

## EXPERIMENT NO: 6

### To Study and Analyze Z and Inverse Z Transform Techniques

#### Objective:

- A. To demonstrate the Z transform (Z. T.) for discrete time domain signal.
- B. To demonstrate the inverse Z transform (I. Z. T.) for Z domain signal.

#### Theory:

In signal processing, the **Z-transform** converts a discrete-time signal, which is a sequence of real or complex numbers, into a complex frequency domain representation.

The **bilateral or two-sided Z-transform** of a discrete-time signal  $x[n]$  is the formal power series  $X(z)$  defined as

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

Where  $n$  is an integer and  $z$  is, in general, a complex number,  $z = Ae^{j\phi}$  here  $A$  is the magnitude and  $\phi$  is the angle or phase of  $z$ .

Alternatively, in cases where  $x[n]$  is defined only for  $n \geq 0$ , the **single-sided or unilateral Z-transform** is defined as

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

The **inverse Z-transform** is

$$x[n] = z^{-1} \{X(z)\} = \frac{1}{2\pi j} \oint_C X(z) z^{-n} dz$$

Where  $C$  is a counterclockwise closed path encircling the origin and entirely in the **region of convergence (ROC)**.

The **region of convergence (ROC)** is the set of points in the complex plane for which the **Z-transform summation converges**.

$$ROC = \{z : \left| \sum_{n=-\infty}^{n=+\infty} x[n] z^{-n} \right| < \infty\}$$

#### Waveforms to be observed:

ZT:

#### Part-A:

- i)  $(0.9)^n u[n] + (1.2)^n u[-n - 1]$
- ii)  $(2)^{-n} \cos\left(\frac{n\pi}{3}\right) u[n - 1]$
- iii)  $(-1)^n n u[n]$

**IZT:**

**Part-B:**

- i)  $X[z] = ((e^{-2} - 2)z)/((z - e^{-2})(z - 2))$
- ii)  $X[z] = (2z^2 - 0.3z + 0.25)/(z^2 + 0.6z + 0.25)$

**MATLAB Program:**

The student must write the code from .mfile and associated functions used in this section.

**Results:**

Using an example, the student must clearly mention input arguments used and corresponding output obtained (in the form of numerical values / graphs) in this section separately for **Part A** and **B**.

**Comments on the results:**

The student must describe in short the inferences drawn from the experiment and observations from the results obtained in his/ her own words.

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