1.1 CLASSIFICATION OF SYSTEMS

1.SYSTEM:

A system is any process that generates an output signal in response to an input signal

1.1.1 STATIC SYSTEM AND DYNAMIC SYSTEM:

A discrete-time system is called static or memory less if its output at any instant and depends at most on the input sample at the same time, but not on past or future samples of the input. In any other case, the system is said to be dynamic or to have memory. If the output of a system at time n is completely determined by the input samples in the interval from n – N to n (N > 0), th e system is said to have memory of duration N.

S.No	System[y(n)]	Static/Dynamic
1	x(n)	Static
2	A(n-2)	Dynamic
3	$X^2(n)$	Static
4	$X(n^2)$	Dynamic
5	$nx(n)+x^2(n)$	Static

1.1.2.TIME INVARIANT AND TIME VARIANT SYSTEM

For a time-invariant system, the output and input should be delayed by some time unit. Any delay provided in the input must be reflected in the output for a time invariant system.

For a time variant system, also, output and input should be delayed by some time constant but the delay at the input should not reflect at the output.

It is very easy to find out that given system is Shift Invariant or Shift Variant. Suppose if the system produces output y(n) by taking input x(n)

$$x(n) \rightarrow y(n)$$

If we delay same input by k units x(n-k) and apply it to same systems, the system produces output y(n-k)

x(n-k) -> y(n-k)

1.1.3. LINEAR AND NON-LINEAR SYSTEM

A linear system follows the laws of superposition. This law is necessary and sufficient condition to prove the linearity of the system.

A non linear system, in which all the conditions, which are being violated in the linear systems, should be satisfied in this case.

Conditions

- The output should not be zero when input applied is zero.
- Any non-linear operator can be applied on the either input or on the output to make the system non-linear.

Response to the system to the sum of signal = sum of individual responses of the system.

T [a1 x1(n) + a2 x2(n)] = T [a1 x1(n)] + T [a2 x2(n)]

S.No	System	Linear or Non linear
1	$e^{x(n)}$	Non linear
2	$x^2\ x(n)$	Non linear
3	Mx(n)+c	Non linear
4	Cos[x(n)]	Non linear
5	X(-n)	Linear

1.1.4. CAUSAL AND NON CAUSAL SYSTEM

A system is causal if output of system at any time depends only past and present inputs. In Causal systems the output is the function of x(n),x(n-1),x(n-2)…. and so on. Example Real time DSP system.

A system is Non causal if output of system at any time depends on future inputs. In Non-Causal systems the output is the function of future inputs also x(n+1),x(n+2)…. and so on.

S.No	System	Causal (or) Non causal
1	x(n)+x(n-3)	Causal
2	x(n)	Causal
3	x(n)+x(n+3)	Non Causal
4	2x(n)	Causal

1.1.5. STABLE AND UNSTABLE SYSTEM

A system is BIBO stable if every bounded input produces a bounded output. The input x(n) is said to be bounded if there exists some finite number Mx such that $|x(n)| \leq Mx < \infty$. The output y(n) is said to be bounded if there exists some finite number My such that $|y(n)| \leq My < \infty$.A system is unstable if any bounded input produces a unbounded output.