MATH 151 Lab 8

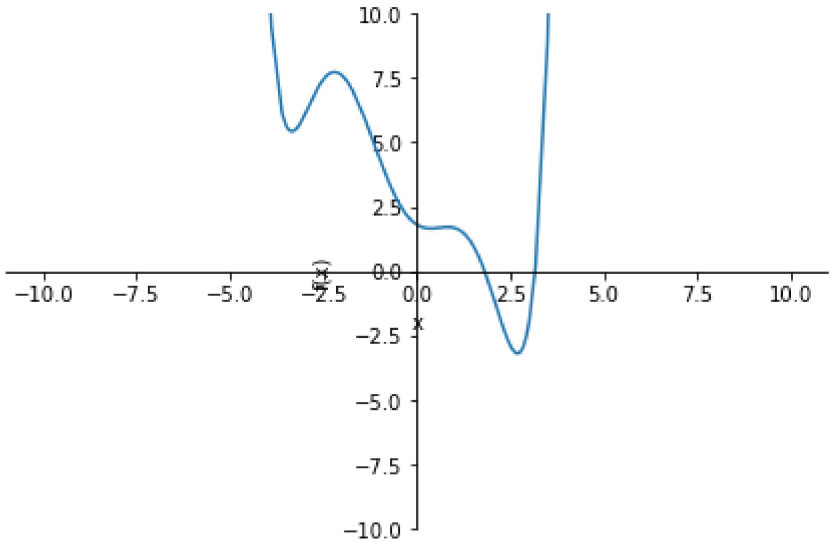
Sutton Elliott and Gavin Love. Section 503.

In [2]:
```
from sympy import *
from sympy.plotting import (plot,plot_parametric)
```

Question 1

1a

In [4]:
```
x= symbols('x')
f= 1/40*(x**6 + 2*x**5 - 16*x**4 - 20*x**3 +64*x**2 - 36*x +72)
plot(f,(x,-10,10), ylim=[-10,10])
print('There seems to be 3 local minima, 2 local maxima, and 3 points of inflection')
```




```
There seems to be 3 local minima, 2 local maxima, and 3 points of inflection
```

1b

In [7]:

```
df= diff(f,x)
cvals= solve(df,x)
print(cvals)
cvals_final= [-3.34, -2.21, 0.37, 0.82, 2.69]
endpts= [-oo,-3.34, -2.21, 0.37, 0.82, 2.69, oo]
testvals= [-4, -3, -1, 0.5, 2, 3]
for n in range(6):
    if df.subs(x,testvals[n]) >0:
        print(f'f is increasing on ({endpts[n]},{endpts[n+1]})')
    else:
        print(f'f is decreasing on ({endpts[n]},{endpts[n+1]})')
```

```
[-3.34365086397455, -2.20571930723638, 0.367785714582751, 0.821156998770767, 2.69376079119075]
f is decreasing on (-oo,-3.34)
f is increasing on (-3.34,-2.21)
f is decreasing on (-2.21,0.37)
f is increasing on (0.37,0.82)
f is decreasing on (0.82,2.69)
f is increasing on (2.69,oo)
```

1c

In [10]:

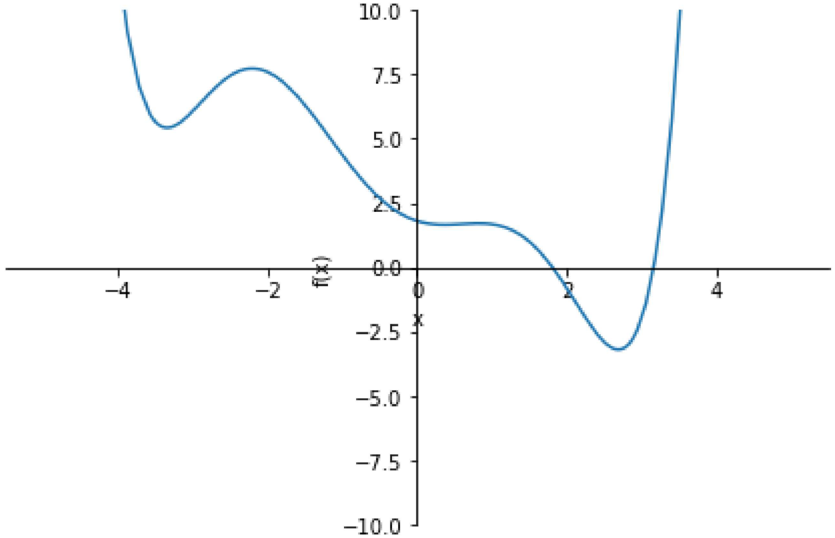
```
df2= diff(f,x,2)
cvals2= solve(df2,x)
print(cvals2)
cvals2_final= [-2.89, -1.16, 0.60, 2.12]
endpts2= [-oo, -2.89, -1.16, 0.60, 2.12, oo]
testvals2= [-3, -2, 0, 2, 3]
for n in range(5):
    if df2.subs(x,testvals2[n]) >0:
        print(f'f is concave up on ({endpts2[n]},{endpts2[n+1]})')
    else:
        print(f'f is concave down on ({endpts2[n]},{endpts2[n+1]})')
```

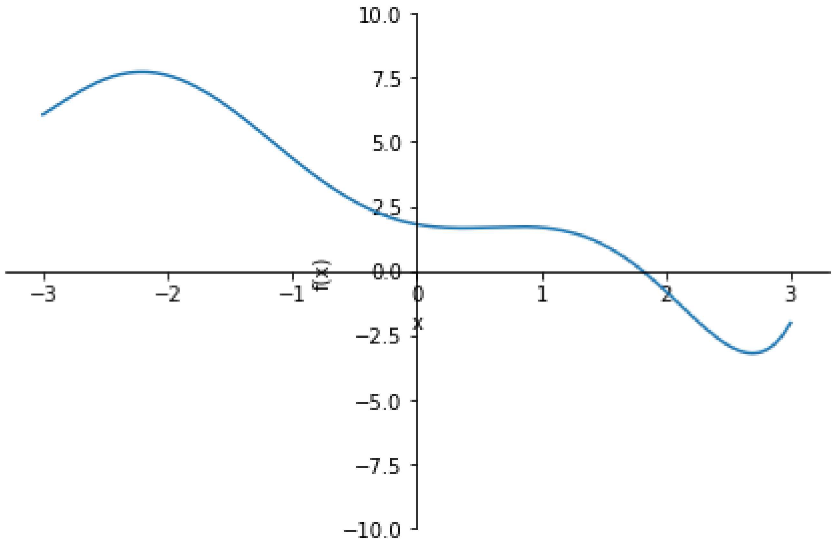
```
[-2.89174218338126 + 1.78636936811663e-30*I, -1.16242859299527 - 5.51234993515341e-30*I, 0.597894461879547
+ 6.00114534019814e-30*I, 2.12294298116364 - 2.27516477316136e-30*I]
f is concave up on (-oo,-2.89)
f is concave down on (-2.89,-1.16)
f is concave up on (-1.16,0.6)
f is concave down on (0.6,2.12)
f is concave up on (2.12,oo)
```

1d

In [13]:

```
plot(f,(x,-5,5), ylim=[-10,10])
plot(f,(x,-3,3), ylim=[-10,10])
print('There are 3 local minima, 2 local maxima, and 4 points of inflection')
```





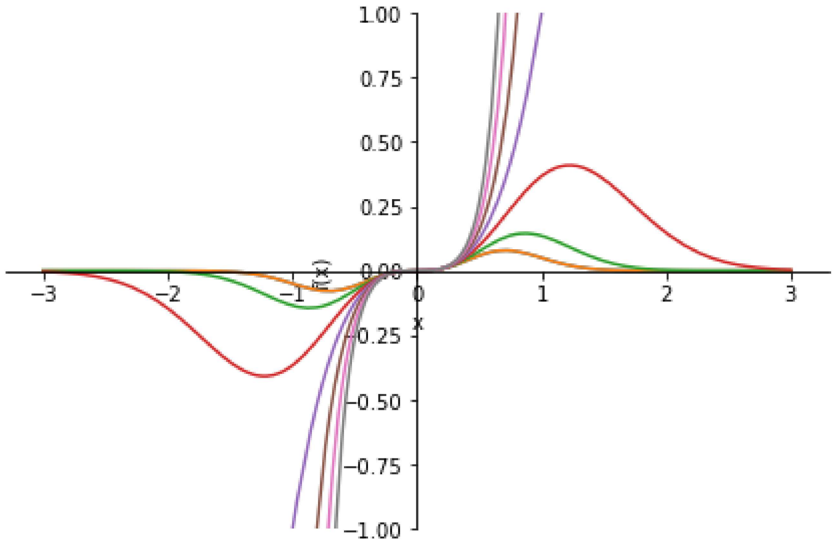

```
There are 3 local minima, 2 local maxima, and 4 points of inflection
```

Question 2

2a

In [72]:

```
x,b= symbols('x b')
g= x**3 * exp(b*x**2)
list_1 = [-3,-2,-1,0,1,2,3]
myplot1= plot(g.subs(b,-3),(x,-3,3),ylim=[-1,1], show=False)
for i in list_1:
    myplot1.extend(plot(g.subs(b,i),(x,-3,3), show=False))
myplot1.show()
```



2b

In [76]:

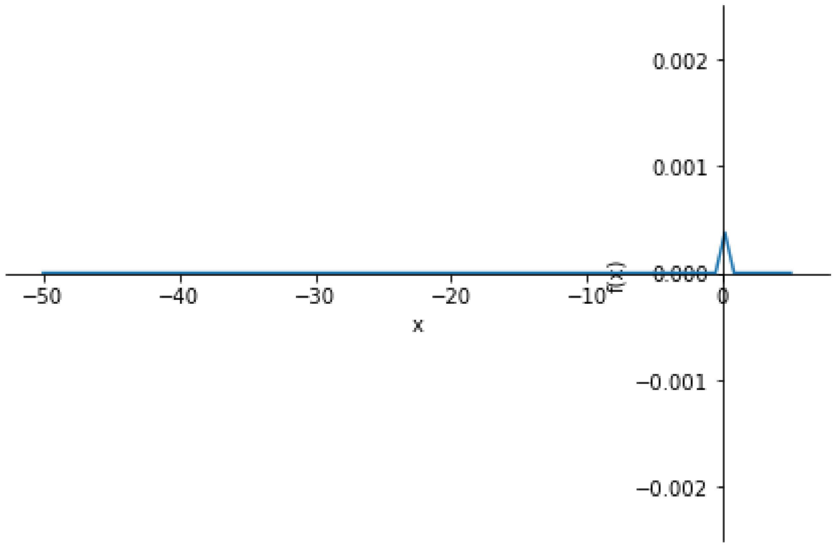
```
dg= diff(g,x)
CP= solve(dg,x)
print(CP)
print('The values when x=-3, -2, -1 are real since inside the sqaure root is negative, so these are the real
```

```
[0, -sqrt(6)*sqrt(-1/b)/2, sqrt(6)*sqrt(-1/b)/2]
The values when x=-3, -2, -1 are real since inside the sqaure root is negative, so these are the real criti
cal values because it would output a real number.
```

2c

In [82]:

```
g_100= g.subs(b,-100)
plot(g_100,(x,-50,5), ylim=[-0.0025, 0.0025])
print('As b approaches -oo the critical values will start to approach 0.')
```




```
As b approaches -oo the critical values will start to approach 0.
```

2d

In [85]:

```
dg2= diff(g,x,2)
IP= solve(dg2,x)
print(IP)
print('The values when x=-3, -2, -1 are real since inside the sqaure root is negative, so these are the real
```

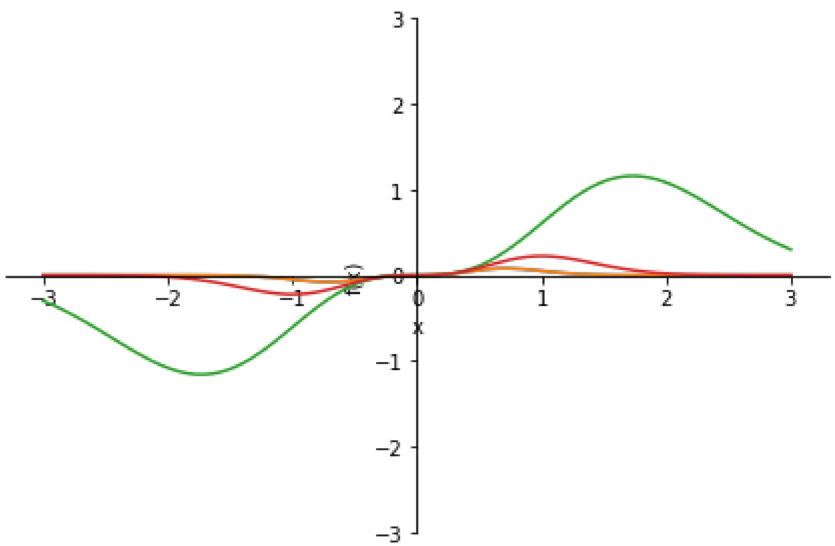
```
[0, -sqrt(2)*sqrt(-1/b)/2, sqrt(2)*sqrt(-1/b)/2, -sqrt(3)*sqrt(-1/b), sqrt(3)*sqrt(-1/b)]
The values when x=-3, -2, -1 are real since inside the sqaure root is negative, so these are the real infle
ction points because it would output a real number.
```

2e

In [93]:

```
crit= solve(dg,x)
k = crit[1]
p= crit[2]
crit1solve= solve(k+1,b)
crit2solve= solve(k-1,b)
print("The value of b where the critical value includes -1 and 1, b=", crit1solve)
print()
print('The values of b when the POI is +1 or -1 are', solve(-sqrt(-2)*sqrt(-1/b)/2+1,b),solve(-sqrt(3)*sqrt(
list1= [-3,-1/2, -3/2]
myplot1 = plot(g.subs(b,-3),(x,-3,3),ylim=[-3,3], show=False)
for i in list1:
    myplot1.extend(plot(g.subs(b,i),(x,-3,3), show=False))
myplot1.show()
```

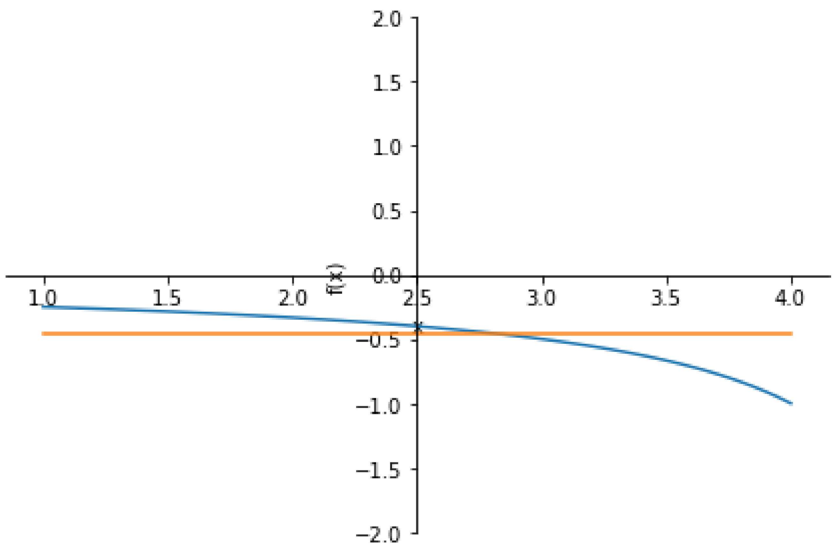
```
The value of b where the critical value includes -1 and 1, b= [-3/2]

The values of b when the POI is +1 or -1 are [] [-3]
```



Question 3

3a

In [11]:
```
# f(x) = ln(5-x), [1,4]
x= symbols('x')
f= ln(5-x)
f1= f.subs(x,1)
IROC= diff(f,x)
AROC= (f.subs(x,4)-f.subs(x,1))/(4-1)
plot((IROC,(x,1,4)), (AROC,(x,1,4)), ylim=[-2,2])
print(f'The function {f} is continuous and differentiable on the interval [1,4]')
print(f'The c value that would satisfy the Mean Value Theorem is 2.8359.')
print('Also when this value is equal to 0:')
display(solve(IROC-AROC,x)[0])
```



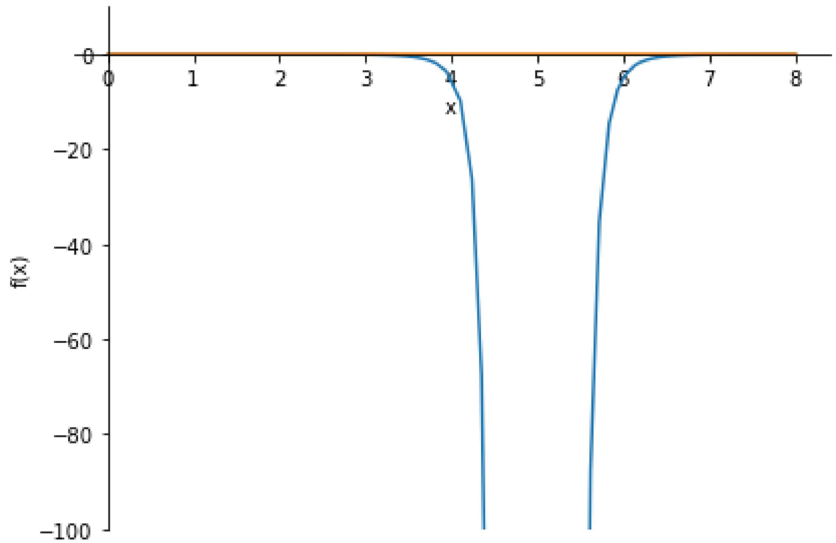

```
The function log(5 - x) is continuous and differentiable on the interval [1,4]
The c value that would satisfy the Mean Value Theorem is 2.8359.
Also when this value is equal to 0:
```

$$\frac{-3 + \log(1024)}{\log(4)}$$

3b

In [12]:

```
g= (x-5)**-5
IROC= diff(g,x)
AROC= (g.subs(x,8)-g.subs(x,0))/(8-0)
plot((IROC,(x,0,8)),(AROC,(x,0,8)), ylim=[-100,10])
print('The graph is not continuous or differentible in the interval [0,8] so there is no value that will sat
```

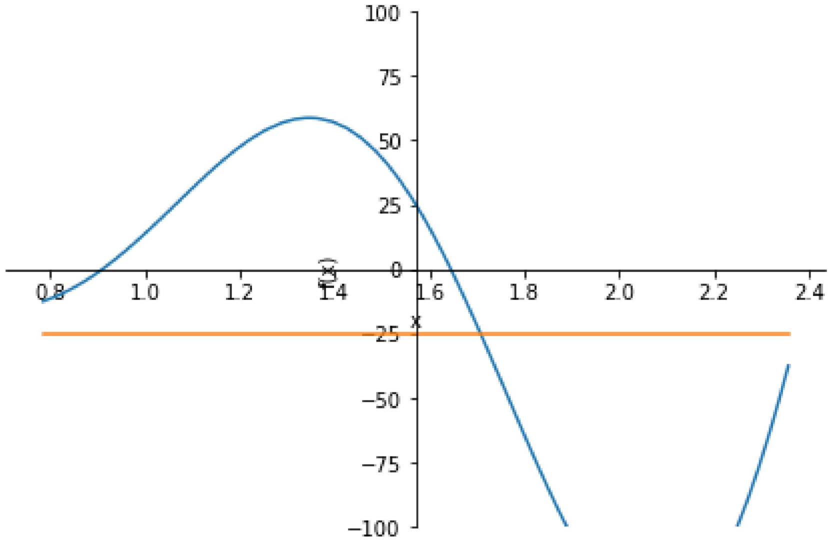



```
The graph is not continuous or differentible in the interval [0,8] so there is no value that will satisfy t
he Mean Value Thereom.
```

3c

In [13]:

```
h= (8*x**2)*cos(4*x)
IROC= diff(h,x)
AROC= (h.subs(x,3*pi/4)-h.subs(x,pi/4))/(pi/2)
plot((IROC,(x,pi/4,3*pi/4)), (AROC,(x,3*pi/4,pi/4)), ylim=[-100,100])
print(f'The function {f} is continuous and differetiable on the interval [pi/4,3pi/4]')
print('The c value that MVT applies to is at x= ')
display(nsolve(IROC-AROC,x,1.8))
```




```
The function log(5 - x) is continuous and differetiable on the interval [pi/4,3pi/4]
The c value that MVT applies to is at x=
```

1.70739757583842