

*Heaven's Light is Our Guide*

## **Rajshahi University of Engineering & Technology**



*Department of Electrical & Computer Engineering*

**Course No:** ECE 4124

**Course Name:** Digital Signal Processing Sessional

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**Experiment No:** 05

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

**Theory:** 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-

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

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-

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

**Software used:** MATLAB

**Code:**

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

```
1. clc;
2. close all;
3. clear all;
4.
5. syms n;
6. x = [1 2 3 4 5];
7. l = length(x);
8.
9. trans = 0;
10. z = sym('z');
11. for i=0:l-1
12.     trans=trans+x(i+1).*z^(-i);
13. end
14.
15. disp('Z-transform of right side signal:');
16. disp(trans);
17.
18. f=iztrans(trans);
19. disp('Inverse Z-transform of right side signal:');
20. disp(f);
```

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

```
1. clc;
2. close all;
3. clear all;
4.
5. syms n;
6. x = [1 2 3 4 5];
7. y = fliplr(x);
8. l = length(y);
9.
10. trans = 0;
11. z = sym('z');
12. for i=0:l-1
13.     trans=trans+y(i+1).*z^(i);
14. end
15.
16. disp('Z-transform of left side signal:');
17. disp(trans);
18.
19. f=iztrans(trans);
20. disp('Inverse Z-transform of left side signal:');
21. disp(f);
```

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

```
1. clc;
2. close all;
3. clear all;
4.
5. syms n;
6. x = [1 2 3 4 5 6 7];
7. n = length(x);
8.
9. k=input('Enter zero index:');
10. p=[];
11. for i=0:k
12.     p(i+1)=x(i+1);
13. end
14.
15. h=fliplr(p);
16. u=length(h);
17.
18. trans = 0;
19. z = sym('z');
20. for i=0:u-1
21.     trans=trans+h(i+1).*z^(i);
22. end
23.
24. q=[];
25. for i=0:(n-k-2)
26.     q(i+1)= x(i+k+2);
27. end
28.
```

```

29. v=length(q);
30. for i=0:v-1
31.     trans=trans+q(i+1).*z^(-(i+1));
32. end
33.
34. disp('Z-transform of non-causal signal:');
35. disp(trans);
36. f=iztrans(trans);
37. disp('Inverse Z-transform of non-causal signal:');
38. 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:

```

Command Window

Enter zero index:3
Z-transform of non-causal signal:
3*z + 5/z + 6/z^2 + 2*z^2 + 7/z^3 + z^3 + 4

Inverse Z-transform of non-causal signal:
5*kroneckerDelta(n - 1, 0) + 6*kroneckerDelta(n - 2, 0) + 7*kroneckerDelta(n - 3, 0)
+ 4*kroneckerDelta(n, 0) + 2*iztrans(z^2, z, n) + iztrans(z^3, z, n) + 3*iztrans(z, z, n)

```

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 or complexities and we got the result as theoretical explanation.