Rajshahi University of Engineering and Technology

DEPT. of Electrical and Computer Engineering

Course No.: ECE 4124

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Experiment Name: Experiment on finding the Z-transform and inverse Z-transform of a function.

Theory:

The Z-Transform is an important tool in DSP that is fundamental to filter design and system analysis. It will help you understand the behavior and stability conditions of a system.

A mathematical technique called the Z-transform is used to translate differential equations in the time domain into algebraic equations in the z-domain.

An extremely helpful tool in the analysis of a linear shift invariant (LSI) system is the Z-transform. Difference equations are used to model an LSI discrete time system. These time-domain difference equations are solved by first converting them into algebraic equations in the z-domain using the Z-transform, manipulating the algebraic equations in the z-domain, and then converting the results back into the time domain using the inverse Z-transform. The Z-transform formula-

$$\mathrm{X(z)} = \sum_{\sum \mathrm{n}=-\infty}^{\infty} \mathrm{x[n]} Z^{-\mathrm{n}}$$

The method of determining the time domain signal x(n) from its Z-transform X(z) is known as the inverse Z-transform. The symbol for the inverse Z-transform is-

$$x(n) = Z^{-1}[\mathrm{X(z)}]$$

Software used: MATLAB

Code:

Z-transform and inverse Z-transform of right-side signal:

```
clc;
close all;
clear all;

syms n;
x = [1 2 3 4 5];
l = length(x);

trans = 0;
z = sym('z');
for i=0:l-1
    trans=trans+x(i+1).*z^(-i);
end

disp('Z-transform of right side signal:');
disp(trans);

```

```
f=iztrans(trans);
disp('Inverse Z-transform of right side signal:');
disp(f);
```

Z-transform and inverse Z-transform of left-side signal:

```
clc;
close all;
clear all;

syms n;
x = [1 2 3 4 5];
y = fliplr(x);
l = length(y);

trans = 0;
z = sym('z');
for i=0:l-1
    trans=trans+y(i+1).*z^(i);
end

disp('Z-transform of left side signal:');
disp(trans);

f=iztrans(trans);
disp('Inverse Z-transform of left side signal:');
disp(f);
```

Z-transform and inverse Z-transform of non-causal signal:

```
clc;
close all;
clear all;

syms n;
x = [1 2 3 4 5 6 7];
n = length(x);

k=input('Enter zero index:');
p=[];
for i=0:k
    p(i+1)=x(i+1);
end

h=fliplr(p);
u=length(h);

trans = 0;
z = sym('z');
for i=0:u-1
    trans=trans+h(i+1).*z^(i);
end

```

```
q=[];
for i=0:(n-k-2)
    q(i+1)= x(i+k+2);
end

v=length(q);
for i=0:v-1
    trans=trans+q(i+1).*z^(-(i+1));
end

disp('Z-transform of non-causal signal:');
disp(trans);
f=iztrans(trans);
disp('Inverse Z-transform of non-causal signal:');
disp(f);
```

Output:

Z-transform and inverse Z-transform of right-side signal:

```
Command Window
  Z-transform of right side signal:
  2/z + 3/z^2 + 4/z^3 + 5/z^4 + 1

  Inverse Z-transform of right side signal:
  2*kroneckerDelta(n - 1, 0) + 3*kroneckerDelta(n - 2, 0) + 4*kroneckerDelta(n - 3, 0)
  5*kroneckerDelta(n - 4, 0) + kroneckerDelta(n, 0)
```

Fig. 1 Z-transform and inverse Z-transform of right sided signal

Z-transform and inverse Z-transform of right-side signal:

```
Command Window
  Z-transform of left side signal:
  z^4 + 2*z^3 + 3*z^2 + 4*z + 5

  Inverse Z-transform of left side signal:
  5*kroneckerDelta(n, 0) + 3*iztrans(z^2, z, n) + 2*iztrans(z^3, z, n) + iztrans(z^4,
  z, n) + 4*iztrans(z, z, n)
```

Fig. 2 Z-transform and inverse Z-transform of left sided signal

Z-transform and inverse Z-transform of non-causal signal:

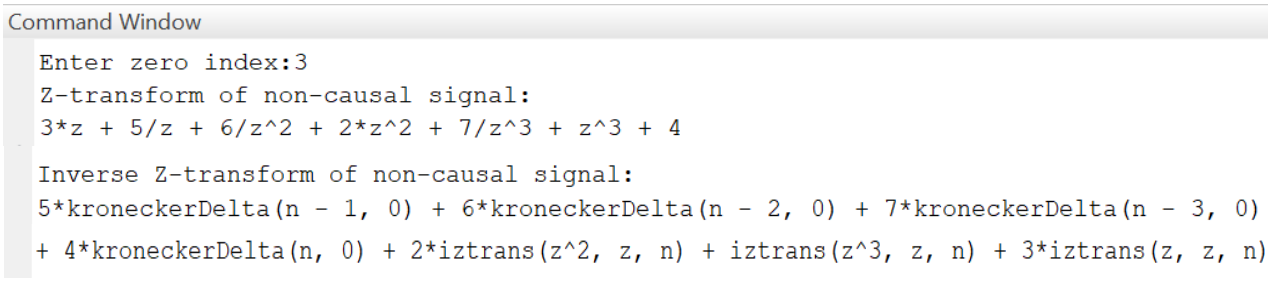

Fig. 3 Z-transform and inverse Z-transform of non-causal signal

Discussion:

In the experiment, we have worked with Z-transform of three types of signals – right side signal, left side signal and both sided that is non-causal signal. In right side signal we found the power of z as negative and in case of left side signal those power of z was positive which was matched with our theoretical explanations also. For inverse z-transform, we used a function 'iztrans' which worked correctly to find out the inverse of the Z-transform of the functions.

Conclusion:

All the code run successfully in the experiment without any type of error and the output was same as the theoretical result.