Heaven's Light is Our Guide

Rajshahi University of Engineering & Technology

(RUET)

Department of ECE

Course No.: ECE 4124

Course Title: Digital Signal Processing Sessional

LAB REPORT

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5.1 Experiment No: 05

5.2 Experiment Date: 22.05.2023

5.3 Experiment Name: Z-transform, zeroes, poles & ROC of Causal, Anti-causal, and Non-causal signal

5.4 Theory:

Casual Signal: In the context of the Z-transform, a causal signal is a sequence that is nonzero only for nonnegative indices or time instances. It is also as right handed signal. The Z-transform of a right-sided signal can be computed using the definition of the Z-transform.

The general formula for the Z-transform of a right-sided signal x[n] is:

$$X(z) = \sum[x[n] * z^{(-n)}], \text{ for } n = 0 \text{ to infinity}$$

Anti-causal Signal: In the context of the Z-transform, a anti-causal signal is a sequence that is nonzero only for negative indices or time instances. It is also called as left handed signal. The Z-transform of a left-sided signal can be computed using the definition of the Z-transform.

The general formula for the Z-transform of a left-sided signal x[n] is:

$$X(z) = \sum[x[n] * z^{(-n)}], \text{ for } n = -\text{infinity to } -1$$

Non-Causal Signal: Non-causal signal in the context of the Z-transform refers to a sequence that has nonzero values for both positive and negative indices or time instances. The Z-transform of a non-causal signal can still be computed using the definition of the Z-transform.

The general formula for the Z-transform of a non-causal signal x[n] is:

$$X(z) = \sum[x[n] * z^{(-n)}], \text{ for all values of } n$$

5.5 Code & Output:

5.5.1.1 Code of Causal Signal:

```
x=[1 2 3 4 5]
b=0;
n=length(x);
y=sym('z');
for i=1:n
    b=b+x(i)*y^(1-i);
end
display(b)

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

5.5.1.2 Output:

```
>> z_transform

x =

     1     2     3     4     5


b =

2/z + 3/z^2 + 4/z^3 + 5/z^4 + 1
```

Figure 5.1: Output of Causal Signal

5.5.1.3 Zeros and poles:

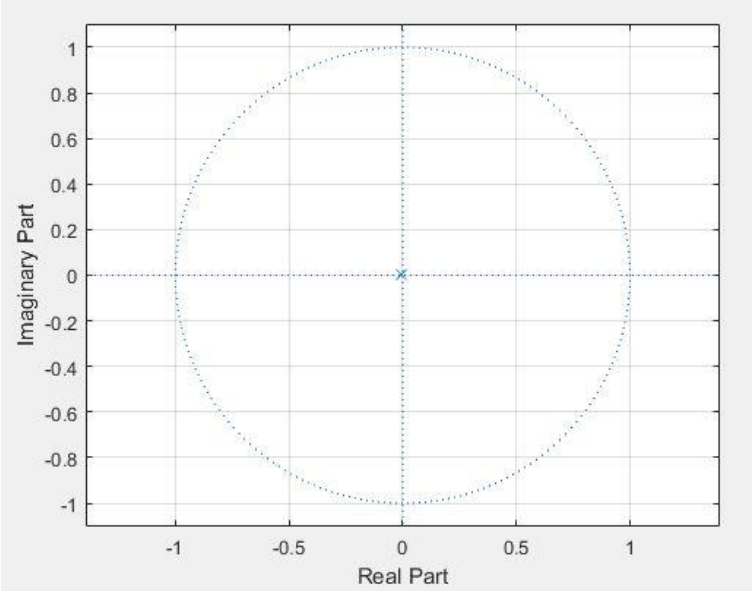

Figure 5.2: Zeros and Poles of Causal Signal

5.5.2.1 Code of Anti Causal signal:

```
x=[1 2 3 4 5]
b=0;
n=length(x);
y=sym('z');
for i=1:n
    b=b+x(i)*y^(i-1);
end
display(b)
z=[];
p=[]
zplane(z,p)
```

5.5.2.2 Output:

```
x =

     1     2     3     4     5


b =

5*z^4 + 4*z^3 + 3*z^2 + 2*z + 1
```

Figure 5.3:Output of anti-causal Signal

5.5.2.3: Poles and Zeros:

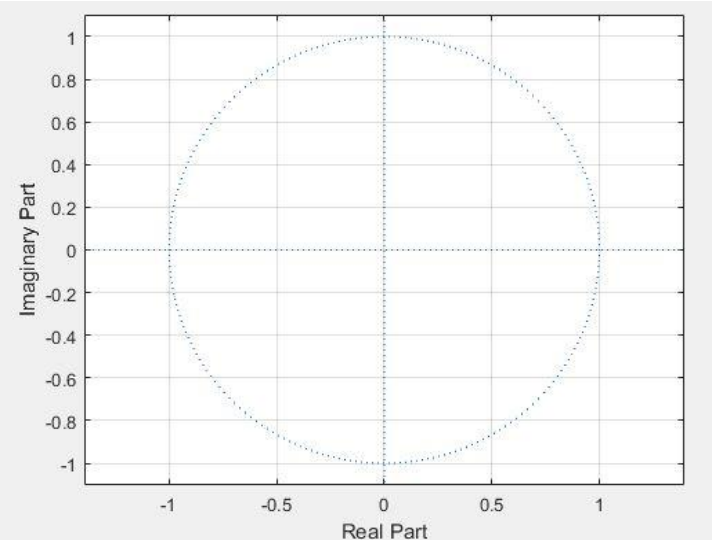

Figure 5.4: Zeros and Poles of anti-causal signal

5.5.3.1 Code of non causal signal:

```
x=[1 2 3 4 5]
value=3;
index=find(x==value);
disp(index);


b=0;
n=length(x);
y=sym('z');
for i=1:n
    b=b+x(i)*y^(index-i);
end
display(b)


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

5.5.3.2 Output:

```
x =

     1     2     3     4     5

     3


b =

2*z + 4/z + 5/z^2 + z^2 + 3
```

Figure 5.3: Output of Non causal signal

5.5.3.3 Poles and Zeros:

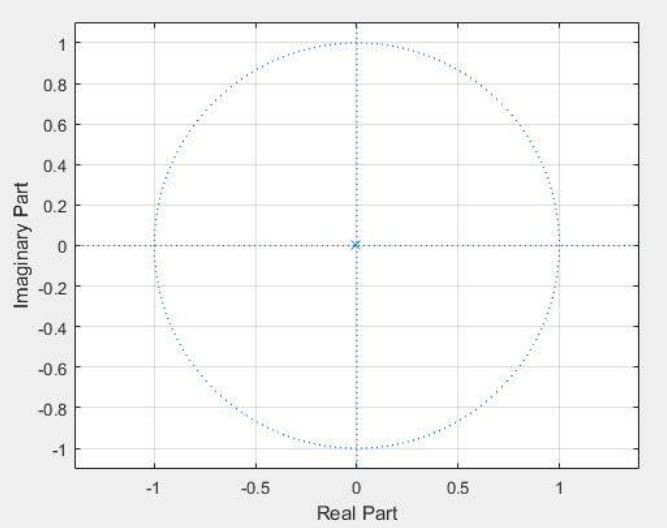

Figure 5.4: Poles and Zeros of non-causal signal

5.6 Discussion: In this experiment, we learnt about some signal like causal signal, anti causal signal and non causal signal. We saw the basic differences of these signals. A causal signal is a sequence that is nonzero only for nonnegative indices or time instances. The Z-transform of a causal signal is typically a rational function with a region of convergence (ROC) that includes the unit circle. An anti-causal signal is a sequence that is nonzero only for negative indices or time instances. The Z-transform of an anti-causal signal is typically a rational function with a region of convergence (ROC) that includes the exterior of the unit circle. A non-causal signal is a sequence that has nonzero values for both positive and negative indices or time instances. The Z-transform of a non-causal signal can still be computed, but the resulting expression may not be a rational function, and the ROC may be a ring or annulus in the Z-plane. We implemented the code for causal, anti causal, non-causal and finally we saw the poles and zeros of different signals.

5.7 Conclusion: We successfully completed the task as we got the exactly same result which we learnt from the theory.