“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

Experiment No: 04

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Experiment No: 04

Experiment Name: Study of

1. Signal delay
2. Z transform and inverse z transformation
3. Zeros and poles of z transformation

Theory

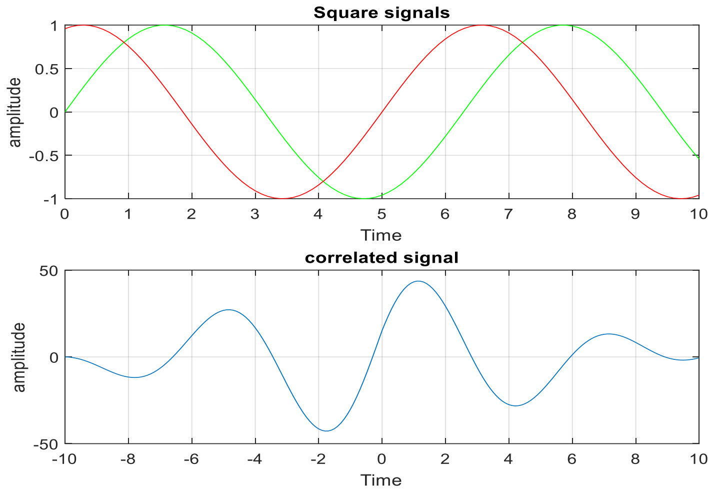
Signal delay refers to the time it takes for a signal to propagate from its source to its destination. It is a fundamental concept in signal processing and communication systems. Delay can introduce a time shift in the signal, affecting synchronization and timing aspects. It is often quantified in terms of the time delay or latency, measured in seconds or samples, and can impact various applications such as audio/video transmission, control systems, and signal analysis.

The Z-transform is a mathematical technique used to analyze and manipulate discrete-time signals. It converts a discrete-time signal into a complex function in the Z-domain, enabling analysis of its frequency response, system behavior, and stability. The inverse Z-transform, on the other hand, converts a Z-transform function back to its original discrete-time signal representation in the time domain. In the Z-transform, zeros and poles are fundamental components that characterize the frequency response and stability properties of discrete-time systems. Zeros are the values of the complex variable where the transfer function is zero, while poles are the values where the transfer function becomes infinite. The distribution of zeros and poles in the Z-domain provides insights into the system's behavior, filtering characteristics, and stability properties.

Code: (signal delay)

```
clc;
clear all;

t=0:0.1:10;
x= sin(t);
y= sin(t-5);
x1=square(x);
y1=square(y);
corr=xcorr(x,y);

[max_val,max_idx]=max(abs(corr));
time_delay=(max_idx-1)/10;
lag=-length(x)+1:length(y)-1;

%ploting signals
figure(2);
subplot(2,1,1);
plot(t,x,'g');
hold on;
plot(t,y,'r');
xlabel('Time');
ylabel('amplitude');
title('Square signals');
grid on;

subplot(2,1,2);
plot(lag/10,corr);
xlabel('Time');
ylabel('amplitude');

title('correlated signal');
grid on;

fprintf('Time delay between x1,y1 is %.2f sec.\n',time_delay);
```

Output:



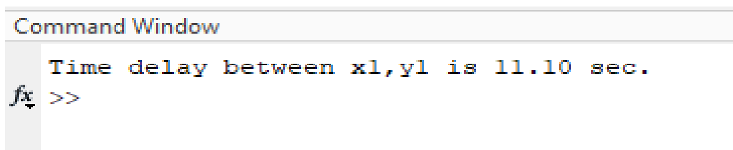


Figure 4.1: Output of signal delay

Code: (Z transformation and inverse z-transformation)

```
clc;
close all;

syms z;  % Define symbolic variable
X_z = ztrans([1 2 3 4], z);  % Define the input signal X(z)
disp('Z-transformation: ');
disp(X_z);  % Display the Z-transform of X(z)

%inverse Z-transformation
syms z;
X_z = (z + 1)/(z - 0.5);  % Define the Z-transform of X(z)
x_n = iztrans(X_z, z); % Compute the inverse Z-transform
disp('Inverse Z-transformation: ');
disp(x_n);% Display the inverse Z-transform
```

Output:

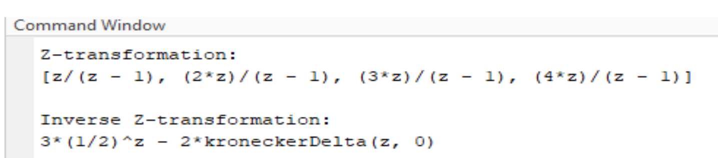


Figure 4.2: Output of z-transformation and inverse z-transformation

Code: (Zeros and poles of z-transformation)

```
clc;
close all;

% Define the numerator and denominator coefficients of the transfer function
num = [1 0 1];
den = [1 -0.5 0.25];

% Compute the zeros and poles
zeros_tf = roots(num);
poles_tf = roots(den);

% Plot the zeros and poles in the z-plane
figure;
zplane(zeros_tf, poles_tf);
title('Zeros and Poles');
```

Output

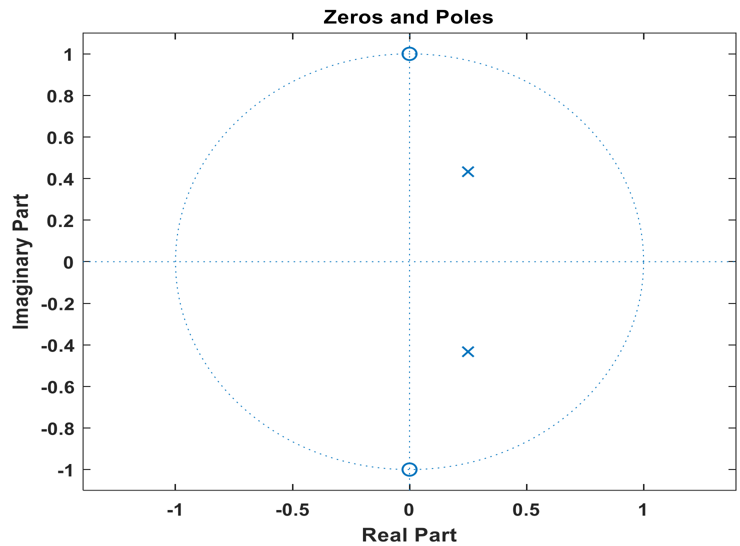


Figure 4.3: Zeros and poles of z-transformation

Conclusion & Discussion

The experiment was accomplished successfully and observed that the output of these codes were as same as the theory.