Experiment No. (7) – Complex and Polar

Object:

Complex numbers are important to digital signal processing. For example, functions like the Fourier transform return their results as complex numbers.

Theory:

A problem arises because the square root of a negative quantity does not exist. To deal with this, we have the imaginary quantity j. (Some people prefer i instead.) This imaginary quantity is defined:

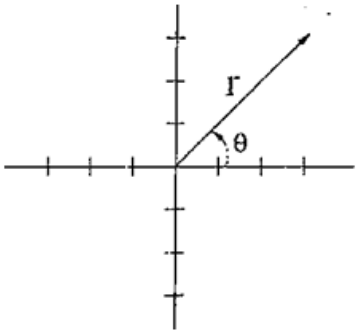
$$\boldsymbol{i = \sqrt{-1}}$$

A complex number has a real part and an imaginary part, in the form:

Real + imaginary * j

For example, a = 3 + 4j.

Polar coordinates tell us where the point is located, but the point is specified by a length and an angle.



- To convert from polar coordinates to complex Cartesian ones:

$$x = r\cos\emptyset$$
$$y = r\sin\emptyset$$

- To convert from Cartesian coordinates to polar ones:

$$r = \sqrt{real^2 + imaginart^2} = \sqrt{x^2 + y^2}$$

$$\emptyset = tan^{-1}\frac{y}{x} = \arctan\frac{y}{x}$$

This leads to a problem when x is negative i.e.:
if ∅ lie in the second and third quadrants. Therefore, their angles should measure between $\frac{\pi}{2}$ (≅1.57) and π(≅3.14) for ∅2 and between $-\frac{\pi}{2}$ and - π for ∅3. Adding π to ∅2 and - π to ∅3 fixes the problem

MATLAB Functions

A. atan

Inverse tangent; result in radians..

Syntax**:** **y =atan(x)**

Return inverse tangent (arctangent) y for each element of x.

B. cart2pol

Transform Cartesian coordinates to polar

Syntax: **[theta,r]=cart2pol(x,y)**

Transforms two-dimensional Cartesian coordinates stored in corresponding elements of arrays x and y into polar coordinates.

C. pol2cart

Transform polar coordinates to Cartesian.

Syntax: **[x,y] = pol2cart(theta,r)**

Transform the polar coordinate data stored in corresponding elements of theta and r to two-dimensional Cartesian, or x,y.

Example

Solution of complex to polar of z = 3 + 4j.

$$\theta 1 = \arctan\frac{b}{a} = \arctan\frac{4}{3} = 0.9273\ rad$$

$$\theta 2 = \arctan\frac{b}{-a} = \arctan\frac{4}{-3} = -0.9273\ rad$$

$$\theta 3 = \arctan\frac{-b}{-a} = \arctan\frac{-4}{-3} = 0.9273\ rad$$

$$\theta 4 = \arctan\frac{-b}{a} = \arctan\frac{-4}{3} = -0.9273\ rad$$

Then:

$$\theta 1 = \arctan\frac{b}{a} = \arctan\frac{4}{3} = 0.9273\ rad$$

$$\theta 2 = \arctan\frac{b}{-a} + \pi = \arctan\frac{4}{-3} + \pi = 2.2143\ rad$$

$$\theta 3 = \arctan\frac{-b}{-a} = \arctan\frac{-4}{-3} - \pi = -2.2143\ rad$$

$$\theta 4 = \arctan\frac{-b}{a} = \arctan\frac{-4}{3} = -0.9273\ rad$$

$$r1 = \sqrt{a^2 + b^2} = \sqrt{3^2 + 4^2} = 5$$

$$r2 = \sqrt{-a^2 + b^2} = \sqrt{-3^2 + 4^2} = 5$$

$$r3 = \sqrt{-a^2 + -b^2} = \sqrt{-3^2 + -4^2} = 5$$

$$r4 = \sqrt{a^2 + -b^2} = \sqrt{3^2 + -4^2} = 5$$

Writing program in matlab

In order to convert matrixes from complex Cartesian to polar coordinates :

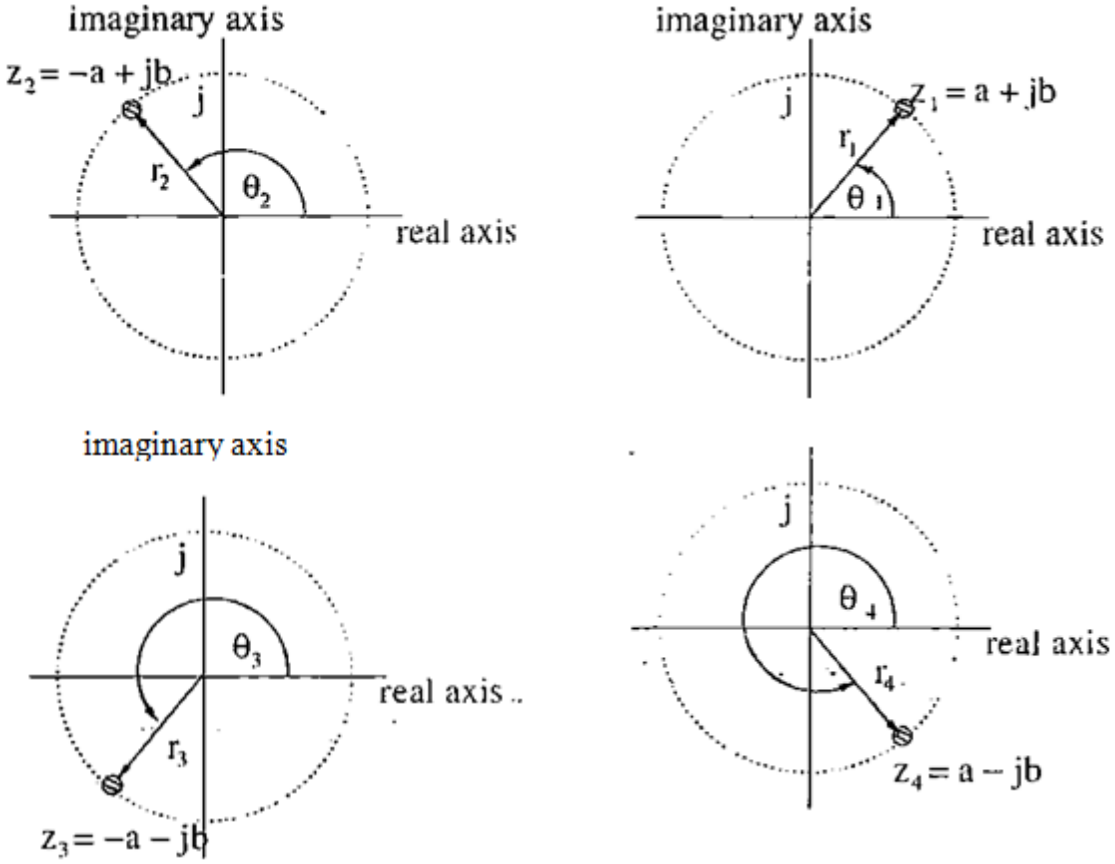
1- calculate x & y and write them in matlab as a matrix.
2- apply the formula : **[theta,R]=cart2pol(x,y).**
   where X & Y are i/p , theta & R are o/p.

In order to convert matrixes from polar coordinates to complex Cartesian:

1- calculate **theta &R** and write them in matlab as a matrix.
2- apply the formula : **[x,y] = poI2cart(theta,r).**
   where X & Y are i/p , theta & R are o/p.

Procedure:

1- Write a program in MATLAB to convert x, y matrixes below from polar coordinates to complex Cartesian
   X= [3, -3, 3 ,-3], Y=[4, 4, -4, -4]
2- Write a program in MATLAB to convert **theta & r** below from complex Cartesian to polar coordinates
   Theta =0. 9273 , R = 5
3- repeat **procedure 1** with the given values x,y.
4- let (a=3 , b=4), Correct the error angles for z2 and z3 in figure below.



Discussion

1- Write a MATLAB program to convert the complex number (Cartesian) to polar using the four angels. Where the values of the first angle are x= 3, y=5.
2- Write a MATLAB program to convert from Polar to Cartesian coordinates. Where π=3.1416