15/feb/2018
17/02/2018

UNIT - I

Discrete type signal & system

★ Classification →

1. Continuous & distribute typ signals → A signal of continuous amplitude & time or an analog signal.

A signal which is represented at discrete instance of time. It is known as discrete time signal.

2. Continuous valued & dis create Valued

3. Periodic & non-periodic signal → Continuous time signal which repeats it self is called as periodic signal &

$$x(t) = x(t+T_0) \quad -(1)$$

condition of periodicity

where T_0 is called as the period of the signal $x(t)$.

4. Deterministic & random signals →

5. even or odd signals →

6. energy & power signals.

n = position

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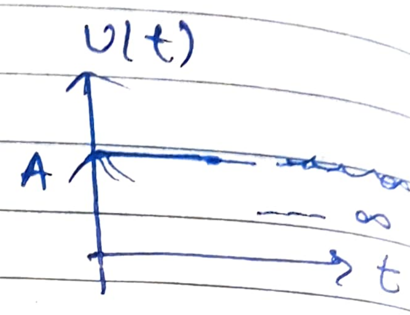
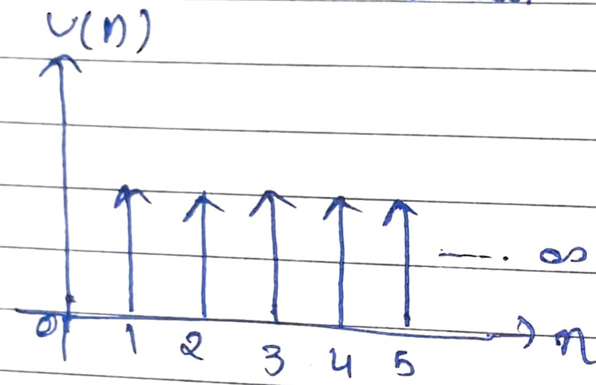
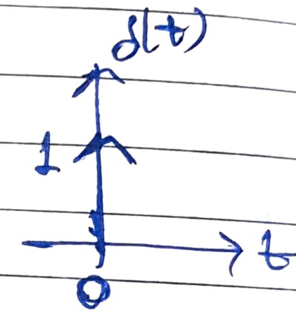
★ Signals →

1. Unit step function →



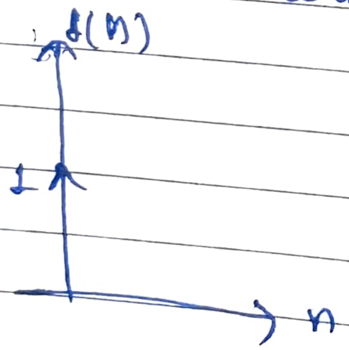
$$u(n) = \begin{cases} 1 & \text{for } n \geq 0 \\ 0 & \text{otherwise} \end{cases}$$





2. Impulse function

$$\delta(n) = \begin{cases} 1 & \text{for } n \geq 0 \\ 0 & \text{otherwise} \end{cases}$$



★ Systems → Properties of discrete time signal & classificatⁿ →
properties of system are with respect to i/p & o/p of systems.

Classification of System

- Static & Dynamic
- time Varient & time invarient
- Linear & non linear
- Causal & non causal
- Stable & unstable

1. Static or dynamic system →

Static System → It is a system in which O/P of at any instant of time depends on any I/P at the same time.

Eg. ⇒ $y(n) = x(n)$ it is a static system.

$y(n) = 3x(n)$ it is a static system.

$y(n) = x^2(n) + 5x(n) + 10$ it → static system

{ I/P & O/P ki eq^n me koi change nhi aana chahi

Dynamic System → It is a system in which O/P at any instant of time depends on I/P signal at the same time as well as other time.

eg → 1. $y(n) = x(n) \xrightarrow{T} y(n) = x(n-K)$ 2. $y(n) = x(n) \xrightarrow{T} y(n) = x(n+K)$

3. $y(n) = x(n) + 5x(n-1)$ → dynamic
4. $y(n) = n\,x(n)$ → static

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5) $y(n) = n x(n) + b x^2(n)$ → static
6) $y(n) = x[n^2]$ → dynamic
7) $y(n) = x(n) \cos(\omega_0 n)$ → static
8) $y(n) = x(-n)$ → dynamic
$y(n) = \sum_{k=0}^{2} x(n-k)$ → dynamic

2. Time Varient & time invarient → A system is time invarient if its i/p o/p characteristic do not change with time.

• Steps to check system time varient or invarient

1. Delay the i/p $x(n)$ by k units. that means $x(n) \xrightarrow{k} x(n-k)$ denote this corresponding o/p by $y'(n)$

2. Int the given eq^n of the system $y(n)$ replace n by n−k throught the system name it as $y''(n)$

3. Compair $y'(n)$ & $y''(n)$ i.e. $y'(n) = y''(n)$ then the system is time invarient otherwise time varient

Q. $y(n) = x(n) - x(n-1)$

$x(n) \xrightarrow{k} x(n-k)$

$x(n-1) \xrightarrow{k} x(n-1-k)$

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delay by K samples in i/p

$y(n) = y'(n) = x(n-K) - x(n-1-K)$

step

$y(n) = y''(n)$

$y''(n) = x(n-K) - x(n-K-1)$

$y'(n) = y''(n)$

then System is ~~tvat~~ invarient.

Q $y(n) = Ax(n) + 6$

$y(n) = y'(n) = A x(n-K) + 6$

$y(n) = y''(n) = A x(n-K) + 6$

$y'(n) = y''(n)$

System is invarient

Q. $y(n) = e^{x(n)}$

$y'(n) = e^{x(n-K)}$

$y''(n) = e^{x(n-K)}$

$y'(n) = y''(n) \Rightarrow$ invarient

Q. $y(n) = x(n) + n\,x(n-1)$

As

$y'(n) = x(n-k) + n\,x(n-1-k)$

$y''(n) = x(n-1) + (n-k)\,x(n-k-1)$

$y'(n) \neq y''(n) \Rightarrow$ Varient

Q. $y(n) = x(n^2)$

$\cancel{y'(n) = x((n^2-k)^2)}$

$\cancel{y''(n) = x((n-k)^2)}$

$\cancel{y'(n) = y''(n)}$

$= x((n)^2)$

$y'(n) = x((n-k)^2)$

$y''(n) = x((n-k)^2)$

$y'(n) = y''(n) \to$ time inverient

Q. $y(n) = y(n-4) + x(n-4)$

$y(n) - y(n-4) = x(n+4)$

$= x(n-k-4)$

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$$TI = (x(n-k)-4)$$

$$y'(n) = y(n-4) + x(n-k-4)$$

$$y''(n) = y(n-k-4) + x(n-k-4)$$

$$y'(n) \neq y''(n) \Rightarrow \text{time Varient}$$

Q. $y(n) = x(-n)$

$$y'(n) = x(-n-k)$$

$$y''(n) = x(-(n-k))$$

$$= x(-n+k)$$

$$y'(n) \neq y''(n) \Rightarrow \text{time Varient}$$

Q. $y(n) = n x^2(n)$

$$y'(n) = n x^2(n-k)$$

$$y''(n) = (n-k) x^2(n-k)$$

$$y'(n) = y''(n) \Rightarrow \text{time Invarient}$$

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Q3. Linear & non linear system → A linear system is system which follows superposition principle.

A system is said to be linear if the combined response of $a_1x_1(n)$ & $a_2x_2(n)$ is equal to addition of individual responses that means

$$T[a_1x_1(n) + a_2x_2(n)] = T[a_1x_1(n)] + T[a_2x_2(n)] \quad -(1)$$

transfer f^n

- check whether the system is linear or non

1. apply zero i/p & check the o/p if o/p is 0 then the system is linear. {not always}
2. apply individual i/p to the system & note down the corresponding o/p. then add all the o/p & denote this addition by $y(n)$ this is the R.H.S. of the eq^n (1)
3. combine all i/p apply it to the system & find out $y''(n)$. This is the L.H.S. of the eq^n (1)
4. If $y'(n) = y''(n)$ then the system is linear other wise non linear

Que $y(n) = n\,x(n)$ check linear or not

$y_1(n) = n\,a_1 x_1(n)$

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$y_2(n) = n \cdot a_2 x_2(n)$

$y'(n) = y_1(n) + y_2(n)$

$y'(n) = n[a_1 x_1(n) + a_2 x_2(n)]$

$y''(n) = n[a_1 x_1(n) + a_2 x_2(n)]$

$y'(n) = y''(n) \Rightarrow$ linear

Q. $y(n) = 3x(n) + 6$

$y_1(n) = \cancel{a_1 3 x_1(n) + 6}\ 3[a_1 x_1(n)] + 6$

$y_2(n) = \cancel{3x_2(n)+6}\ 3[a_2 x_2(n)] + 6$

$y'(n) = y_1(n) + y_2(n) \Rightarrow 3[a_1 x_1(n) + a_2 x_2(n)] +$

$y''(n) = 3[a_1 x_1(n) + a_2 x_2 n)] + 6$

$y'(n) \neq y''(n) \Rightarrow$ non linear

Q $y(n) = e^{x(n)}$

$y_1(n) = e^{a_1 x_1(n)}$

$y_2(n) = e^{a_2 x_2(n)}$

$y'(n) = y_1(n) + y_2(n)$

$y'(n) = e^{a_1 \cancel{f} x_1(n)} + e^{a_2 x_2(n)}$

$y''(n) = e^{a_1 x_1(n) + a_2 x_2(n)}$

$= e^{a_1 x_1(n)} \cdot e^{a_2 x_2(n)}$

$y'(n) \neq y''(n) \Rightarrow$ non linear

Q. $y(n) = \cos[x(n)]$

$y_1(n) = \cos[x_1(n)]$

$y_2(n) = \cos[x_2(n)]$

$y'(n) = \cos[x_1(n)] + \cos(x_2(n))$

$y''(n) = \cos[x_1(n) + x_2(n)]$

$y'(n) \neq y''(n) =$ non linear

Q. $y(n) = x(n) + \cancel{\text{...}}\ n\, x(n+1)$

$y_1(n) = x_1(n) + n\, x_1(n+1)$

$y_2(n) = x_2(n) + n\, x_2(n+1)$

$y'(n) = [x_1(n) + x_2(n)] + n\,[x_1(n+1) + x_2(n+1)$

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$y''(n) = [x_1(n) + x_2(n)] + n[x_1(n+1) + x_2(n+1)]$

$y'(n) = y''(n) \Rightarrow$ Linear

d. $y(n) = x(n^2)$

$y_1(n) = x_1(n^2)$

$y_2(n) = x_2(n^2)$

$y'(n) = x_1(n^2) + x_2(n^2)$

$y''(n) = [x_1(n)]^2 \Rightarrow x(n)^2$

$y''(n) = [\cancel{x_1(n)} + \cancel{x_2(n)}]^2 \; x_1(n)^2 + x_2(n)^2$

$y'(n) = y''(n)$

e. $y(n) = x^2(n)$

$y_1(n) = [x(n)]^2 \Rightarrow [x_1(n)]^2$

$y_2(n) = [x_2(n)]^2$

$y'(n) = [x_1(n)]^2 + [x_2(n)]^2$

$y''(n) = \cancel{[x_1(n)]^2} \; [x(n)]^2$

$= [(x_1(n))^2 + (x_2(n)]^2$

$y'(n) \neq y''(n) \Rightarrow$ non linear

Q. $y(n) = x(n) \cdot n(n-n_0)$

$y_1(n) = x_1(n) \cdot n(n-n_0)$

$y_2(n) = x_2(n) \cdot n(n-n_0)$

$y'(n) = n(n-n_0)\,[x_1(n) + x_2(n)]$

$y''(n) = [x_1(n) + x_2(n)]\, n(n-n_0)$

$y'(n) = y''(n)$ linear

Q.n $y(n) = x(n) \cdot \cos(\omega_0 n)$

$y'(n) = [x_1(n) + x_2(n)] \cos(\omega_0 n)$

$y''(n) = [x_1(n) + x_2(n)] \cos(\omega_0 n)$

$y'(n) = y''(n) \Rightarrow$ linear

* causal & non causal → A system is said to be causal if O/P at any instant of time depends only present & past I/P.

Eg:- $x(n), x(n-1), x(n-2)$