Heaven's Light is Our Guide

Rajshahi University of Engineering& Technology

Department of Electrical & Computer Engineering

Course No: ECE 4124
Course Name: Digital Signal Processing

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Experiment No: 05

Experiment Name: Z transform and Inverse Z transform of Causal, Non Causal and Anti-Causal system

Theory:

A mathematical technique called the Z-transform is used to translate differential equations in the time domain into algebraic equations in the z-domain.

The analysis of a linear shift invariant (LSI) system is the Z-transform. Difference equations are used to model an LSI discrete time system. These time-domain difference equations are solved by first converting them into algebraic equations in the z-domain using the Z-transform, manipulating the algebraic equations in the z-domain, and then converting the results back into the time domain using the inverse Z-transform.

The Z-transform formula

X(z) = ∑ x[n]Z −n ∞ ∑n=−∞

The method of determining the time domain signal x(n) from its Z-transform X(z) is known as the inverse Z-transform.

The symbol for the inverse Z-transform is- $x(n)$ = Z −1 [X(z)]

Required software: MATLAB

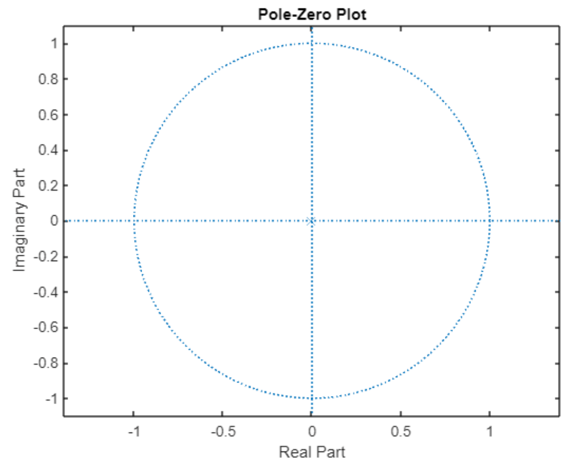
Code:

Causal System:

```
clc;
clear all;
x=input('array: ');b=0;
y=sym('z');
n=length(x);
for i=1:n
   b=b+x(i)*y^(1-i);

end
b
z=[];
p=[0]
zplane(z,p)
```

Output:

```
array:
[2 3 3 4]

b =

3/z + 3/z^2 + 4/z^3 + 2


p =

     0
```

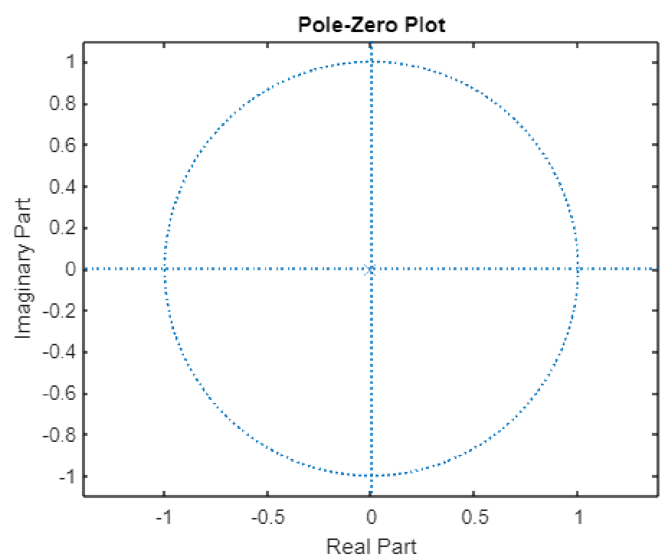


Non causal System:

```
clc;

clear all;
x=input('array: ');
b=0;
y=sym('z');
n=length(x);
m=input('index:')
for i=1:n
   b=b+x(i)*y^(m-i);

end
b
z=[];
p=[0]
zplane(z,p)
```

Output:

```
array:
[1 2 3 4]
index:
4

m =

     4


b =

z^3 + 2*z^2 + 3*z + 4


p =

     0
```

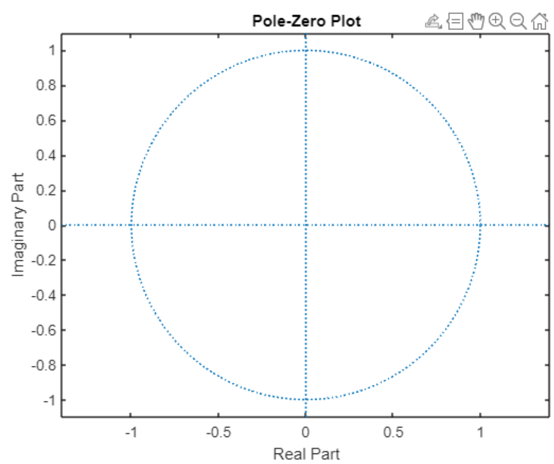


Anti causal System:

```
clc;
clear all;
x=input('array: ');b=0;
y=sym('z');
n=length(x);
for i=1:n
   b=b+x(i)*y^(-(i-n));

end
b
z=[];
p=[]
zplane(z,p)
```

Output:

```
array:
[1 2 3 4]

b =

z^3 + 2*z^2 + 3*z + 4


p =

     []
```



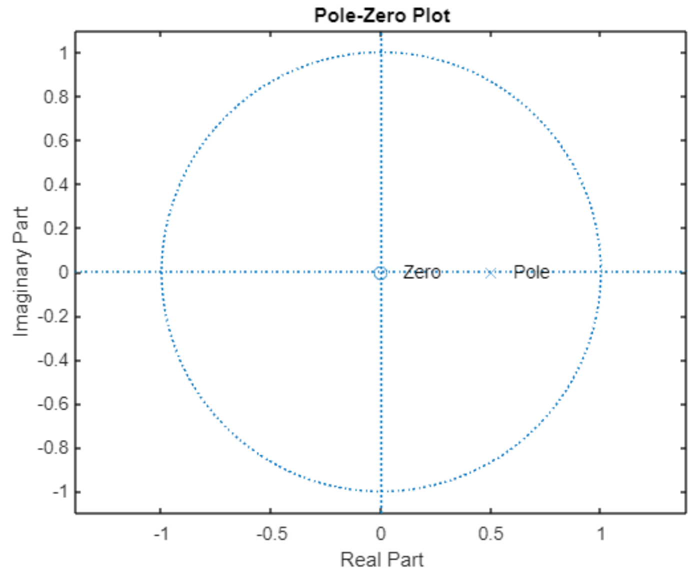
Inverse Z transform:

```
clc;
clear all;
y=sym('z');syms n;
%f=exp(-2*n);
f=2^-n;
F=ztrans(f)
t=iztrans(F);
t=simplify(t);
disp(t);z=[0];
%p=poles(F);
%zplane(z,p);
%grid
b = [1];
a = [1 -1/2];

[b,a] = eqtflength(b,a);
[z,p,k] = tf2zp(b,a)
```

```
zplane(b,a)
text(real(z)+0.1,imag(z),"Zero")
text(real(p)+0.1,imag(p),"Pole")
```

Output:

```
F =

z/(z - 1/2)

1/2^n


z =

     0


p =

    0.5000


k =

     1
```



Conclusion:

The experiment was done successfully as we have achieved the expected output which matches theoretical analysis.