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Experiment Name:

1. Z-Transform and Inverse Z-Transform of Causal Signal

2. Z-Transform and Inverse Z-Transform of Anti Causal Signal

3. Z-Transform and Inverse Z-Transform of Non Causal Signal

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Theory :

Z-Transform: Z-transform is the discrete counterpart of Laplace transform. z-transform converts difference equations of discrete time systems to algebraic equations which simplifies the discrete time system analysis.

Causal Signal:

A causal signal is a signal for which the value at any given time index depends only on the values of the signal for previous time indices (or the current time index itself), but not on future time indices. In other words, the signal's values do not depend on events that occur in the future.

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

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

Anti-Causal Signal:

An anti-causal signal is a signal for which the value at any given time index depends only on the values of the signal for future time indices, but not on previous time indices. The values of an anti-causal signal do not depend on events that occurred before the current time index.

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

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

Non-Causal Signal:

A non-causal signal is a signal for which the values at a particular time index depend on both past and future time indices. Non-causal signals violate the concept of causality, as they depend on events both before and after the current time index.

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

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

Code:

Z-Transform and Inverse Z-Transform of Causal Signal:

```
clc;
clear all;
close all;

n = 0:5;
x = [1 1 3 4 5 7];

syms z;
X = sum(x .* z.^(-n));
disp('Z-transform of the signal:');
disp(X);

syms k;
x_inverse = iztrans(X, z, k);
disp('Inverse Z-transform of the Z-transform:');
disp(x_inverse);
```

Z-Transform and Inverse Z-Transform of Anti Causal Signal:

```
clc;
clear all;
close all;

n = 0:5;
x = [1 1 3 4 5 7];
x_flipped = fliplr(x);

syms z;
X = sum(x_flipped .* z.^n);
disp('Z-transform of the flipped signal:');
disp(X);

syms k;
x_inverse = iztrans(X, z, k);
disp('Inverse Z-transform of the Z-transform:');
disp(x_inverse);
```

Z-Transform and Inverse Z-Transform of Non Causal Signal:

```
clc;
clear all;
close all;


n = -3:3;
x = [1 1 3 4 5 7 9];


syms z;
X = sum(x .* z.^(-n));
disp('Z-transform of the non-causal signal:');
disp(X);


syms k;
x_inverse = iztrans(X, z, k);
disp('Inverse Z-transform of the Z-transform:');
disp(x_inverse);
```


Output:

Z-Transform and Inverse Z-Transform of Causal Signal:

```
Z-transform of the signal:


1/z + 3/z^2 + 4/z^3 + 5/z^4 + 7/z^5 + 1



Inverse Z-transform of the Z-transform:

kroneckerDelta(k - 1, 0) + 3*kroneckerDelta(k - 2, 0) +
4*kroneckerDelta(k - 3, 0) + 5*kroneckerDelta(k - 4, 0) +
7*kroneckerDelta(k - 5, 0) + kroneckerDelta(k, 0)
```

Z-Transform and Inverse Z-Transform of Anti Causal Signal:

```
Z-transform of the flipped signal:

z^5 + z^4 + 3*z^3 + 4*z^2 + 5*z + 7
```

```
Inverse Z-transform of the Z-transform:

7*kroneckerDelta(k, 0) + 4*iztrans(z^2, z, k) + 3*iztrans(z^3, z, k) +
iztrans(z^4, z, k) + iztrans(z^5, z, k) + 5*iztrans(z, z, k)
```

Z-Transform and Inverse Z-Transform of Non Causal Signal:

```
Z-transform of the non-causal signal:

3*z + 5/z + 7/z^2 + z^2 + 9/z^3 + z^3 + 4
```

```
Inverse Z-transform of the Z-transform:

5*kroneckerDelta(k - 1, 0) + 7*kroneckerDelta(k - 2, 0) +
9*kroneckerDelta(k - 3, 0) + 4*kroneckerDelta(k, 0) + iztrans(z^2, z,
k) + iztrans(z^3, z, k) + 3*iztrans(z, z, k)
```

Discussion : In this experiment, we learned about causal, anti causal and non causal signals. We also learnt how to apply Z-transform to these signals. Also we have implemented inverse Z-transform in this experiment. We have learnt that in causal signal there are values only in the positive side; for anti causal the values are only in the negative side. For non causal signal there are values both in the positive and negative side.

Conclusion : The Z-trasnsform and inverse Z-transform results we got were as expected. The codes worked as intended and were executed without any errors. So, we can come to a conclusion that the experiments were done successfully.