MATH 152 Lab 8

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In [1]:
```
from sympy import *
from sympy.plotting import (plot,plot_parametric)
import matplotlib.pyplot as plt
import numpy as np
```

Question 1

1a

In [2]:
```
n, ub = symbols('n ub')
expr = (n**50 * 50**n) / factorial(n)
s = Sum(expr, (n, 1, ub))

terms = [N(expr.subs(n, i)) for i in range(1, 6)]
print(f"The first 5 terms are: {terms}")
print(f"The terms appear to be increasing.")
```

```
The first 5 terms are: [50.0000000000000, 1.40737488355328e+18, 1.49562080769136e+28,
3.30117343809435e+35, 2.31296463463574e+41]
The terms appear to be increasing.
```

1b

In [3]:
```
an1 = ((n + 1)**50 * 50**(n + 1)) / factorial(n + 1)
an = (n**50 * 50**n) / factorial(n)
L = Limit(an1 / an, n, oo)
L = simplify(L)
print(f"The limit is: {L}")
print(f"The limit is 0, so the series converges.")
```

```
The limit is: 0
The limit is 0, so the series converges.
```

1c

In [4]:
```
print("The answer to part (b) tells that the terms of the series decrease fast enough
```

```
The answer to part (b) tells that the terms of the series decrease fast enough that t
he series converges.
```

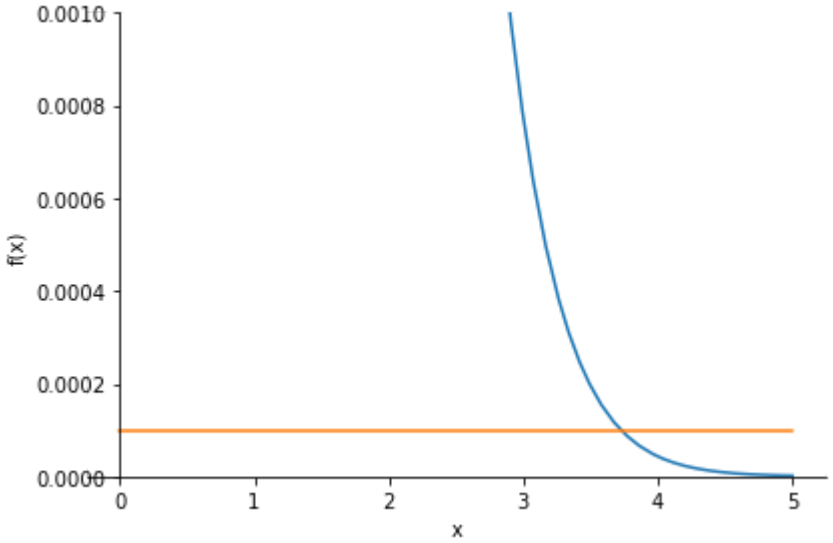
Question 2

2a

In [5]:
```
an = (n**8) * E**(-5*n)

x = symbols('x')
```

```
plot((integrate(an, (n, x, oo))), 0.0001, (x, 0, 5),ylim = (0, 0.001))
print("It appears that at least four terms are needed to approximate the integral to 0
```




```
It appears that at least four terms are needed to approximate the integral to 0.0001
by looking at the graph.
```

2b

In [6]:
```
terms = nsolve(integrate(an, (n, x, oo)) - 0.0001, 3.7)
print(f"The number of terms needed to approximate the series to 0.0001 is: {ceiling(te
```

```
The number of terms needed to approximate the series to 0.0001 is: 4
```

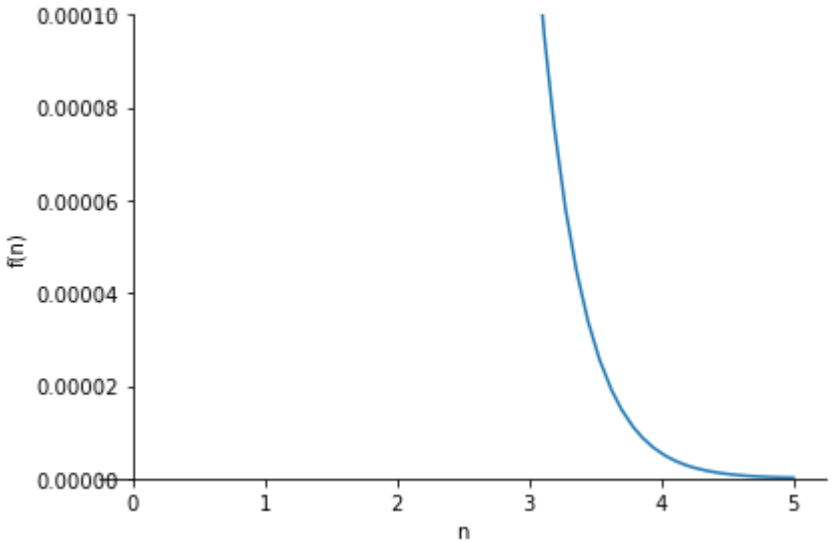
2c

In [7]:
```
print(f"The sum of the series within 0.0001 using the integral is {N(integrate(an, (n,
```

```
The sum of the series within 0.0001 using the integral is 0.0191950368579348
```

2d

In [8]:
```
plot(an.subs(n, n+1), (n, 0, 5), ylim = (0, 0.0001))
print("It appears that at least three terms are needed to approximate the integral to
```



It appears that at least three terms are needed to approximate the integral to 0.0001 by looking at the graph.

2e

In [9]:
```
terms = nsolve(an.subs(n, n+1) - 0.0001, 3)
print(f"The number of terms needed to approximate the series to 0.0001 is: {ceiling(te
```

```
The number of terms needed to approximate the series to 0.0001 is: 4
```

2f

In [10]:
```
print(f"The sum of the series within 0.0001 using the alternating series estimation th
```

```
The sum of the series within 0.0001 using the alternating series estimation theorem i
s 0.00301248965909831
```

Question 3

3a

In [11]:
```
x, n = symbols('x n')
expr = factorial(n)**2 / factorial(2*n) * x**n
s = Sum(expr, (n, 0, oo))

print(f"The limit of the ratio test as n approaches infinity is: {limit(abs(simplify(e
```

```
The limit of the ratio test as n approaches infinity is: Abs(x)/4
```

3b

In [12]:
```
print(f"The radius of convergence is 4. The endpoints of the interval of convergence a
```

```
The radius of convergence is 4. The endpoints of the interval of convergence are -4 a
nd 4.
```

3c

In [13]:
```
try:
    print(f"The sum of the series when x = 4 is: {N(s.subs(x, 4))}")
except ValueError:
    print("The series diverges for x = 4.")
```

```
The series diverges for x = 4.
```

3d

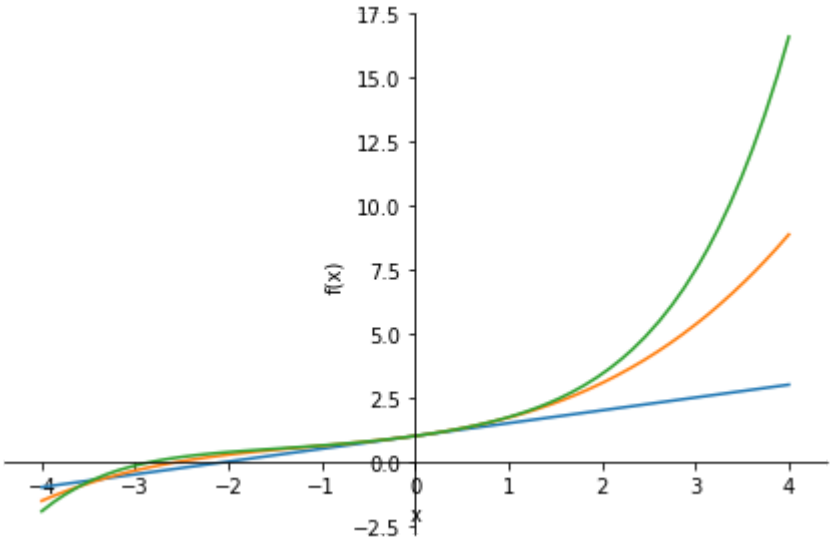
In [14]:
```
nvals = [10, 100, 1000, 10000]
for i in nvals:
    print(f"The value of |an| when n = {i} is: {N(abs(expr.subs(x, -4).subs(n, i)))}")

print(f"Based on the values of |an|, the series diverges for x = -4.")
```

```
The value of |an| when n = 10 is: 5.67546385503042
The value of |an| when n = 100 is: 17.7467079428307
The value of |an| when n = 1000 is: 56.0569188406160
The value of |an| when n = 10000 is: 177.247600671712
Based on the values of |an|, the series diverges for x = -4.
```

3e

In [15]:
```
plot(Sum(expr, (n, 0, 1)), Sum(expr, (n, 0, 3)), Sum(expr, (n, 0, 5)), (x, -4, 4))
```



Out[15]:
```
<sympy.plotting.plot.Plot at 0x26498d1f070>
```