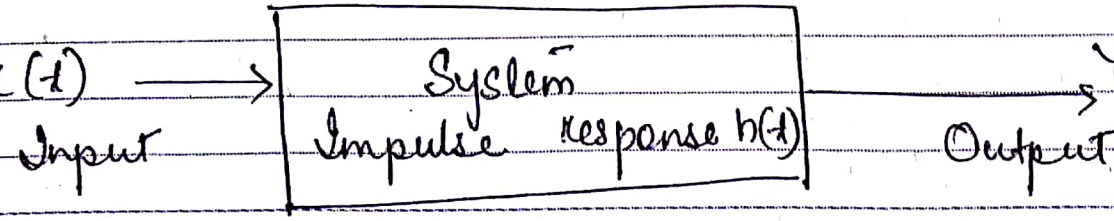
SYSTEMS

SYSTEMS:—

- A system is defined as an entity that acts on an input signal and transforms it into an output signal.

- A system may also be defined as set of elements or functional blocks which are connected together and produces an output in response to the input signal.

- The response or output of the system depends upon the transfer function of the system.



The relation between the input $x(t)$ and the output $y(t)$ of a system has the form

$$y(t) = \text{Operation on } x(t)$$

Mathematically, $y(t) = T[x(t)]$

Like signals systems may also be broadly classified under

(a) Continuous-time system

$$y(t) = T[x(t)]$$

(b) Discrete-time system.

$$y(n) = T[x(n)]$$

Both continuous-time and discrete-time systems may be classified as under—

① Lumped parameter and distributed parameter system.

② Static (memoryless) and dynamic (memory) system.

③ Causal and non-causal system.

④ Linear and non-linear system.

⑤ Time-invariant and time varying system.

⑥ Stable and unstable system.

⑦ Invertible and non-invertible system.

⑧ FIR and IIR system.

① LUMPED parameter and DISTRIBUTED parameter systems:

— Systems in which each component is lumped at one point in space — Lumped parameter systems. Described by ordinary differential eq^n's.

— Systems in which signals are functions of space as well as time. These are called distributed parameter systems. Described by partial diff^n eq^n.

② Static and Dynamic Systems :—

— A system is said to be static or memoryless, if the response is due to present input alone; i.e. for a static or memoryless system, the output at any instant

t (or n) depends only on the input applied at that instant t (or n) but not on the past or future values of input.

eg $y(t) = x(t)$

$y(t) = x^2(t)$

- A system is said to be dynamic or memory system if the response depends upon past or future values. inputs.

eg:- $y(t) = x(t-1)$

$y(t) = x(t) + x(t+2)$.

8. Find whether the following systems are dynamic or not :-

(a) $y(t) = x(t-3)$

(b) $y(t) = x(2t)$

(c) $y(t) = \frac{d^2x(t)}{dt^2} + 2x(t)$

(d) $y(n) = x(n+2)$

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

(f) $y(n) = x(n-2) + x(n)$

(3) Causal and Non-Causal systems :-

- A system is said to be causal if the output of the system at any time t depends only on the present and the past values of the input but not on the future inputs.

eg :- $y(t) = x(t-2) + 2x(t)$

$y(t) = t\,x(t)$

$y(n) = n\,x(n)$

$y(n) = x(n-2) + x(n-1) + x(n)$.

- A system is ~~~~ said to be non-causal if the output of the system at any time 't' depends of on the future inputs.

eg:- $y(t) = x(t+2) + x(t)$

$y(t) = x^2(t) + tx(t+1)$

$y(n) = x(n) + x(2n)$.

8. Check whether the following systems are causal or not.

(a) $y(t) = x^2(t) + x(t-4)$

(b) $y(t) = x(2-t) + x(t-4)$

(c) $y(t) = \int_{-\infty}^{3t} x(\tau)\, d\tau$

(d) $y(t) = x(t/2)$

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

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

(a) Given,

$$y(t) = x^2(t) + x(t-4)$$

For $t = -2$, $y(-2) = x^2(-2) + x(-6)$

For $t = 0$, $y(0) = x^2(0) + x(-4)$

For $t = 2$, $y(2) = x^2(2) + x(-2)$.

∴ For all values of t, the output depends only on the present and past values of input. So, the system is causal.

(b) Given,

$$y(t) = x(2-t) + x(t-4)$$

For $t=-1$, $y(-1) = x(3) + x(-5)$

For $t=0$, $y(0) = x(2) + x(-4)$

For $t=1$, $y(1) = x(1) + x(-3)$

For some values of t, the output depends on the future i/p.

$\therefore$ System is non-causal.