Heaven's Light is Our Guide

Rajshahi University of Engineering & Technology

Department of Electrical & Computer Engineering

Course No: ECE 4124

Course Title: Digital Signal Processing Sessional

Submitted By:	**Submitted To:**
Name: Md. Turag Islam **Roll:** 1810020 **Date of Submission:**11/06/2023	Hafsa Binte Kibria Lecturer, ECE RUET

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:

> **Causal Signal:** A causal signal is one where the output at a given time depends only on the present and past input values. It doesn't rely on future values. Mathematically, a causal signal x[n] satisfies x[n] = 0 for n < 0.
>
> **Anti-causal Signal:** An anti-causal signal is one where the output at a given time depends only on future input values. It doesn't rely on past or present values. Mathematically, an anti-causal signal x[n] satisfies x[n] = 0 for n > 0.
>
> **Non-causal Signal:** A non-causal signal is one where the output at a given time depends on both past and future input values. It doesn't have a causal relationship. Mathematically, a non-causal signal x[n] is defined for all n.

Code:

i) 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)
```

ii) Anti-causal Signal

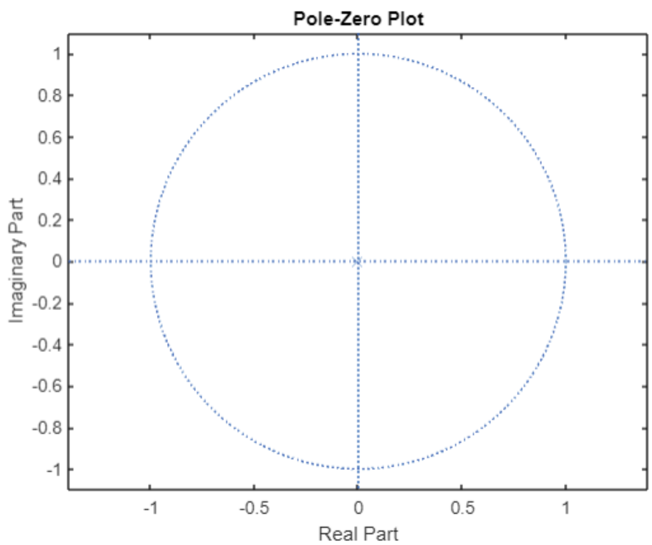
```
x=[3 1 2 4]
b=0;
n=length(x);
y=sym('z');
for i=1:n b=b+x(i)*y^(i-1);
end
display(b)
z=[];
p=[]
zplane(z,p)
```

iii) Non-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)
```

Output:

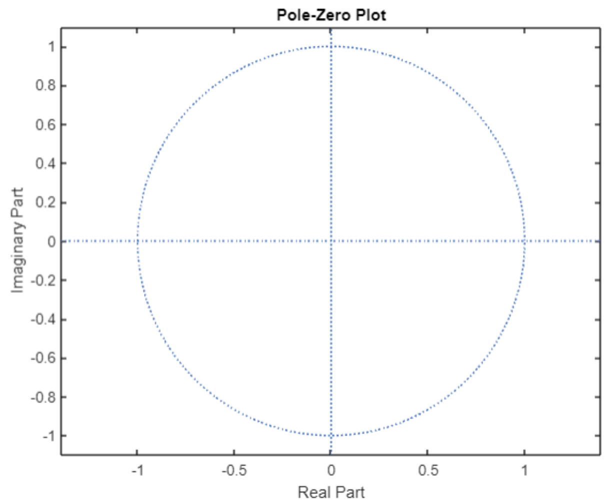
i)Causal Signal




```
>> causal

x =

     3     1     2     4


b =

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

Figure: Poles and Zeros Output & Result

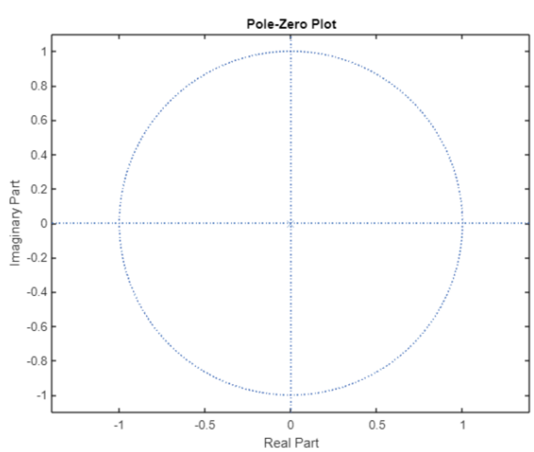
ii)Anti-causal Signal




```
>> anti_causal

x =

     3     1     2     4


b =

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

Figure: Poles and Zeros Output & Result

ii)Non-causal Signal



```
>> non_causal

x =

     3     1     2     4

Enter the Index:
2
     2


b =

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

Figure: Poles and Zeros Output & Result

Discussion:

The analysis of causal, anti-causal, and non-causal signals' poles and zeros in the Z-plane allowed us to understand their frequency domain behavior. Comparing their pole-zero plots highlighted the relationship between signal causality and Z-plane positions.

The Z-plane plots demonstrated that causal signals tend to have poles inside the unit circle, indicating stability, while anti-causal signals tend to have poles outside the unit circle, indicating instability. Non-causal signals often have a mix of poles inside and outside the unit circle.

Conclusion:

In conclusion, the lab experiment on studying causal, anti-causal, and non-causal signals and their respective poles and zeros in the Z-plane deepened our comprehension of signal behavior in the frequency domain. The distribution of poles and zeros in the Z-plane provides valuable insights into the stability and characteristics of signals. This knowledge is crucial for signal processing, system analysis, and designing stable systems in various engineering applications.