1.2. CLASSIFICATION OF SIGNALS

1. Single channel and Multi-channel signals
2. Single dimensional and Multi-dimensional signals
3. Continuous time and Discrete time signals.
4. Continuous valued and discrete valued signals.
5. Analog and digital signals.
6. Deterministic and Random signals
7. Periodic signal and Non-periodic signal
8. Symmetrical (even) and Anti-Symmetrical (odd) signal
9. Energy and Power signal

1.2.1. SINGLE CHANNEL AND MULTI-CHANNEL SIGNALS

If signal is generated from single sensor or source it is called as single channel signal. If the signals are generated from multiple sensors or multiple sources or multiple signals are generated from same source called as Multi-channel signal.

Example ECG signals. Multi-channel signal will be the vector sum of signals generated from multiple sources.

1.2.2. SINGLE DIMENSIONAL AND MULTI-DIMENSIONAL SIGNALS

If signal is a function of one independent variable it is called as single dimensional signal like speech signal and if signal is function of M independent variables called as Multi - dimensional signals. Gray scale level of image or Intensity at particular pixel on black and white TV is examples of M-D signals.

1.2.3. CONTINUOUS TIME AND DISCRETE TIME SIGNALS.

1. Continuous time signals.

This signal can be defined at any time instance & they can take all values in the continuous interval (a, b) where a can be $-\infty$ & b can be ∞. These are described by differential equations. This signal is denoted by x (t).The speed control of a dc motor using a taco generator feedback or Sine or exponential waveforms.

2. Discrete time signals.

This signal can be defined only at certain specific values of time. These times instance need not be equidistant but in practice they are usually takes at equally spaced intervals. These are described by difference equation. These signals are denoted by x

(n) or notation x (nT) can also be used. Microprocessors and computer based systems uses discrete time signals.

1.2.4. CONTINUOUS VALUED AND DISCRETE VALUED SIGNALS.

1. Continuous Valued signals

If a signal takes on all possible values on a finite or infinite range, it is said to be continuous valued signal. Continuous Valued and continuous time signals are basically analog signals.

2. Discrete Valued signals

If signal takes values from a finite set of possible values, it is said to be discrete valued signal. Discrete time signal with set of discrete amplitude are called digital signal.

1.2.5. ANALOG AND DIGITAL SIGNAL

1. Analog signal

These are basically continuous time & continuous amplitude signals.
ECG signals, Speech signal, Television signal etc. All the signals generated from various sources in nature are analog.

2. Digital signal

These are basically discrete time signals & discrete amplitude signals. These signals are basically obtained by sampling & quantization process. All signal representation in computers and digital signal processors are digital.

1.2.6. DETERMINISTIC AND RANDOM SIGNALS

1. Deterministic signals

Deterministic signals can be represented or described by a mathematical equation or lookup table. Deterministic signals are preferable because for analysis and processing of signals we can use mathematical model of the signal. The value of the deterministic signal can be evaluated at time (past, present or future) without certainty.
Example: Sine or exponential waveforms.

2. Random signals

Random signals that cannot be represented or described by a mathematical equation or lookup table. Not Preferable. The random signals can be described with the help of their statistical properties. The value of the random signal cannot be evaluated at any instant of time.

Example Noise signal or Speech signal

1.2.7. PERIODIC SIGNAL AND NON-PERIODIC SIGNAL

The signal x (n) is said to be periodic if x(n+N)= x(n) for all n where N is the fundamental period of the signal. If the signal does not satisfy above property called as Non-Periodic signals.

Discrete time signal is periodic if its frequency can be expressed as a ratio of two integers. f= k/N where k is integer constant.

1.2.8. SYMMETRICAL (EVEN) AND ANTI-SYMMETRICAL (ODD) SIGNAL

A signal is called as symmetrical (even) if x(n) = x(-n) and if x(-n) = -x(n) then signal is odd.

X1(n) = cos (ωn) and x2(n) = sin (ωn) are good examples of even & odd signals respectively.

Every discrete signal can be represented in terms of even & odd signals.

Even component of discrete time signal is given by

$$X_e(n)=\frac{X(n)+X(-n)}{2}$$

Odd component of discrete time signal is given by

$$X_o(n)=\frac{X(n)-X(-n)}{2}$$

1.2.9. ENERGY SIGNAL AND POWER SIGNAL

Discrete time signals are also classified as finite energy or finite average power signals. The energy of a discrete time signal x (n) is given by

$$E_x = \sum_{n=-\infty}^{\infty}|x(n)|^2$$

The average power for a discrete time signal x (n) is defined as

$$P_x = \lim_{N\to\infty}\frac{1}{2N+1}\sum_{n=-N}^{n=+N}|x(n)|^2$$

If Energy is finite and power is zero for x (n) then x(n) is an energy signal. If power is finite and energy is infinite then x (n) is power signal. There are some signals which are neither energy nor a power signal.