MATH 151 Lab 3

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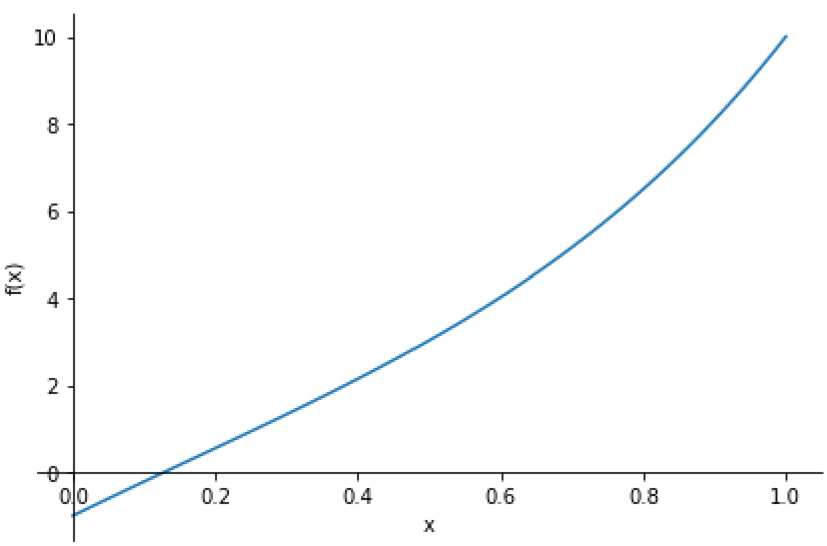
In [26]:
```
from sympy import *
from sympy.solvers import solve
from sympy import Symbol, N
from sympy.plotting import (plot,plot_parametric)
```

Question 1

In [27]:
```
#conditions of IVT

x = Symbol('x')
f = pow(x,5)+4*pow(x,3)-2*pow(x,2)+8*x-1

# interval = [0,1]
# print(f"F({interval[0]}) = {f.evalf(interval[0])}")
# #num of values to itterate through

plot(f,(x,0,1))

print("observe that there are no holes gaps or spaces along the interval [0,1] fo
print("therefore f(x) satisfys IVT over the interval [0,1]")
```




```
observe that there are no holes gaps or spaces along the interval [0,1] for f
(x)
therefore f(x) satisfys IVT over the interval [0,1]
```

1a

In [28]:
```
#result of IVT

x = Symbol('x')
f = pow(x,5)+4*pow(x,3)-2*pow(x,2)+8*x-1

def find_val(function, val):
    return function.subs(x, val)

interval = [0,1]

f0 = find_val(f,interval[0])
f1 = find_val(f,interval[-1])

print("f(0) =",f0)
print("f(1) =",f1)

if f0 < 0 and f1 > 0 or -f0 < 0 and -f1 > 0:
    print("0 is between f(0), f(1)")
    print(f"IVT is statistfied over the interval [{interval[0]},{interval[-1]}]")
    print("ergo a root exists")
else:
    print("0 is not between f(0), f(1)")
    print(f"IVT is not statistfied over the interval [{interval[0]},{interval[-1]
    print("ergo a root doest exist")
```

```
f(0) = -1
f(1) = 10
0 is between f(0), f(1)
IVT is statistfied over the interval [0,1]
ergo a root exists
```

1b

In [29]:
```
#root

x = Symbol('x')
f = pow(x,5)+4*pow(x,3)-2*pow(x,2)+8*x-1



interval = [0,1]


print(f"IVT is statistfied over the interval [{interval[0]},{interval[-1]}]")
print("ergo a root exists")
print(f"the root over the interval [{interval[0]},{interval[-1]}] for f(x) if x =
```

```
IVT is statistfied over the interval [0,1]
ergo a root exists
the root over the interval [0,1] for f(x) if x = 0.128044891411745
```

Question 2

2a

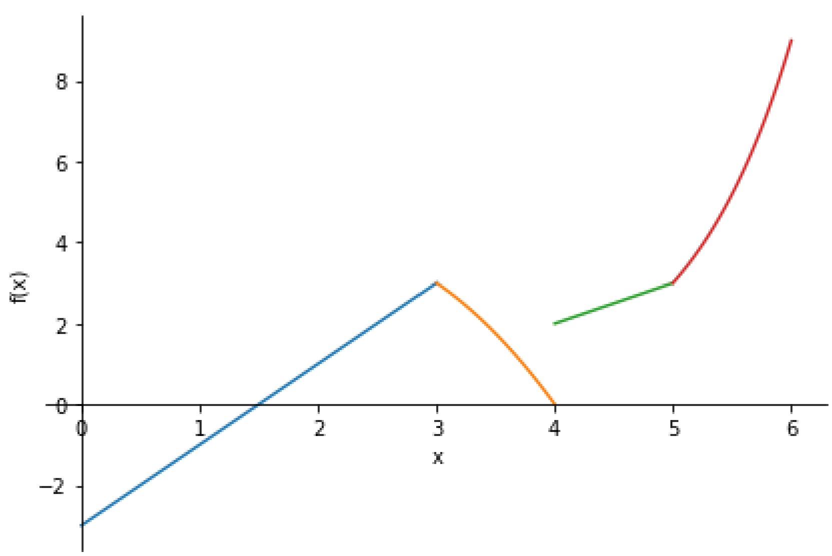
In [31]:

```
#limits

x = Symbol('x')

f = 0


eqs = [2*x-3, 4*x - x**2, (x**2-6*x + 8)/(x-4), exp((x-4)*ln(3))]

nums = [3,4,5]

def eq(val):
    if val >= 0 and val <= 3:
        f = 2*x-3
    elif val > 3 and val <= 4:
        f = 4*x - x**2
    elif val > 4 and val < 5:
        f = (x**2-6*x + 8)/(x-4)
    elif val >= 5:
        f = exp((x-4)*ln(3))
    elif f == 0:
        print("------------EQUATION DID NOT WORK------------")

    return f.subs(x,val)

for i in range(0,3):


    lim1 = limit(eqs[i],x,nums[i])

    lim2 = limit(eqs[i+1],x,nums[i])

    print(f"at the first potential break point of F(x), where x = {nums[i]}:")
    print(f"the equation from the left: {eqs[i]}, has a limit of {lim1}")
    print(f"the equation from the right: {eqs[i+1]}, has a limit of {lim2}")

    if lim1 == lim2:

        print(f"since the limits of {eqs[i]} and {eqs[i+1]} are equal, we know up

    else:

        print(f"since the limits of {eqs[i]} and {eqs[i+1]} are not equal, we tha

        if eq(nums[i]) == lim1:
            print(f"given that the limit of F(X) from the left is equal to F(X) a
            print("F(x) is left side continuous")
        elif eq(nums[i]) == lim2:
            print(f"given that the limit of F(X) from the right is equal to F(X)
            print("F(x) is right side continuous")


    print("\n")
```

```
at the first potential break point of F(x), where x = 3:
the equation from the left: 2*x - 3, has a limit of 3
the equation from the right: -x**2 + 4*x, has a limit of 3
since the limits of 2*x - 3 and -x**2 + 4*x are equal, we know up to this point
F(x) is continuous


at the first potential break point of F(x), where x = 4:
the equation from the left: -x**2 + 4*x, has a limit of 0
the equation from the right: (x**2 - 6*x + 8)/(x - 4), has a limit of 2
since the limits of -x**2 + 4*x and (x**2 - 6*x + 8)/(x - 4) are not equal, we
that F(x) has a break point at x = 4
given that the limit of F(X) from the left is equal to F(X) at x = 4
F(x) is left side continuous


at the first potential break point of F(x), where x = 5:
the equation from the left: (x**2 - 6*x + 8)/(x - 4), has a limit of 3
the equation from the right: exp((x - 4)*log(3)), has a limit of 3
since the limits of (x**2 - 6*x + 8)/(x - 4) and exp((x - 4)*log(3)) are equal,
we know up to this point F(x) is continuous
```

2b

In [32]:
```
#graph

plot((eqs[0],(x,0,3)),(eqs[1],(x,3,4)),(eqs[2],(x,4,5)),(eqs[3],(x,5,6)))
```

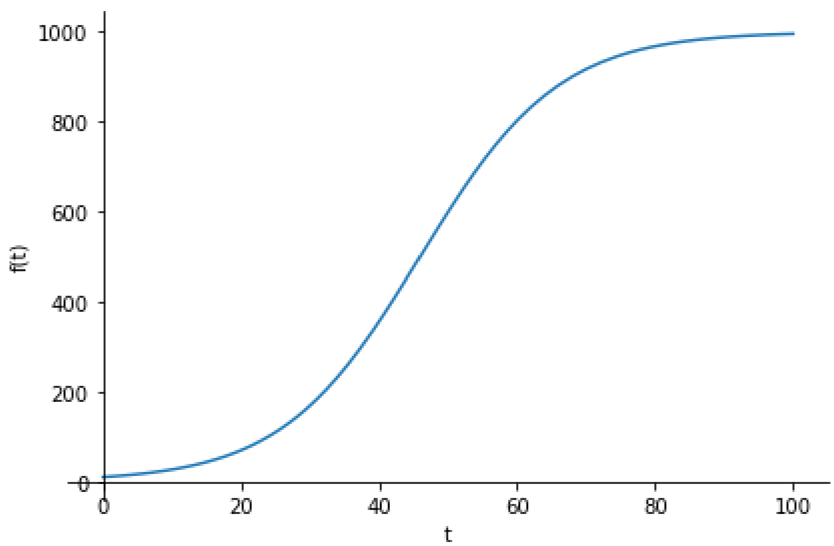


Out[32]: `<sympy.plotting.plot.Plot at 0x2bd0c5cdc10>`

Question 3

3a

In [33]:
```
#graph

P0 = 10
t = Symbol('t')
r = .1
K = 1000

Pop = (P0*K)/((P0+(K-P0)*exp(-r*t)))

plot(Pop,(t,0,100))
```



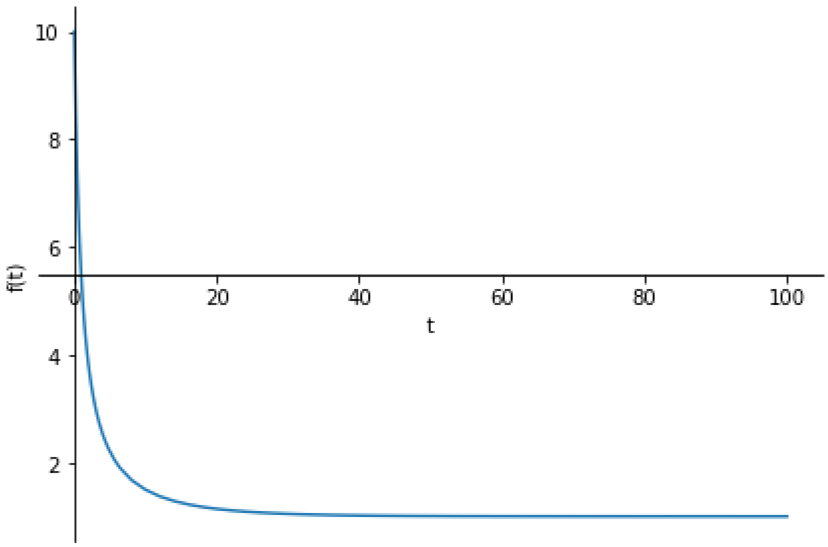
Out[33]: <sympy.plotting.plot.Plot at 0x2bd0c5b1b20>

In [34]:
```
#limit
print(f"the limit of Pop(t) as x approaches infinity where K = {K} is {limit(Pop,
```

```
the limit of Pop(t) as x approaches infinity where K = 1000 is 1000
```

3b

In [35]:
```
#graph
P0 = 10
t = Symbol('t')
r = .1
K = 1

Pop = (P0*K)/((P0+(K-P0)*exp(-r*t)))

plot(Pop,(t,0,100))
```



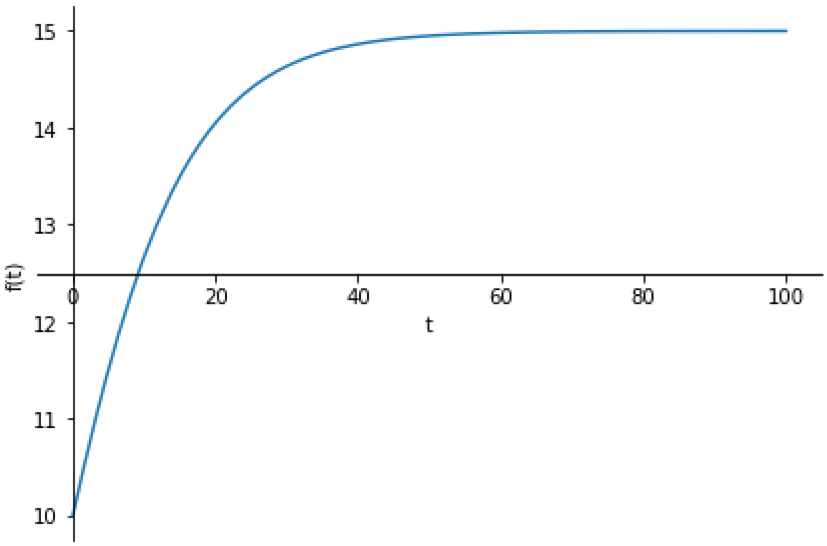
Out[35]: <sympy.plotting.plot.Plot at 0x2bd0c5b1b80>

In [36]:
```
#Limit
print(f"the limit of Pop(t) as x approaches infinity where K = {K} is {limit(Pop,
```

```
the limit of Pop(t) as x approaches infinity where K = 1 is 1
```

3c

In [37]:
```
#graph
P0 = 10
t = Symbol('t')
r = .1
K = 15

Pop = (P0*K)/((P0+(K-P0)*exp(-r*t)))

plot(Pop,(t,0,100))
```



Out[37]: <sympy.plotting.plot.Plot at 0x2bd0c7642b0>

In [38]:
```
#Limit
print(f"the limit of Pop(t) as x approaches infinity where K = {K} is {limit(Pop,
```

```
the limit of Pop(t) as x approaches infinity where K = 15 is 15
```

3d

In [39]:
```
#observation on K
print("as x approaches infinity Pop(x) approaches K")
```

```
as x approaches infinity Pop(x) approaches K
```

In [ ]: