Rajshahi University of Engineering & Technology, Rajshahi

COURSE TITLE- Digital Signal Processing Sessional

COURSE NO- ECE 4124

18 SERIES

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Experiment No: 04

Experiment Name:

- Take a continuous square wave signal, make a delay of that signal and do the auto correlation of the two signal.
- Take a discrete square wave signal, make a delay of that signal and do the auto correlation of the two signal.
- Write a code for calculating z-transform of a signal.

Experiment Date: 14/05/23

Theory:

A discrete signal or discrete-time signal is a time series consisting of a sequence of quantities. And a continuous signal or a continuous-time signal is a varying quantity whose domain, which is often time, is a continuum. That is, the function's domain is an uncountable set. The function itself need not to be continuous. To contrast, a discrete-time signal has a countable domain, like the natural numbers.

The correlation of two functions or signals or waveforms is defined as the measure of similarity between those signals. And the autocorrelation function is defined as the measure of similarity or coherence between a signal and its time delayed version. Therefore, the autocorrelation is the correlation of a signal with itself.

The Z-Transform is an important tool in DSP that is fundamental to filter design and system analysis. The Z-transform converts a discrete-time signal, which is a sequence of real or complex numbers, into a complex frequency-domain representation. Also, it can be considered as a discrete-time equivalent of the Laplace transform.

Required Software: MATLAB

Code:

I. **Autocorrelation of continuous signal:**

```
clc;
clear all;
close all;

t= 0:1:10;
f=10;
x=10*sin(2*f*pi*t);
x1=10*sin(2*f*pi*(t-4));
```

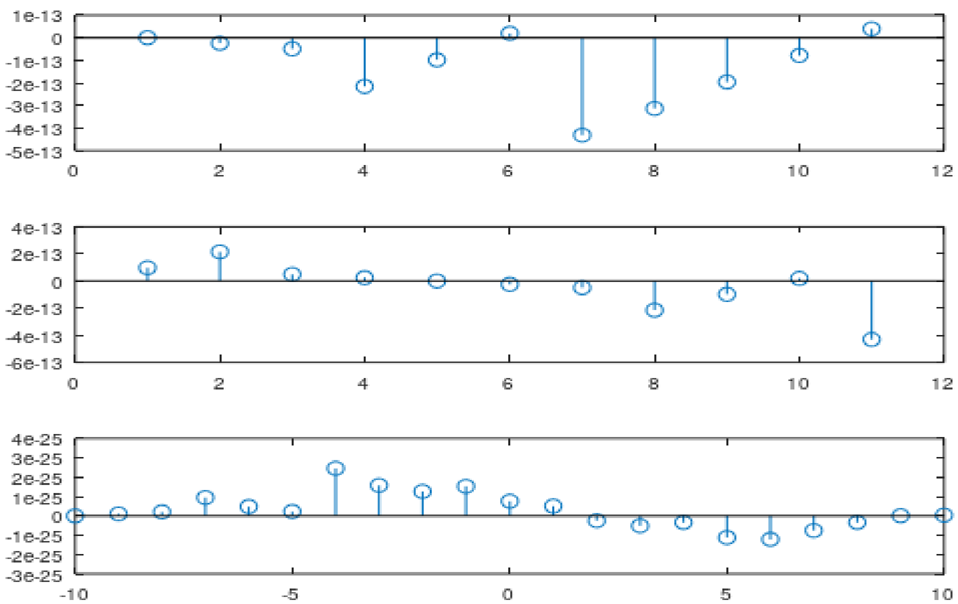
```
plot(xcorr(x,x1));
z=xcorr(x,x1);
[autocorr, lags] = xcorr(x,x1)
subplot(3,1,1);
stem(x);
subplot(3,1,2);
stem(x1);
subplot(3,1,3);
stem(lags,autocorr);
[~, index] = max(autocorr);
delay_sample = abs(lags(index))
Fs=1;
delay_seconds = delay_sample/Fs
```

Output:

```
lags =

  -10   -9   -8   -7   -6   -5   -4   -3   -2   -1    0    1    2    3    4    5    6    7    8    9   10

delay_sample = 4
delay_seconds = 4
```



II. Autocorrelation of discrete signal:

```
clc;
clear all;
close all;

x=[0 0 1 2 3 4];
x1=[1 2 3 4];
[autocorr, lags] = xcorr(x,x1)
subplot(3,1,1);
stem(x);
subplot(3,1,2);
```

```
stem(x1);
subplot(3,1,3);
stem(lags,autocorr);
[~, index] = max(autocorr);
delay_sample = abs(lags(index))
Fs=1;
delay_seconds = delay_sample/Fs
```

Output:

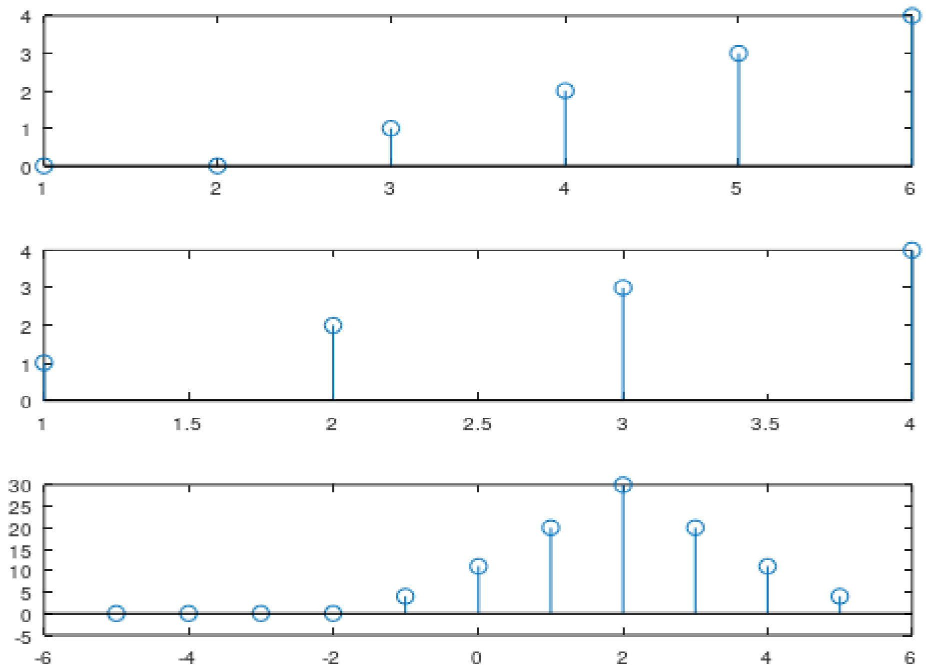
```
autocorr =

   -0.0000         0   -0.0000   -0.0000    4.0000   11.0000   20.0000   30.0000   20.0000   11.0000    4.0000

lags =

  -5   -4   -3   -2   -1    0    1    2    3    4    5

delay_sample = 2
delay_seconds = 2
```



III. Z-transform of a signal:

```
clc
 clear all
 close all
  syms n z
   x = 2^n
   z_transform = ztrans(x)
```

Output:

```
z_transform =

z/(z - 2)
```

Discussion:

In this experiment we plotted Auto Correlation continuous & discrete signal. Here firstly in auto correlation of continuous signal we plotted & creating the delay of that signal by using xcorr function. Secondly in auto correlation of discrete signal we plotted. Here we calculated the maximum value of the delay. Lastly we plotted the z transform code, a function syms n z was declared. Then a signal was declared. Finally, the z transform of the signal was calculated and displayed. Here ztrans function was used.

Conclusion: All the desired outputs were achieved successfully.