Time Domain Analysis of LTI – DT System

Dr.K.S.Vishvaksenan

SSN College of Engineering

Objective

- To discuss the time domain analysis of discrete time system

- To determine the response of any linear time invariant system to any arbitrary signal

What is LTI/LSI system?

- A system which satisfies both "**Linearity**" and "**Time/Shift Invariance**" property is said to be LTI/LSI system.

Time Domain Analysis of DT- LTI System

❖Methods

- Classical Method – Solution to difference equation
- Convolution Sum

❑ Both the methods are used to find the output/response of the system in the time domain

What is difference equation?

- Difference equation gives the relationship between the input and output of the system.

Classical Method

- **Zero Input Response/ Natural Response** – determine homogeneous solution alone – To find the response due to some initial conditions.
- **Zero State response/ Forced Response** – determine particular solution also – To find the response due to some applied input.

Classical Method (contd…)

- **Complete/Total Response** – It is the addition of natural and forced response.
- In other words, the response from the system obtained due to the initial conditions and applied input to the system.

Classical Method (contd…)

- **Impulse Response** : The response due to a unit impulse signal which is applied as an input to the system

- **Step Response** : The response due to a unit step signal which is applied as an input to the system

Convolution Sum

Convolution is used to find the response of the system given the input x(n) and the impulse response h(n).

$$y(n) = x(n) * h(n)$$

Convolution Sum (Contd…)

Steps involved in convolution :

- Folding
- Shifting
- Multiplication
- Summation

Properties of Convolution Sum

- ✓ Distributive Property
- ✓ Associative Property
- ✓ Commutative Property

Methods for Computing Convolution Sum

- **For Finite Duration Sequence:**
  (i) Graphical Method
  (ii) Matrix Method
  (iii) Cross table Method
  (iv) Analytical Method
- **For Infinite Duration Signal:**
  (i) Graphical Method
  (ii) Analytical Method

- System : A physical device that operates on an input signal inorder to change/modify the characteristics of that signal into a desired signal.

  DT System : y(n) = T{x(n}

Broad Classification of Systems:

(i) Continuous Time System

(ii) Discrete Time System

(iii) Digital System

Correlation

- It is the measure of the degree of similarity between any two sequences

Types of Correlation:

(i) Auto-Correlation

(ii)Cross- Correlation

Correlation (Contd...)

Steps involved in correlation :

- Shifting
- Multiplication
- Summation

Deconvolution

- In certain applications, the response of the system y(n) and impulse response h(n) are known and from that the input to the system x(n) is to be found out.

Summary

- The response for any LTI system can be determined by convolution which is discussed here.