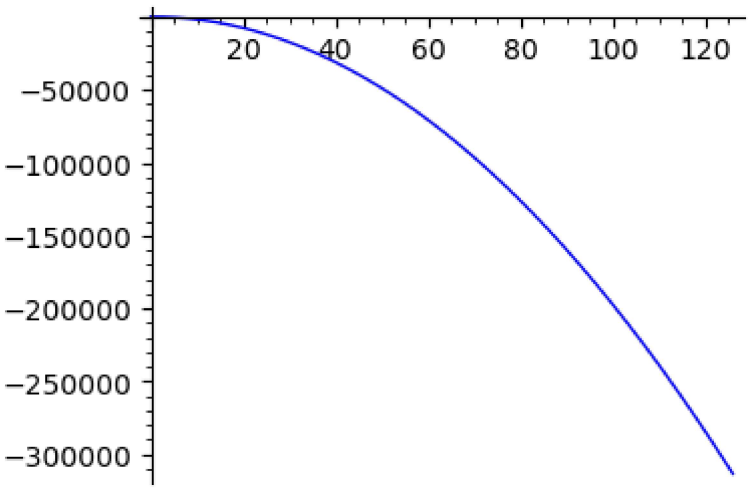
In [49]:
```
show(p1+p2+p3+p4+p5+p6)
```



The hubble space telescope was developed was deployed on April 24, 1990 by the space stuttle discovry . A model for the velocity of the shuttle during this mission ,from liftoff at t=0 until he solid rocket boosters were jettisoned at t=126 sec,is given by v(t)=0.001302t^3-20.09029t^2+23.61t-3.083 Using this model ,estimate the absolute maximum and minimum values of the acceleration of the shuttle between liftoff and thw jettisoning of the booster.

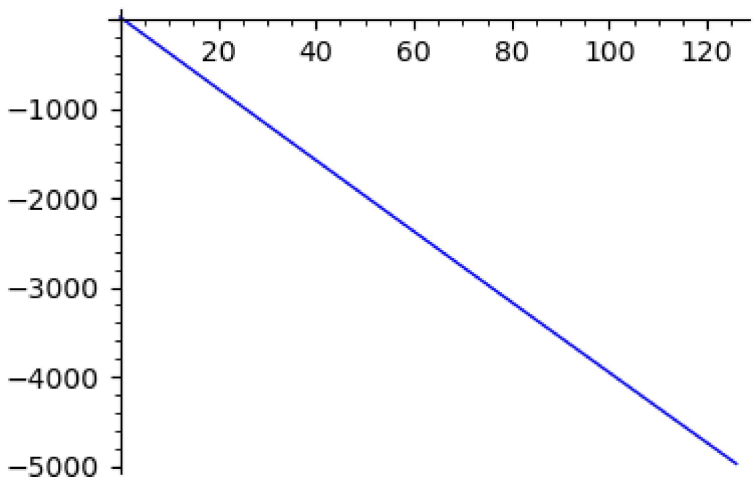
In [50]:
```
var('t')
v(t)=0.001302*t^3-20.09029*t^2+23.61*t-3.083
plot(v,0,126,figsize=4)
```

Out[50]:



In [51]:
```
a=v.diff()
a.plot(0,126,figsize=4)
```

Out[51]:



In [52]:
```
a.find_local_minimum(0,126)
```

Out[52]: (-4977.131349515218, 125.9999980996971)

In [53]:
```
a.find_local_maximum(0,126)
```

Out[53]: (23.609999727268548, 6.787643476263135e-09)

EXERCISE 3.35

QUE 1

In [1]:
```
f(x)=(x^4)*e^(-x)
show(f(x))
```

$x^4 e^{(-x)}$

In [2]:
```
f.find_local_maximum(-1,1)
```

Out[2]: (2.7182813252461533, -0.9999999629756616)

QUE 2

In [9]:
```
# let consider value of A and B be 1 and L be 10
```

In [7]:
```
var('p,v')
p=v^3+(1/v)
d=diff(p,v)
show(d)
p=v^3+(100/v)
```

$$3\,v^{2} - \frac{1}{v^{2}}$$

In [5]:
```
p.find_local_minimum(-1,1)
```

Out[5]: (-59907451853.14301, -1.6692414200013008e-09)

CONCLUSION:

In this practical, I learned the to perform various differencial calculus operations such as finding limits and derivatives , maximum and minimum , derivatives of implicit functions and also the partial derivative value of a function ,using sageMath.

In [ ]: