PART-B

Find the maxima and minima of the function $x/(1+x^2)$.

In [1]:

```
from sympy import Symbol, solve, Derivative
import sympy as sp
x = Symbol('x')
f = x/(1+x**2)

d1 = Derivative(f, x).doit()
print(d1)

critical_points = solve(d1)
print(critical_points)



d2 = Derivative(f, x, 2).doit()
print(d2)

for i in range(len(critical_points)):
    print("critical point", i+1, "=", critical_points[i])

    print("second derivative at",critical_points[i], "=", d2.subs({x:critical_points
    #evalf() evaluates the final value of the expression
```

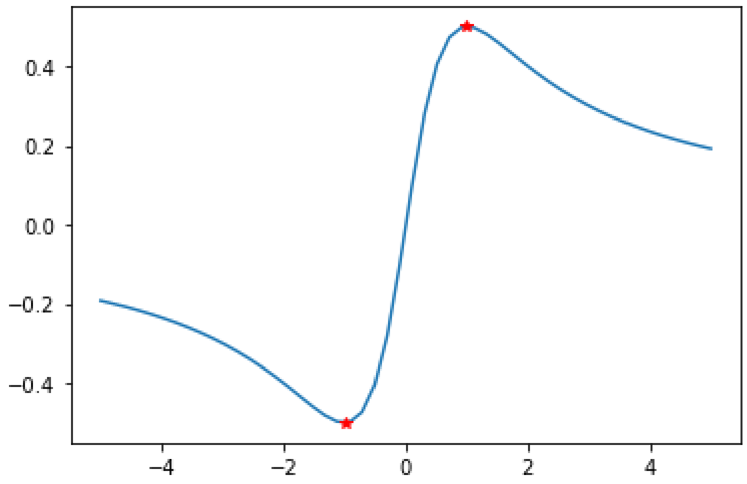
```
-2*x**2/(x**2 + 1)**2 + 1/(x**2 + 1)
[-1, 1]
2*x*(4*x**2/(x**2 + 1) - 3)/(x**2 + 1)**2
critical point 1 = -1
second derivative at -1 = 0.500000000000000

critical point 2 = 1
second derivative at 1 = -0.500000000000000
```

In [2]:

```
from matplotlib.pyplot import *
from numpy import *
a = linspace(-5,5)
b  = a/(1+a**2)
plot(a,b)

for i in range(len(critical_points)):
    plot(critical_points[i],f.subs({x:critical_points[i]}), color='r', marker = '*')
```



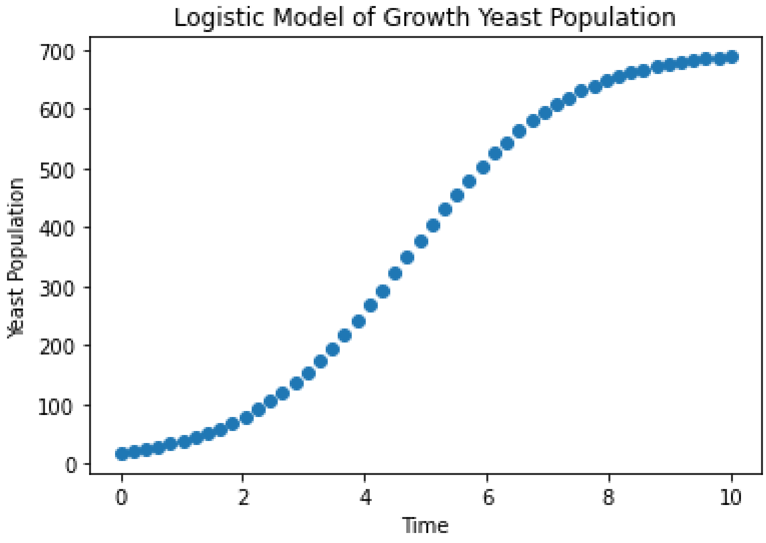
Researcher stock a tank with 18 yeast and the estimated the carrying capacity is 700 yeast. Assuming that the yeast population growth satisfies the logistic equation with a growth rate of 0.773, find population after t years.

In [4]:

```
from scipy.integrate import odeint
# ODE are solved in Python with the Scipy.integrate package using function ODEINT.
#(ODEINT: General integration of ordinary differential equations.)
import numpy as np
import matplotlib.pyplot as plt
```

In [5]:

```
def g(P,t):
    eq=k*P*(1-P/700)
    return eq
k=0.773
P0=18
t=np.linspace(0,10,50)
P1=odeint(g,P0,t)
plt.plot(t,P1,"o")
plt.title("Logistic Model of Growth Yeast Population")
plt.xlabel("Time")
plt.ylabel("Yeast Population")
None
```


Logistic Model of Growth Yeast Population
Yeast Population
Time