SNS COLLEGE OF TECHNOLOGY

An Autonomous Institution

Coimbatore-35

Accredited by NBA – AICTE and Accredited by NAAC – UGC with 'A+' Grade
Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

19ECB212 – DIGITAL SIGNAL PROCESSING

II YEAR/ IV SEMESTER

UNIT 1 – DISCRETE FOURIER TRANSFORM

TOPIC – REVIEW OF SIGNALS AND SYSTEMS

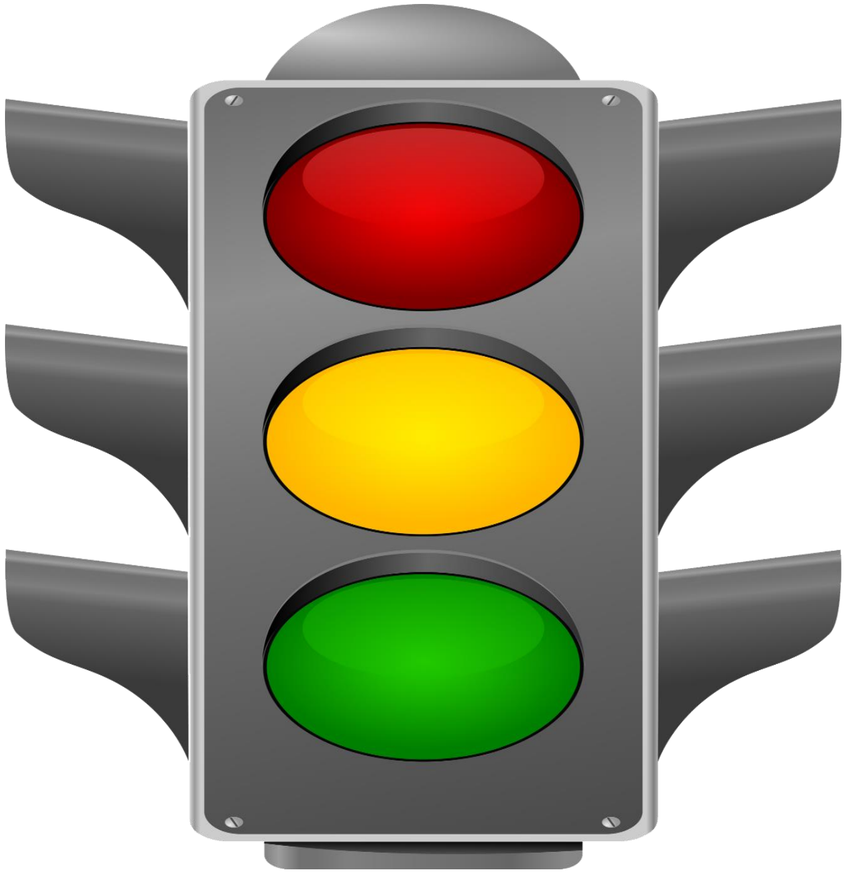
EMPATHY

1. • Clear Understanding of Signals
2. • To recollect Systems
3. • Analysis of Signals and Systems

SIGNALS

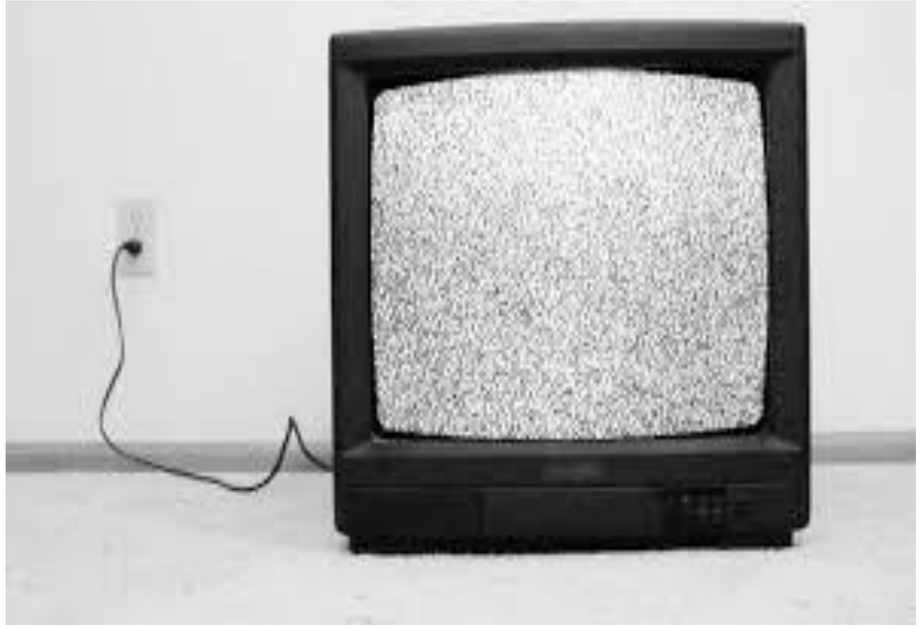
- **Signal:** A function of one or more independent variables which contains some information
- Radio Signal & TV Signal are **Electrical Signals**
- Sound Signal & Pressure Signal are **Non Electrical Signals**
- Signal is a function of time **i.e f(t)**

SIGNALS

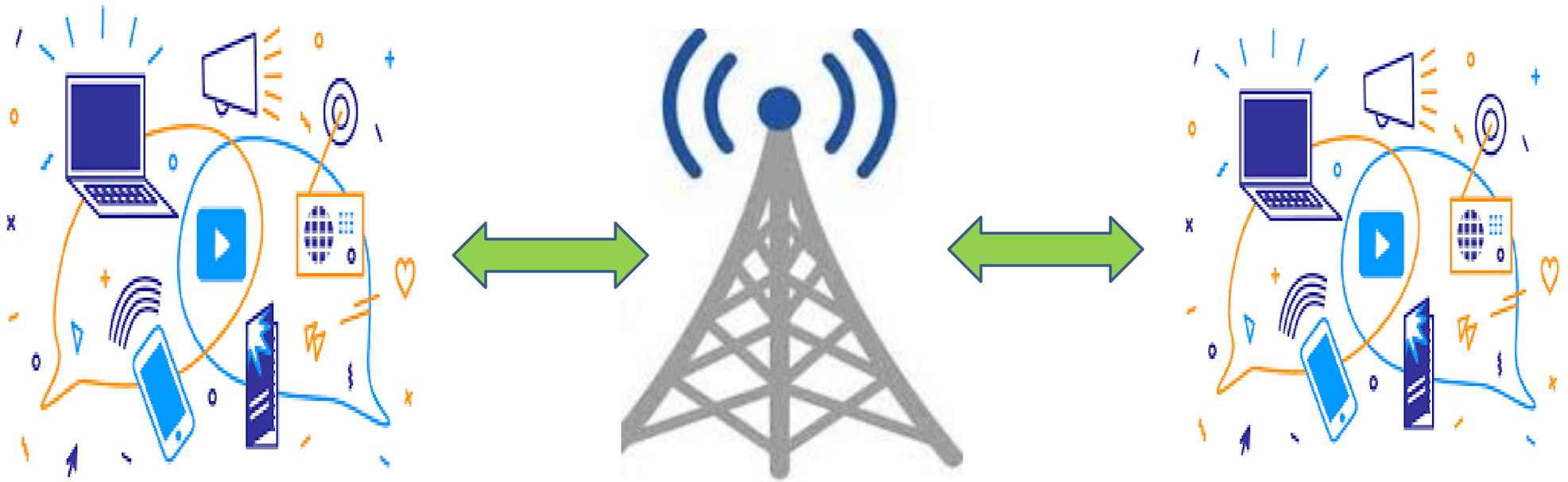


NOISE SIGNAL

- Noise is a Signal???
- **Yes,** Noise is also a signal which doesn't contains any information

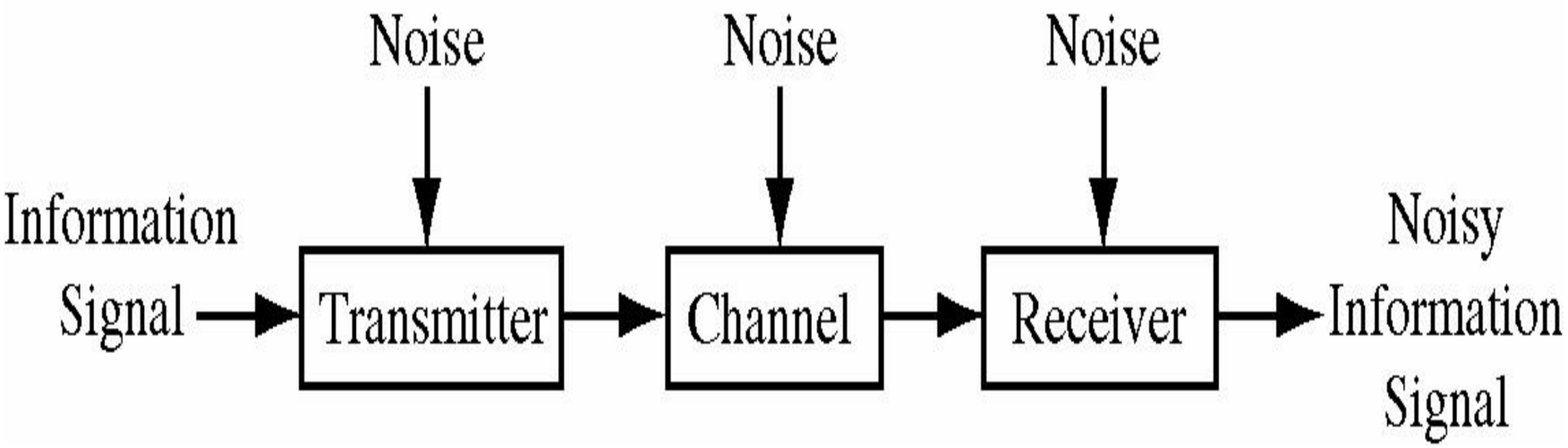


IS IT RELATED WITH COMMUNICATION



COMMUNICATION SYSTEM

- A communication system has an information signal plus noise signals
- It consists of an interconnection of smaller systems

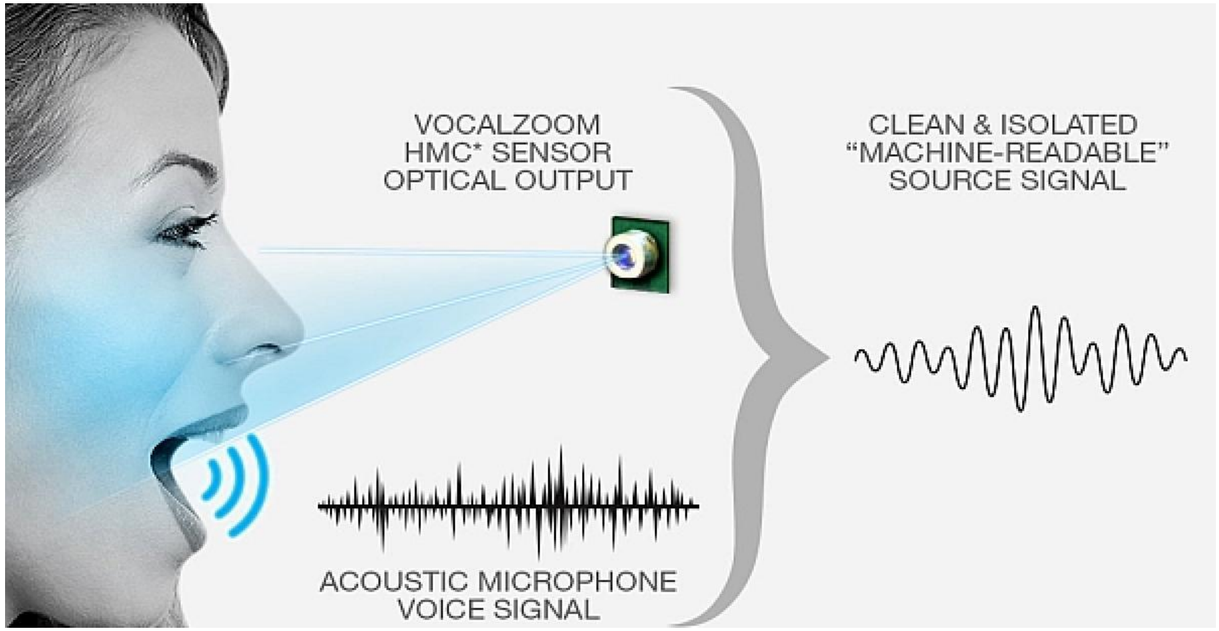


ANALOG SIGNALS

- A signal could be an analog quantity that means it is defined with respect to the time. It is a continuous signal.

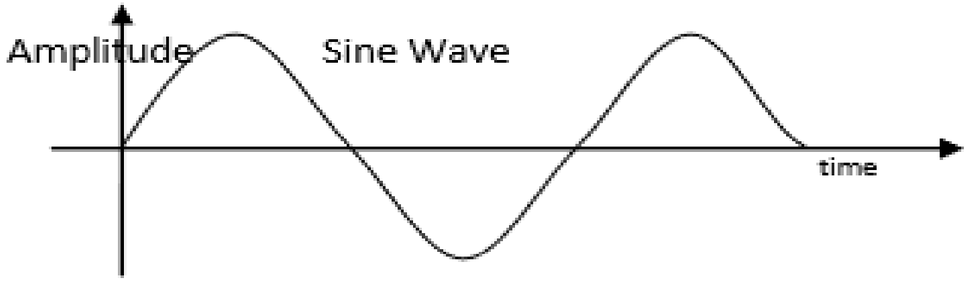
ANALOG SIGNALS

- Human voice is an example of analog signals. When you speak, the voice that is produced travel through air in the form of pressure waves and thus belongs to a mathematical function, having independent variables of space and time and a value corresponding to air pressure.

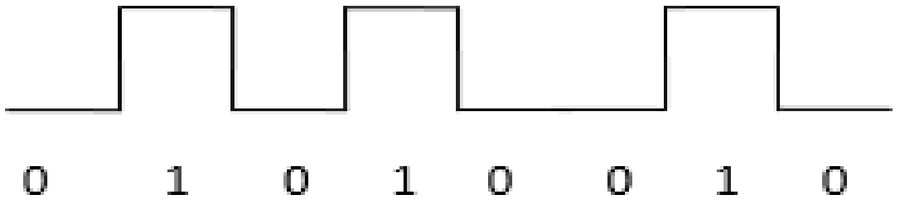


ANALOG AND DIGITAL SIGNAL

- **Analog Signal:** A signal that is defined for every instants of time is known as analog signal



- **Digital Signal:** The signals that are discrete in time and quantized in amplitude is called digital signal



DIGITAL SIGNALS

Example:

CLASSIFICATION OF SIGNALS

- It can be classified into two types

➢ Continuous time signal

➢Discrete time signal

- It can be further classified into four types

➢ Periodic & Aperiodic Signal

➢ Even and Odd Signal

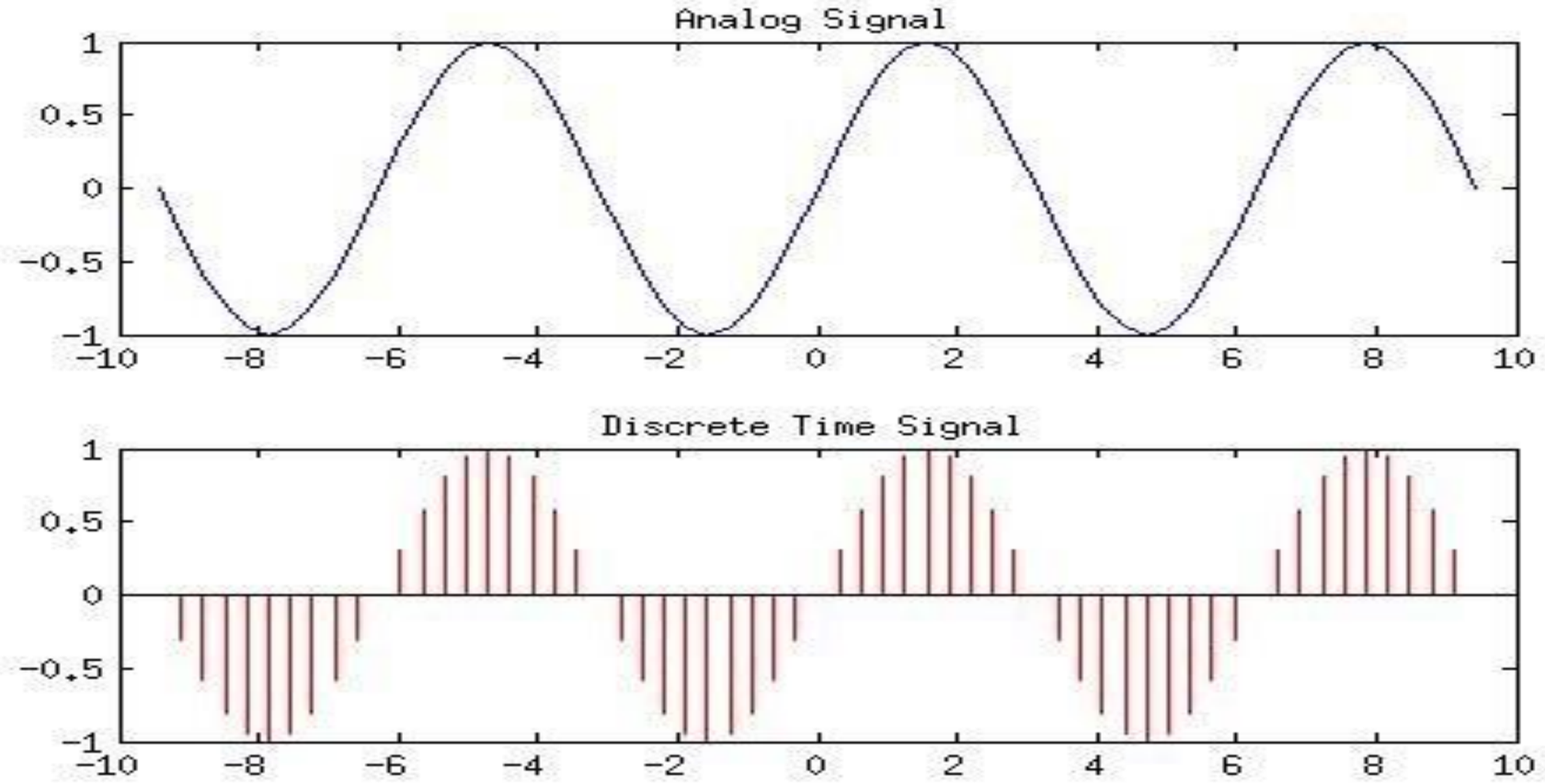
➢ Energy and Power Signal

➢Deterministic and Random Signal

CONTINUOUS & DISCRETE TIME SIGNAL

- **Continuous Time Signal:** A signal that is defined for every instants of time is known as continuous time signal
- Continuous time signals are continuous in amplitude and continuous in time.
- It is denoted by **x(t)**
- **Discrete Time Signal:** A signal that is defined for discrete instants of time is known as discrete time signal. Discrete time signals are continuous in amplitude and discrete in time.
- It is also obtained by sampling a continuous time signal.
- It is denoted by **x(n)**

CONTINUOUS & DISCRETE TIME SIGNAL



PERIODIC AND APERIODIC SIGNAL

- A **periodic signal** is a signal that repeats its pattern over time at regular intervals, known as the period. In other words, after a certain amount of time, the signal will repeat exactly as it did before.
- A discrete periodic signal x(n) is one that repeats its pattern over time with a fixed period N,
- Mathematically, this can be represented as:

  $x(n)=x(n+N)$,

  where N is the period of the signal, and n is any integer representing the discrete time index.

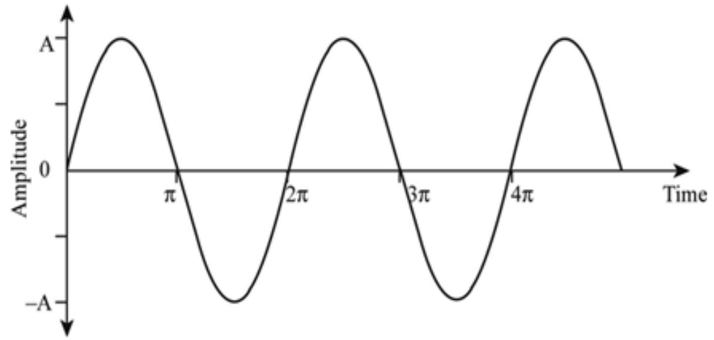
- This equation signifies that the signal's behavior repeats every N samples.

PERIODIC AND APERIODIC SIGNAL

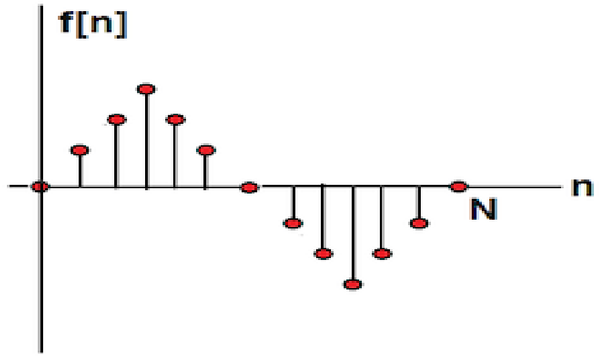
- An **aperiodic signal** is a signal that does not exhibit any repetitive pattern over time. Unlike periodic signals, which repeat their patterns at regular intervals, aperiodic signals do not have a fixed period. This means that the signal's behavior does not repeat identically over any finite duration..

PERIODIC AND APERIODIC SIGNAL

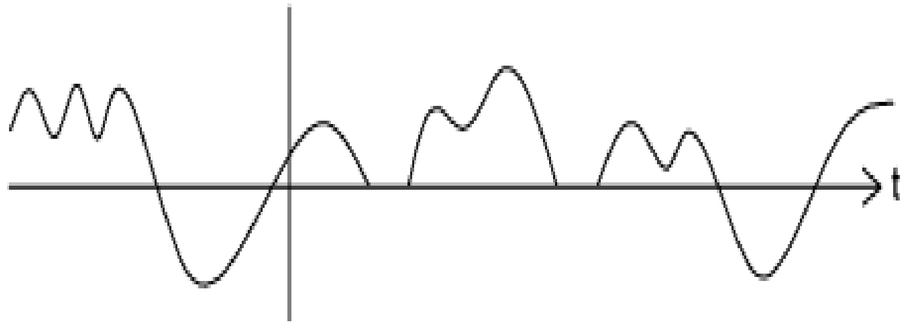
CT Periodic Signal
$x(t) = x(t+T)$



DT Periodic Signal



APeriodic Signal



EVEN AND ODD SIGNAL

- **Even Signal:** A Signal is said to be an even signal if the inversion of time axis does not change the amplitude. **Eg. Cosine Wave: Cos (-θ) = Cos θ**
- Even signal satisfies the condition x(-n) = x(n)

$$\mathbf{X_e(n) = \{x(n) + x(-n)\}/2}$$

- **Odd Signal:** A signal is said to be an odd signal if the inversion of time axis also inverse the amplitude of the signal.

  Eg. Sine Wave: Sin (-θ)= - Sin θ
- Odd signal satisfies the condition x(-n) = - x(n)

$$\mathbf{X_o(n) = \{x(n) - x(-n)\}/2}$$

ENERGY AND POWER SIGNAL

- Energy Signal: The signal which has finite energy and zero average power. 0<E<∞

$$Energy\ E = \lim_{T\to\infty} \int_{-T}^{T} |x(t)|^2 dt \qquad Energy\ E = \lim_{N\to\infty} \sum_{n=-N}^{N} |x(n)|^2$$

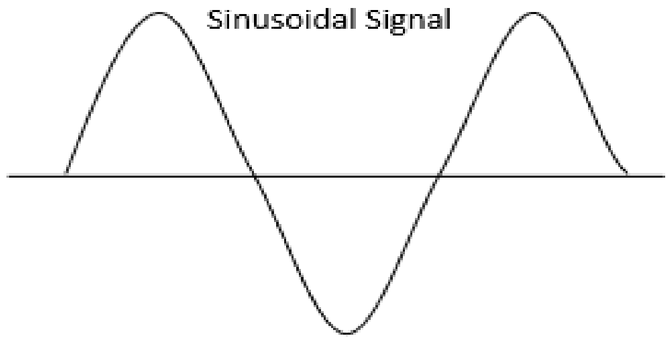
- Power Signal: The signal which has finite average power and infinite energy. 0<P<∞

$$P = \lim_{T\to\infty} \frac{1}{2T} \int_{-T}^{T} |x(t)|^2 dt \qquad P = \lim_{N\to\infty} \frac{1}{2N+1} \sum_{n=-N}^{N} |x(n)|^2$$

DETERMINISTIC AND RANDOM SIGNAL

- **Deterministic signal:** A signal which can be completely represented by any mathematical equation

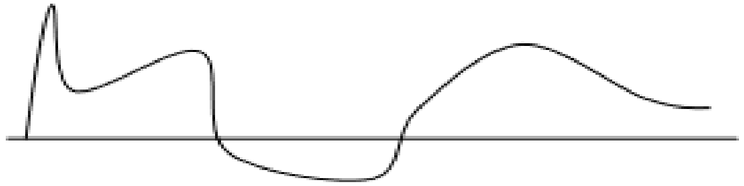
Eg: Sinusoidal Signal



Deterministic signal

- **Random signal:** A signal which cannot be completely represented by any mathematical equation

Eg: Noise Signal

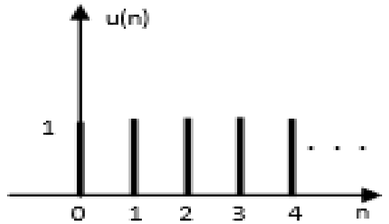


Random signal

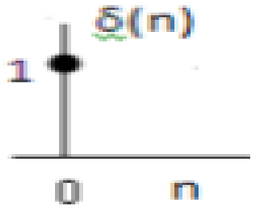
DISCRETE TIME SIGNALS

u (n) = 1 for n ≥ 0

= 0 for n< 0



Unit step signal



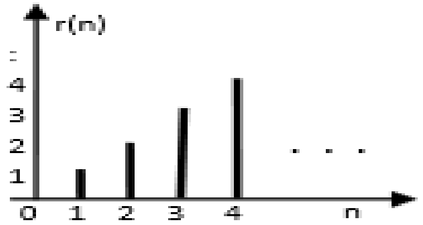
Unit Impulse signal

δ (n) = 1 for n = 0

= 0 for n ≠ 0

r (n) = n for n ≥ 0

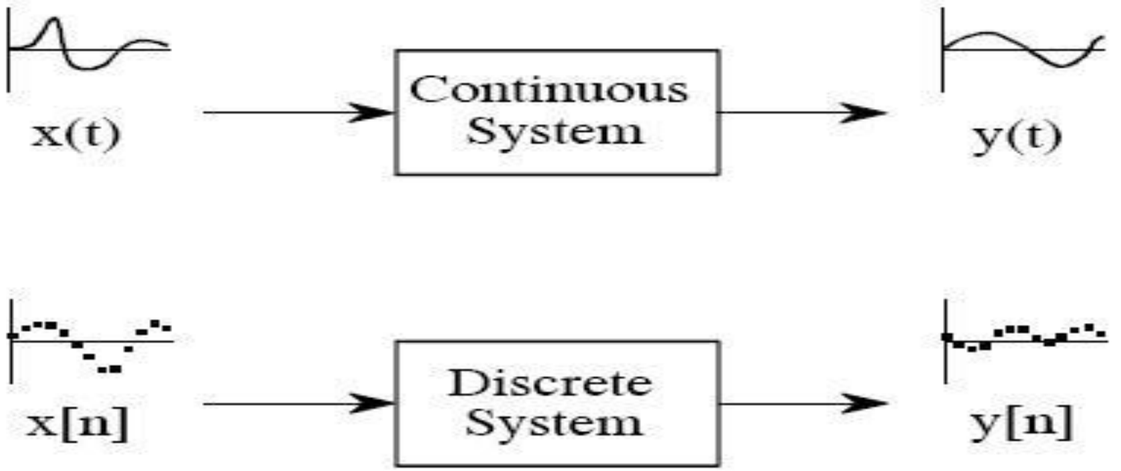
= 0 for n < 0



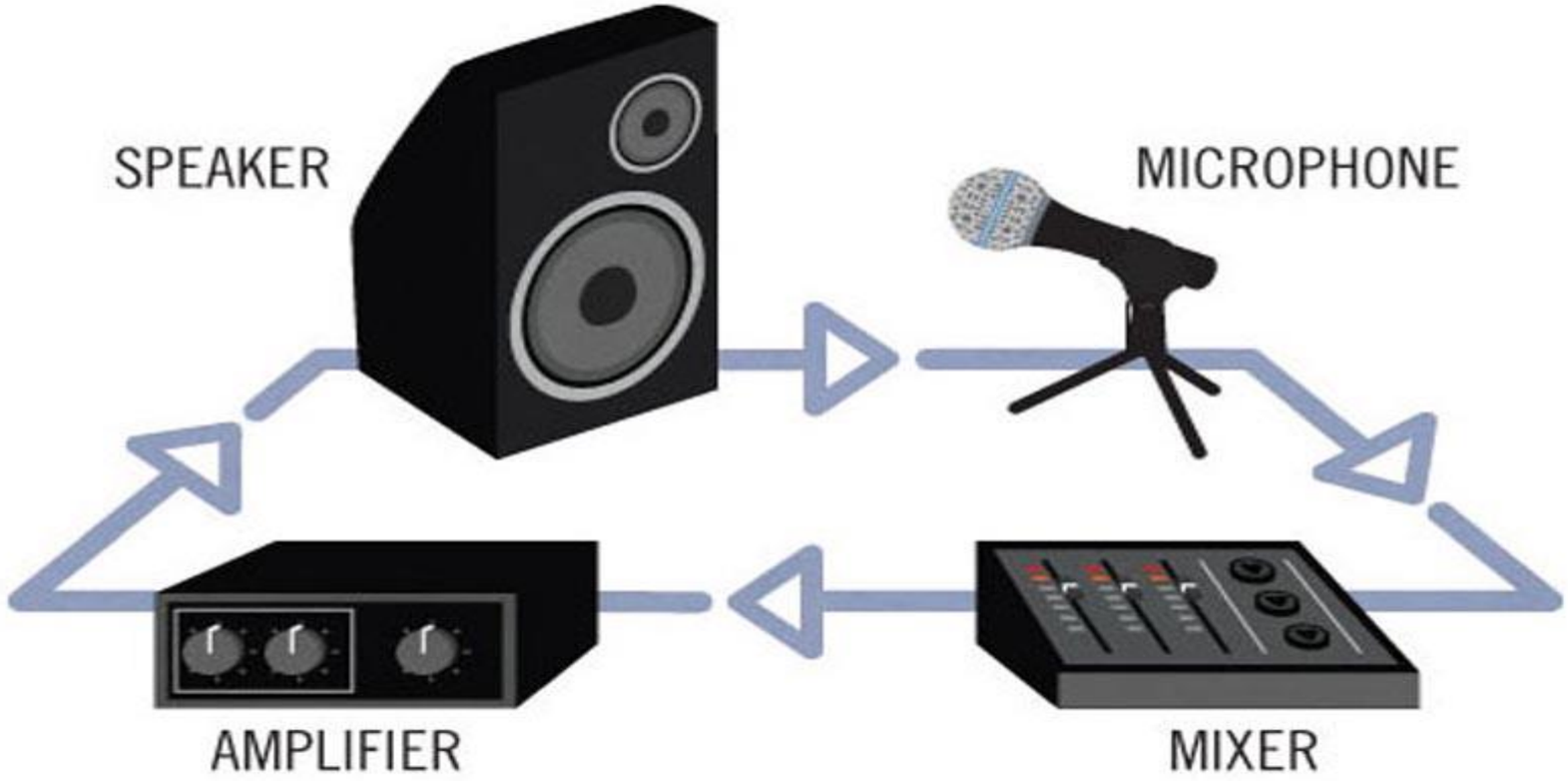
Unit Ramp signal

SYSTEM

- A System is a set of elements or functional blocks that are connected together to produces an output with response to input signal
- Systems process input signals to produce output signals
- Eg. Audio amplifier, Receiver



Example: Audio Amplifier



Example: TV Signal Broadcasting

CT & DT SYSTEM

- **Continuous Time System:** It operates on a continuous time signal (input or excitation) produces another continuous time signal (output or response)
- **Response y(t) = T {x(t)}**

- **Discrete Time System:** It operates on a discrete time signal (input or excitation) and produces another discrete time signal (output or response)
- **Response $y(n)$ = N {x (n)}**

APPLICATION AREAS

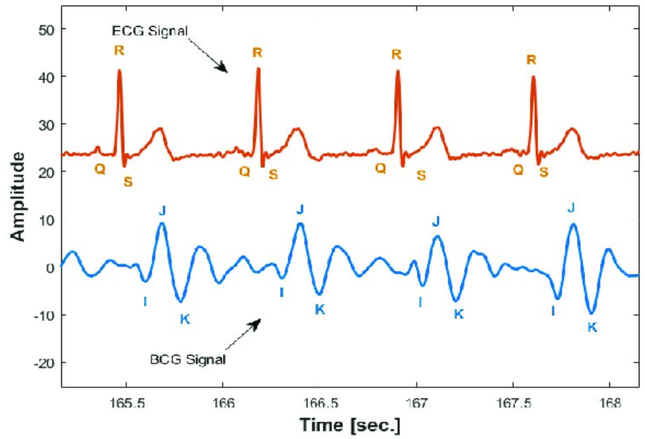
- Communications
- Audio and Speech Processing
- Image, Video Processing
- Circuit Design
- Biomedical Engineering
- Military Applications

APPLICATIONS

- Acoustics
- Communications: Transmission in mobile phones, GPS, radar and sonar
- Multimedia: Compress signals to store data such as CDs, DVDs

APPLICATIONS

- Biomedical: Extract information from biological signals
- Electrocardiogram (ECG) electrical signals generated by the heart
- Electroencephalogram (EEG) electrical signals generated by the brain
- Medical Imaging
- Biometrics: Fingerprint identification and iris recognition



ASSESSMENT

1. A signal which contains ----------
2. List the classification of signals.
3. What is meant by Periodic and Aperiodic Signal.
4. A signal that is defined for every instants of time is known as ----------
5. Give some applications of signals.
6. Define System and mention its types.
7. What is meant by deterministic and Random Signal.
8. Define Even and Odd Signal.

THANK YOU