Date
22/10/21

Q.1) Check whether the following systems are :-
1. Static or dynamic, 2. Linear or non-linear, 3. Casual or non-casual, 4. Time invariant or time variant.

(a) $y(n) = a^n u(n)$

Sol^n (i)

$y(-1) = a^{-1} u(-1)$

$y(0) = a^0 u(0)$

$y(1) = a^1 u(1)$

∵ Present i/p gives present o/p

∴ It is static.

(ii) ∵ $u(n)$ exists for all $n \geq 0$

∴ It & $y(n)$ is non-linear.

(iii) $y(-1) = a^{-1} u(-1)$

$y(0) = a^0 u(0)$

$y(1) = a^1 u(1)$

∴ $y(n)$ is casual.

(iv) $y(n-T) = a^{n-T} \cdot u(n-T)$

$y(n,T) = a^n u(n-T)$

∵ $y(n-T) \neq y(n,T)$

∴ It is time variant.

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(b) $y(t) = at\,x(t) + bt^2 x(t-2)$

Sol:-

(i) Given,

$y(t) = at\,x(t) + bt^2 x(t-2)$

As there is time-shifting.

∴ It is dynamic

(ii) For i/p, $x_1(t)$, $y_1(t) = at\,x_1(t) + bt^2 x_2(t-2)$

For i/p, $x_2(t)$, $y_2(t) = at\,x_2(t) + bt^2 x_2(t-2)$

$\therefore a y_1(t) + b y_2(t) = [a^2 t\,x_1(t) + ab t^2 x_2(t-2)] + [ab t\,x_2(t) + b^2 t^2 x_2(t-2)]$

The o/p due to weighted sum of i/ps. is:-

$y_3(t) = T[ax_1(t) + bx_2(t)]$

$= at[ax_1(t) + bx_2(t)] + bt^2[ax_1(t-2) + bx_2(t-2)]$

$= [a^2 t\,x_1(t) + ab t^2 x_2(t-2)] + [ab t\,x_2(t) + b^2 t^2 x_2(t-2)]$

$\therefore y_3(t) = a y_1(t) + b y_2(t)$

∴ It is linear

(iii) $y(-1) = -a\,x(-1) + b\,x(-3)$

$y(0) = 0$

$y(1) = a\,x(1) + b\,x(-1)$

As the o/p depends on present and past values only

∴ It is casual.

$y(t) = at\,x(t) + bt^2\,x(t-2)$

$y(t-T) = a(t-T)\,x(t-T) + b(t-T)^2\,x(t-T-2)$

$y(t,T) = at\,x(t-T) + bt^2 x(t-T-2)$

$\therefore y(t-T) \neq y(t,T)$

∴ It is time variant.

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