DELHI TECHNOLOGICAL UNIVERSITY

MATHEMATICS –III (MC-203)

PRACTICAL FILE

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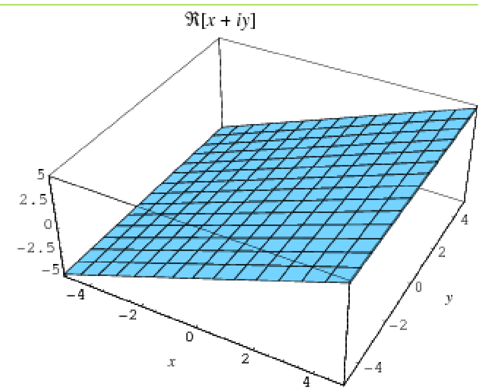
AIM

Find and plot Re(f(z)), Im(f(z)), and |f| as surfaces over the z-plane. Also, plot the two families of curves Re(f(z))=constant and Im(f(z))=constant in the same figure, and the curves |f|=constant in another figure when (i) f(z)=z^3, (ii) f(z)=1/z .

THEORY

Real Part



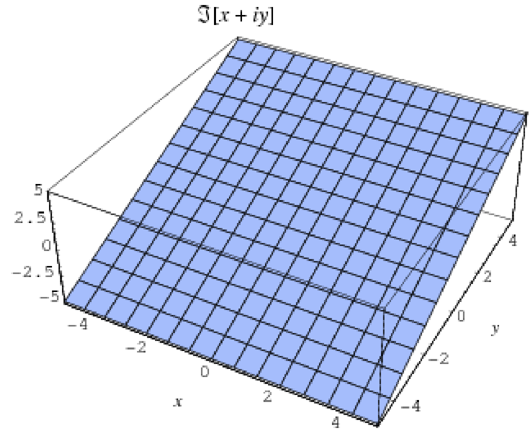
The real part $\Re[z]$ of a complex number $z = x + i\,y$ is the real number *not* multiplying i, so $\Re[x + i\,y] = x$. In terms of z itself,

$$\Re[z] = \frac{1}{2}(z + \bar{z}),$$

where $\bar{z}$ is the complex conjugate of z. The real part is implemented in the Wolfram Language as Re[*z*].

A nonzero complex number with zero real part is called an imaginary number or sometimes, for emphasis, a purely imaginary number.

Imaginary Part



The imaginary part $\mathrm{I}[z]$ of a complex number $z = x + i\,y$ is the real number multiplying i, so $\mathrm{I}[x + i\,y] = y$. In terms of z itself,

$$\mathrm{I}[z] = \frac{z - \bar{z}}{2\,i},$$

where $\bar{z}$ is the complex conjugate of z. The imaginary part is implemented in the Wolfram Language as `Im`[*z*].

The modulus of a complex number z, also called the complex norm, is denoted $|z|$ and defined by

$$|x + i\,y| \equiv \sqrt{x^2 + y^2}\,.$$

If z is expressed as a complex exponential (i.e., a phasor), then

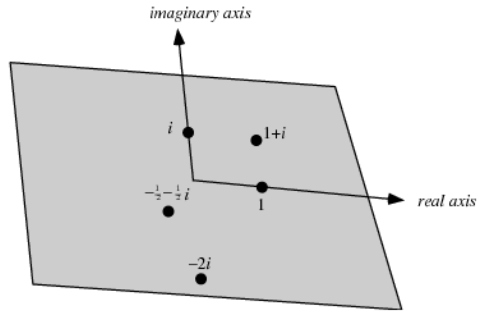
$$\left|r\,e^{i\,\phi}\right| = |r|.$$

The complex modulus is implemented in the Wolfram Language as `Abs`[*z*], or as `Norm`[*z*].

The square $|z|^2$ of $|z|$ is sometimes called the absolute square.

Complex Plane

EXPLORE THIS TOPIC IN The *MathWorld* Classroom



The complex plane is the plane of complex numbers spanned by the vectors 1 and i, where i is the imaginary number. Every complex number corresponds to a unique point in the complex plane. The line in the plane with $i = 0$ is the real line. The complex plane is sometimes called the Argand plane or Gauss plane, and a plot of complex numbers in the plane is sometimes called an Argand diagram.

The complex plane together with the point at infinity $\mathbb{C} \cup \{\infty\}$ is known as the Riemann sphere or extended complex plane and denoted $\mathbb{C}^*$ or $\hat{\mathbb{C}}$. However, the notation $\mathbb{C}^*$ is also used to denote the punctured plane $\mathbb{C} - \{0\}$.

SOURCE CODE

1. Surfaces

f=1/z

```
clear all;

close all;

%if the function is f=1/z

%for f=u+iv, u=real(f)/(abs(f)^2)


syms re(x,y) im(x,y) md(x,y)

z=x +i*y


%real part of w

re=x/(abs(z)^2)


%imaginary part of w

im=-y/(abs(z)^2)
```

```
%absolute f
md=abs(z)

%plotting the surfaces
ezsurf(re,im,md)
hold on
grid on
legend('Re(f)','Im(f)','Abs(f)')

clear all;
close all;
%if the function is f=z^3
%for f=u+iv
```

f=z^3

```
syms re(x,y) im(x,y) md(x,y)
z=x +i*y

%real part of w
re = x^3 - (3*y*y*x);

%imaginary part of w
im = (3*x*x*y) - y^3;

%absolute f
md=abs(z)

%plotting the surfaces
ezsurf(re,im,md)
hold on
grid on
```

```
legend('Re(f)','Im(f)','Abs(f)')
```

2. Curves

f=1/z

```
%plotting curves for f=constant
close all;
clear all;

syms rf(x) imf(y) z(x,y)

%z=x + i*y;
%f=1/z; f=u+iv

%let
c=.5;

%const = real(f) = x/(x^2+y^2)
rf = sqrt((-c*x*x + x)/c);
fplot(rf,'r')
hold on
fplot(-rf,'r')
hold on

%const = imag(f) = -y/(x^2+y^2)
im(y) =sqrt((c*y*y +y)/c);
fplot(im,'b')
hold on
fplot(-im,'b')
grid on
legend('Re(f)','Re(f)','Im(f)', 'Im(f)')
```

```
%plotting curves for f=constant
close all;
clear all;

syms md(x) z(x,y)

z=x + i*y;
%f=1/z; f=u+iv
%const = abs(f)= sqrt(x^2+y^2)

%let
c=1;

md(x) = sqrt(c*c - x*x);
fplot(md,'r')
hold on
```

f=z^3

```
%plotting curves for f=constant
close all;
clear all;

syms rf(x) imf(y) z(x,y)

%z=x + i*y;
%f=z^3; f=u+iv
```

```
%let
c=.5;

%const = real(f) = sqrt((x*x*x - c)/(3*x))
rf = sqrt((x*x*x - c)/(3*x));
fplot(rf,'r')
hold on
fplot(-rf,'r')

%const = imag(f) =
im(y) =sqrt((y*y*y + c)/(3*y));
fplot(im,'b')
hold on
fplot(-im,'b')
grid on
legend('Re(f)', 'Re(f)', 'Im(f)','Im(f)')
```

OUTPUT

1. **Surfaces**

   f=1/z:

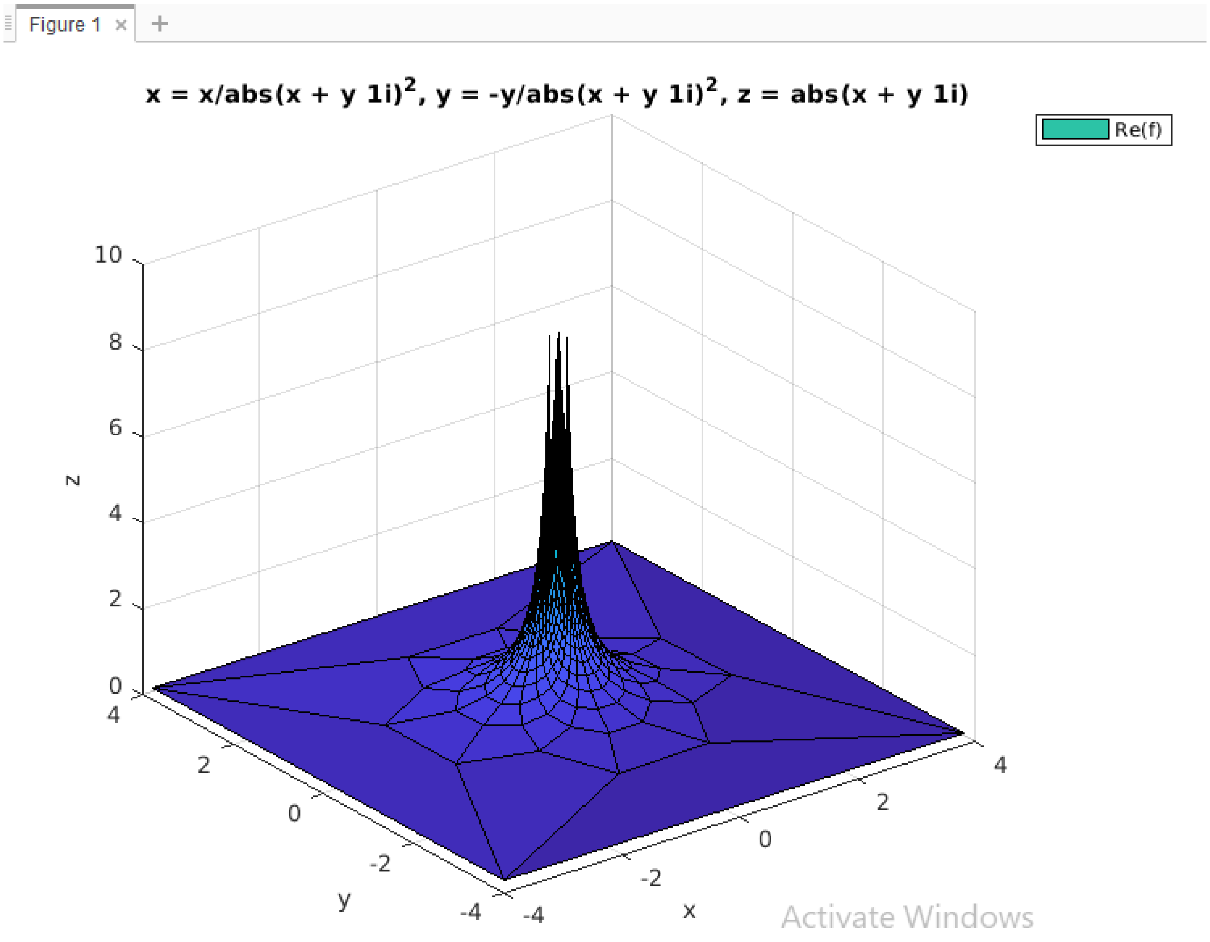


Figure 1
x = x/abs(x + y 1i)^2, y = -y/abs(x + y 1i)^2, z = abs(x + y 1i)
Re(f)
10
8
6
z
4
2
0
4
2
0
-2
y
-4
-4
-2
0
x
2
4
Activate Windows

f=z^3:

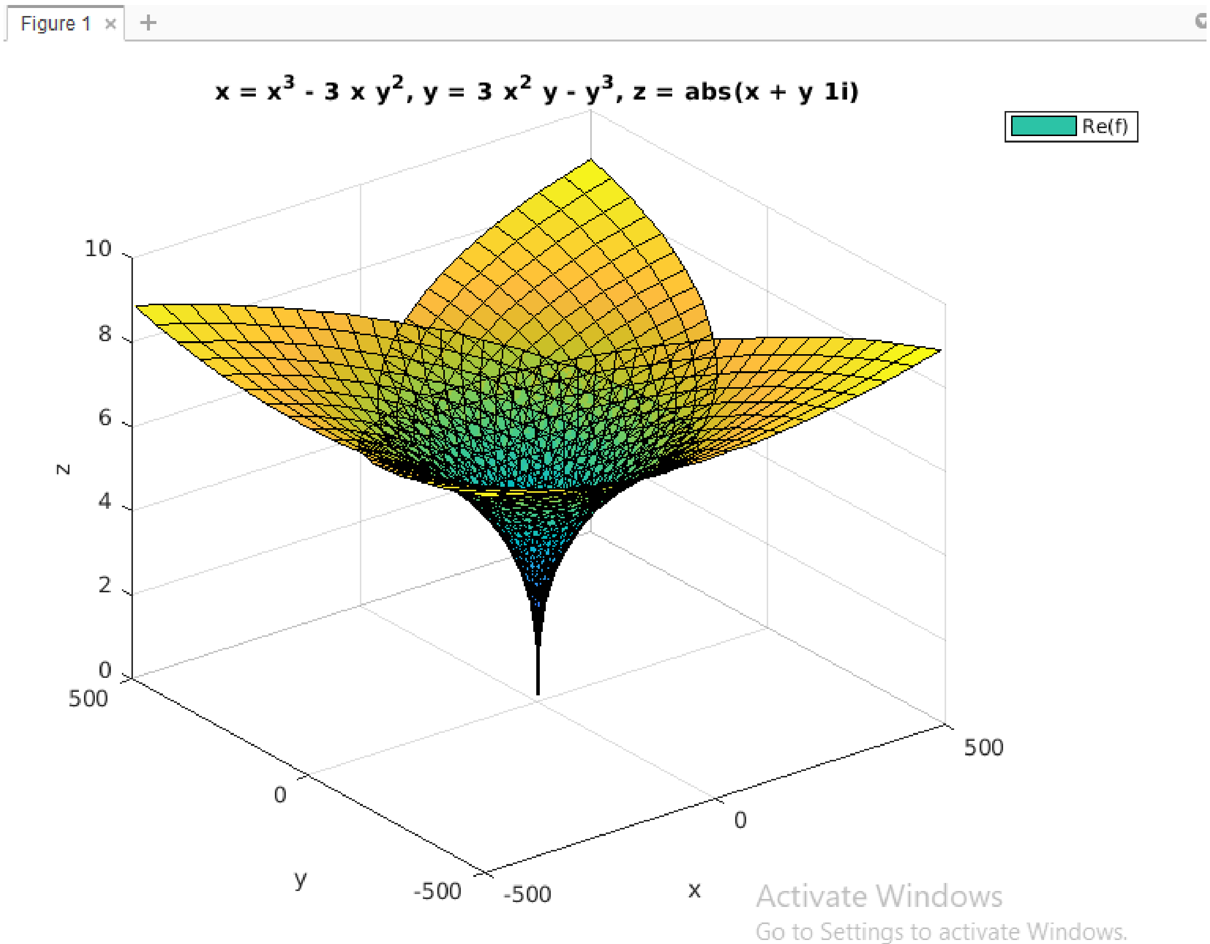


Figure 1
x = x^3 - 3 x y^2, y = 3 x^2 y - y^3, z = abs(x + y 1i)
Re(f)
z
10
8
6
4
2
0
500
0
y
-500
-500
0
500
x
Activate Windows
Go to Settings to activate Windows.

2. Curves
f=1/z

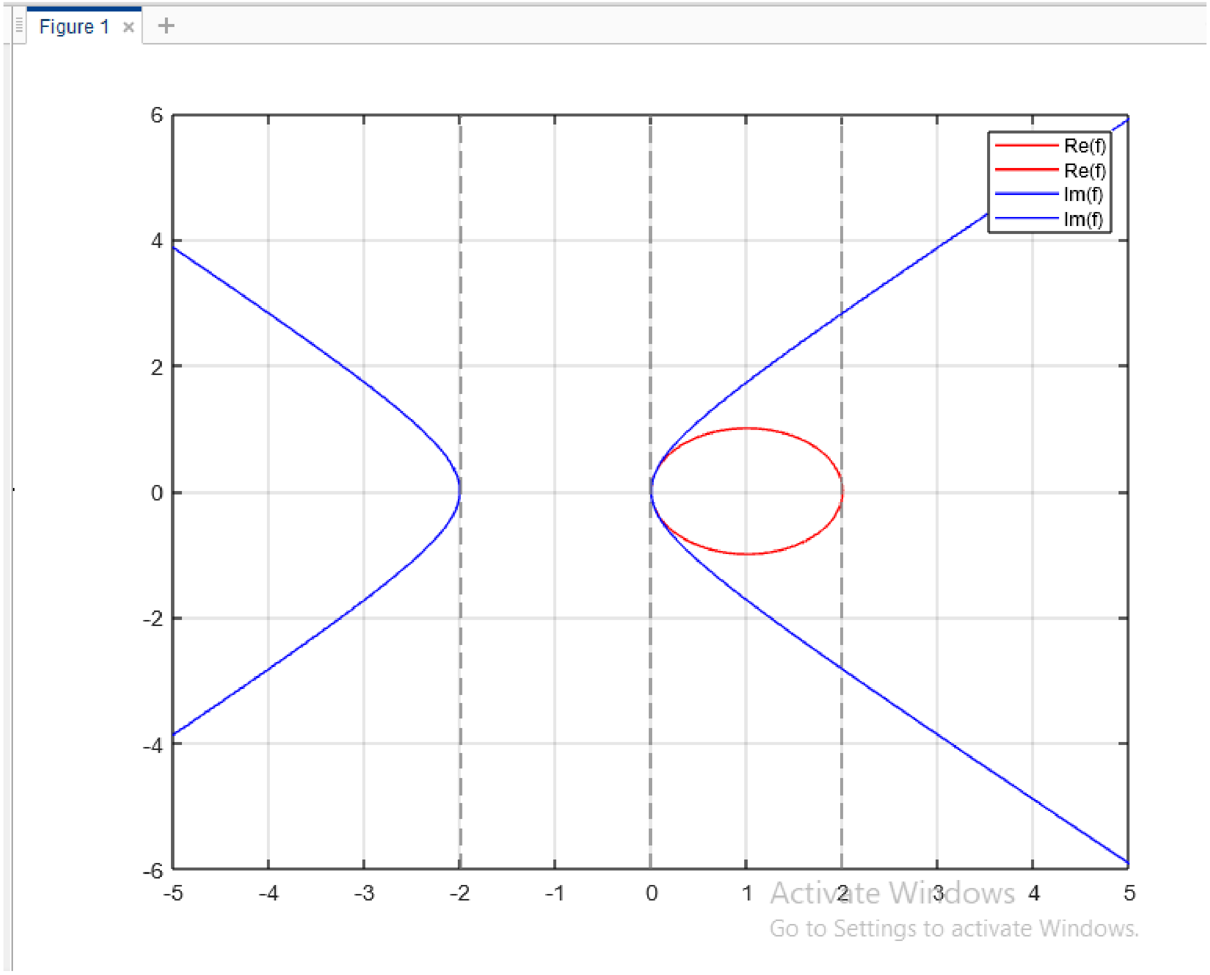


Figure 1
6
4
2
0
-2
-4
-6
-5
-4
-3
-2
-1
0
1
2
3
4
5
Re(f)
Re(f)
Im(f)
Im(f)
Activate Windows
Go to Settings to activate Windows.

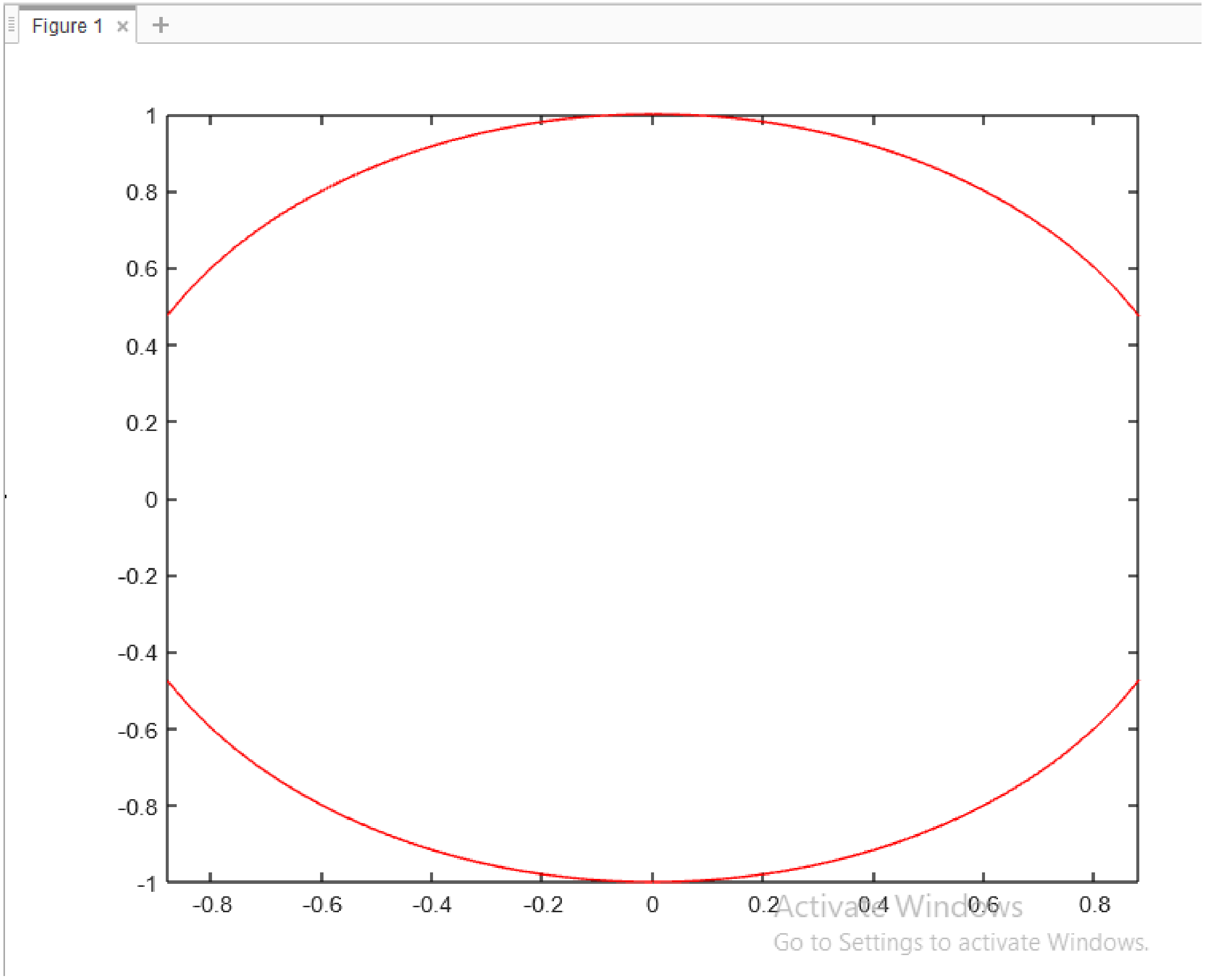


Figure 1
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
-0.8
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
Activate Windows
Go to Settings to activate Windows.

f=z^3

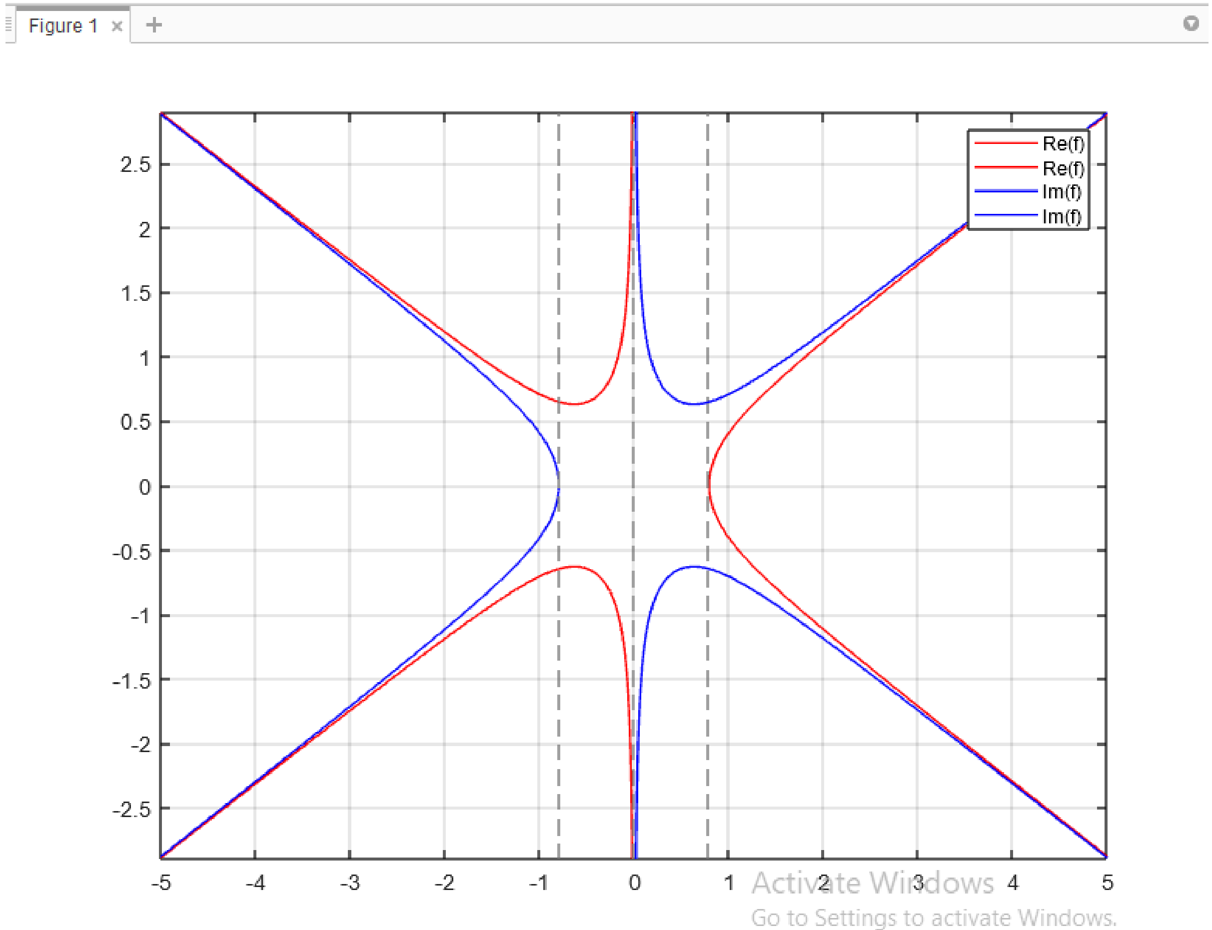


Figure 1
Re(f)
Re(f)
Im(f)
Im(f)
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
-5
-4
-3
-2
-1
0
1
2
3
4
5
Activate Windows
Go to Settings to activate Windows.