Experiment No: 05
Experiment Date: 22-05-2023
Experiment Name: Study of Causal, Anti-causal, Non-causal Signals, Their Respective Poles & Zeros on the Z-plane

Theory:
In signal processing and systems theory, causal, anti-causal, and non-causal signals describe different relationships between the cause and effect of the signal.
1.Causal Signals:A causal signal is a signal whose output values depend only on past and present input values, but not on future input values. In other words, the output at any moment depends only on the past and present input values up to that moment. Causal signals are commonly encountered in many physical systems and real-world phenomena. Causal signals are, for example, the reading of a temperature sensor, stock market data or audio recording.
2. Anti-causal Signals: An anti-causal signal is the opposite of a causal signal. This means that output values depend only on future and current input values, but not on past input values. In other words, the output at any given moment depends only on the current and future input values. Counter-causal signals are rarer in practice and often arise in theoretical scenarios. An example of a counter-causal signal would be predicting future stock prices based on current and future data without considering past data.
3.Non-causal Signals: Non-causal signals are those whose output values depend on past and future input values. These signals violate the principle of causality and are usually considered hypothetical or theoretical constructs. Non-causal signals cannot be applied in practice, but they can be used as mathematical models or analysis tools. They can help understand the behavior of systems or explore theoretical concepts. An example of a non-causal signal would be a mathematical function that produces an output based on both past and future input values.

Code:
1.Causal Signal:
```
x=[3 1 2 4]
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)
```

2.Anti-causal Signal:

```
x=[3 1 2 4]
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)
```

3.Non-causal Signal:

```
x=[3 1 2 4]
c=input('Enter the Index: ');
 disp(c); b=0;
 n=length(x);
y=sym('z');
for i=0:n-1
if i>=c-1 b=b+x(i+1)*y^(c-i-1);
else
b=b+x(i+1)/y^(i-c+1);
end
end
display(b)
 z=[];
 p=[0]
zplane(z,p)
```

Output:

1.Causal Signal:

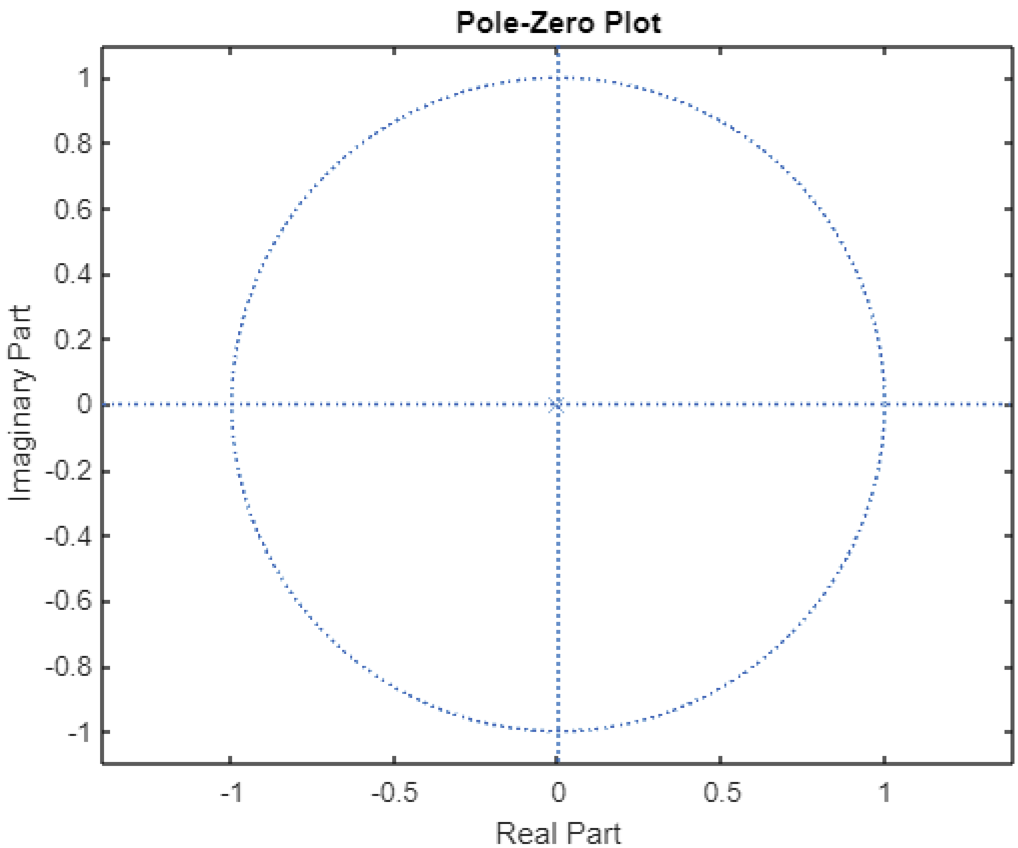

Figure 01: Poles and Zeros Output

```
>> causal

x =

     3     1     2     4


b =

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

Figure 02: Result

2. Anti-causal Signal:

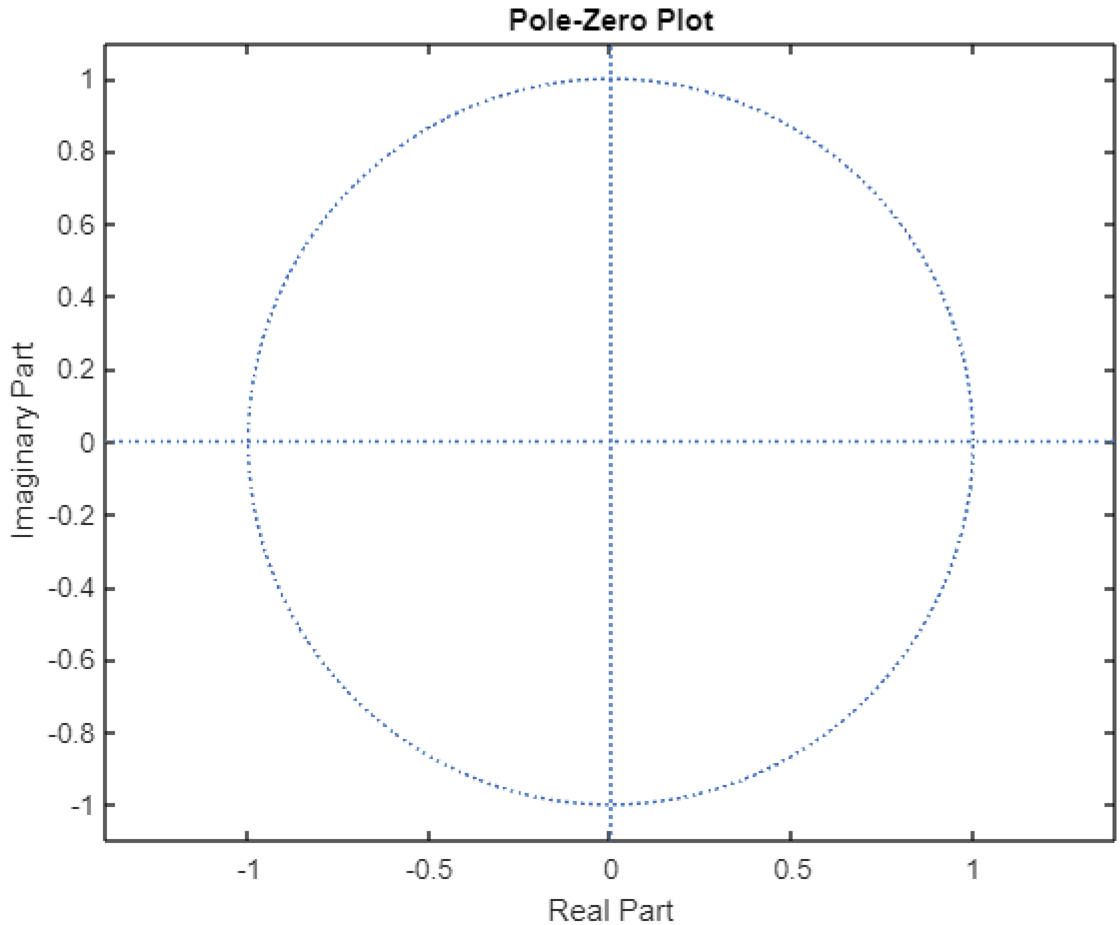

Figure 03: Poles and Zeros Output

```
>> anti_causal

x =

     3     1     2     4


b =

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

Figure 04: Result

3.Non-causal Signal:

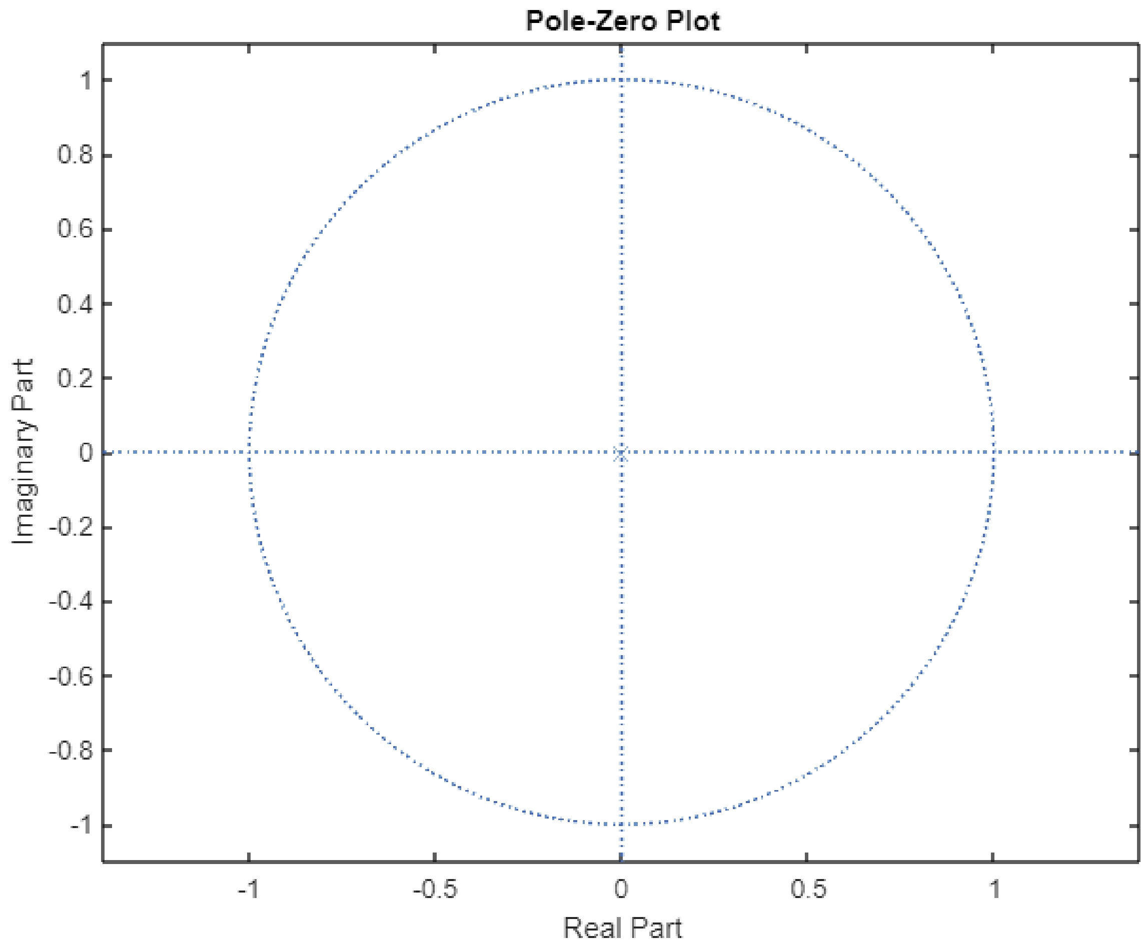

Figure 05: Poles and Zeros Output

```
>> non_causal

x =

     3     1     2     4

Enter the Index:
2
     2


b =

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

Figure 06: Result

Discussion and conclusion: A causal signal is a sequence that has values only for non-negative indices or time instances. When we apply the Z-transform to a causal signal, we usually get a rational function whose region of convergence (ROC) covers the unit circle. On the other hand, a causal signal is a sequence that has values only for negative indices or time instances. When we apply the Z-transform to an anti-causal signal, we usually get a rational function whose region of convergence (ROC) covers the outside of the unit circle.