

Experiment No : 05

Experiment Name : Write code to determine the Z-transform of causal, anticausal and non-causal signal in MATLAB.

Theory :

The z-transform is a very important tool in describing and analyzing digital systems. It also offers techniques for digital filter design and frequency analysis of digital signals. We begin with the definition of z-transform.

The z-transform of a causal sequence $x(n)$, designated by $X(z)$ or $Z(x(n))$, is defined as

$$X(z) = Z(x(n)) = \sum_{n=0}^{\infty} x(n) z^{-n}$$

where z is the complex variable. Here, the summation taken from $n = 0$ to $n = \infty$ is in accordance with the fact that for most situations, the digital signal $x(n)$ is a causal sequence, that is, $x(n) = 0$ for $n < 0$.

The z-transform of an anticausal sequence $x(n)$, designated by $X(z)$ or $Z(x(n))$, is defined as

$$X(z) = Z(x(n)) = \sum_{n=-\infty}^{-1} x(n) z^{-n}$$

Similarly, The z-transform of a non-causal sequence $x(n)$, designated by $X(z)$ or $Z(x(n))$, is defined as

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

A non-causal signal is a type of signal that exists for both positive and negative value.

Code:

1. Causal Signal

```
clc
clear all
close all

x=[5 2 5 7 8 1];
b=0;
n=length(x);
y=sym('z');

for i=1:n

    b=b+x(i)*y^(1-i);
end
disp('Z transform of x = ');
disp(b);
```

Output:

Z transform of x =
2/z + 5/z^2 + 7/z^3 + 8/z^4 +
1/z^5 + 5

2. Anticausal Signal

```
clc
clear all
close all

x=[1 2 5 7 0 1];
b=0;
n=length(x);
y=sym('z');

for i=1:n
    b=b+x(i)*y^(i-1);
end
disp('Z transform of x = ');
disp(b);
```

Output:

```
Z transform of x =
z^5 + 7*z^3 + 5*z^2 + 2*z + 1
```

3. Non-causal Signal

```
clc
clear all
close all
x=[1 2 3 4 5 6];

pos=input('Enter the Zero index = ');
n=length(x);
y=sym('z');
b=0;
a=0;

for i=1:n
    if i>=pos
        b=b+x(i)*y^(pos-i);
    else
        b=b+x(i)*y^((-1)*(i-pos));
    end
end
disp('Z transform of x = ');
disp(b);
```

Output:

```
Enter the Zero index = 3
Z transform of x =
2*z + 4/z + 5/z^2 + z^2 + 6/z^3 + 3
```

Discussion : In this experiment we learned about the z transformation of causal, anticausal and non-causal signal. For a causal signal, the power of z is negative in z domain. The power of z is positive in z domain for anticausal signal. Non-causal signal is tow sided. For non-causal signal we take the zero position of a signal from the user and calculated the z transformation according to that value. We got the exact value as theory for MATLAB code.

Conclusion : This experiment was done successfully in the laboratory using MATLAB.