MATH 151 Lab 5

Put team members' names and section number here.

Kevin Lei Jonathan Madding Pan Zhou John Schumacher

Section number 576

In [1]:
```
from sympy import *
from sympy.plotting import (plot,plot_parametric)
```

Question 1

1a

In [2]:
```
#8 derivatives
x, n = symbols("x, n")

expr0 = E ** x * (1 + x ** 2)

i = 1
while i <= 8:
    print("f", end = "")
    for j in range(i):
        print("'", end = "")
    print(f"(x) = {diff(expr0, x, i)}")
    i += 1
```

```
f'(x) = 2*x*exp(x) + (x**2 + 1)*exp(x)
f''(x) = (x**2 + 4*x + 3)*exp(x)
f'''(x) = (x**2 + 6*x + 7)*exp(x)
f''''(x) = (x**2 + 8*x + 13)*exp(x)
f'''''(x) = (x**2 + 10*x + 21)*exp(x)
f''''''(x) = (x**2 + 12*x + 31)*exp(x)
f'''''''(x) = (x**2 + 14*x + 43)*exp(x)
f''''''''(x) = (x**2 + 16*x + 57)*exp(x)
```

1b

In [3]:
```
#formula for derivative
nthderiv = E ** x * (x ** 2 + 2 * n * x + (n ** 2 - n + 1))
print(f"The formula for the nth derivative of f is {nthderiv}")
```

```
The formula for the nth derivative of f is (n**2 + 2*n*x - n + x**2 + 1)*exp(x)
```

1c

In [4]:
```
#50th
print(f"{diff(expr0, x, 50)}")
print(f"{nthderiv.subs(n, 50)}")
```

```
(x**2 + 100*x + 2451)*exp(x)
(x**2 + 100*x + 2451)*exp(x)
```

Question 2

2a

In [5]:
```
k, t = symbols("k, t")
y = cos(k * t)
print(f"k = {solve(4 * diff(y, t, 2) + 25 * y, k)}")
```

```
k = [-5/2, 5/2, pi/(2*t), 3*pi/(2*t)]
```

2b

In [6]:
```
A, B = symbols("A, B")
eq = A * sin(k * t) + B * cos(k * t)
for i in solve(4 * diff(y, t, 2) + 25 * y, k):
    if (4 * diff(eq, t, 2) + 25 * eq).subs(k, i) == 0:
        print(f"Every member of the family of functions y = A sin(kt) + B cos(kt) is a
    else:
        print(f"Not every member of the family of functions y = A sin(kt) + B cos(kt)
```

```
Every member of the family of functions y = A sin(kt) + B cos(kt) is also a solution
for k = -5/2.
Every member of the family of functions y = A sin(kt) + B cos(kt) is also a solution
for k = 5/2.
Not every member of the family of functions y = A sin(kt) + B cos(kt) is also a solut
ion for k = pi/(2*t).
Not every member of the family of functions y = A sin(kt) + B cos(kt) is also a solut
ion for k = 3*pi/(2*t).
```

Question 3

3a

In [7]:
```
#derivative
g = ((t - 2) / (2 * t + 1)) ** 9
print(diff(g, t, 1))
```

```
-18*(t - 2)**9/(2*t + 1)**10 + 9*(t - 2)**8/(2*t + 1)**9
```

3b

In [8]:
```
#simplify
print(simplify(diff(g, t, 1)))
```

```
45*(t - 2)**8/(2*t + 1)**10
```

3c

In [9]:
```
#horizontal tangent lines
print(f"Function g would have a horizontal tangent line at x = {solve(diff(g, t, 1), t
```

```
Function g would have a horizontal tangent line at x = [2]
```

3d

In [10]:
```
#derivative
f = (2 * t + 1) ** 5 * (t ** 2 - t + 2) ** 4
print(diff(f, t, 1))
```

```
(2*t + 1)**5*(8*t - 4)*(t**2 - t + 2)**3 + 10*(2*t + 1)**4*(t**2 - t + 2)**4
```

3e

In [11]:
```
#simplify
print(simplify(diff(f, t, 1)))
```

```
(2*t + 1)**4*(t**2 - t + 2)**3*(10*t**2 - 10*t + 4*(2*t - 1)*(2*t + 1) + 20)
```

3f

In [12]:
```
#factor
print(factor(diff(f, t, 1)))
```

```
2*(2*t + 1)**4*(t**2 - t + 2)**3*(13*t**2 - 5*t + 8)
```

3g

In [13]:
```
print("The factored version would be more useful for locating the horizontal tangent l
```

```
The factored version would be more useful for locating the horizontal tangent lines o
f f(t) since in its factored form, it is easier to see where t could equal zero, whic
h is really just where the derivative is equal to zero or a horizontal tangent.
```

Question 4

4a

In [14]:
```
#ROC
mu, W, theta = symbols("mu, W, theta")
F = mu * W / (mu * sin(theta) + cos(theta))

print(f"F'(theta) = {diff(F, theta, 1)}")
```

```
F'(theta) = W*mu*(-mu*cos(theta) + sin(theta))/(mu*sin(theta) + cos(theta))**2
```

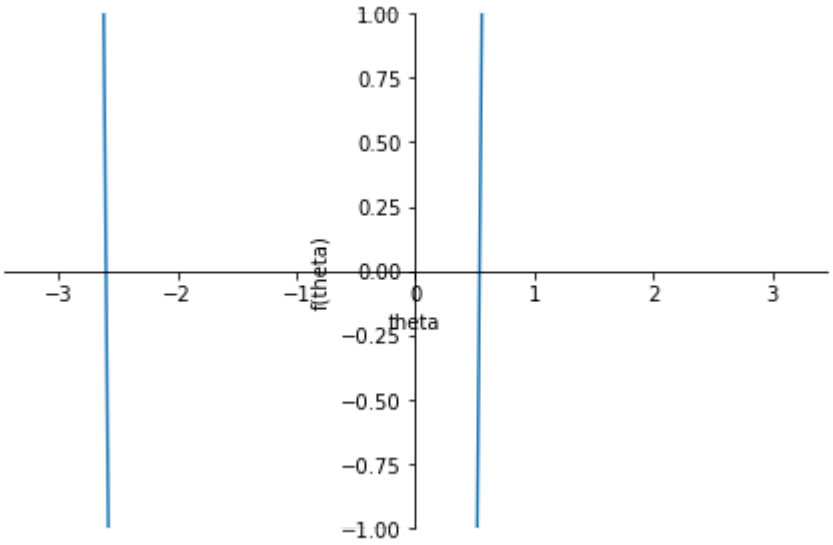
4b

In [15]:
```
#ROC = 0
print(f"theta = {solve(diff(F, theta, 1), theta)}")
```

```
theta = [2*atan((sqrt(mu**2 + 1) - 1)/mu), -2*atan((sqrt(mu**2 + 1) + 1)/mu)]
```

4c

In [16]:
```
#graph
plot(diff(F.subs([(W, 100), (mu, 0.6)]), theta, 1), (theta, -1 * pi, pi), ylim = (-1,
print("According to the graph, the values of theta where dF/dTheta = 0 is about -2.5 a
```



According to the graph, the values of theta where dF/dTheta = 0 is about -2.5 and 0.5

4d

In [17]:
```
#verify (c)
print(f"Given the conditions of part c, dF/dTheta equals zero in the domain of [-pi, p
```

Given the conditions of part c, dF/dTheta equals zero in the domain of [-pi, pi] when theta equals 0.540419500270584 and -2.60117315331921.