UNIT-1

1. **Communication:-** The process of exchange information between two places is called communication.

Communication System:- The group of devices, circuits and instruments which facilitates the process of communication is known as communication system.

2. **Block diagram of communication system:-**

Message source → [Transmitter] → [Channel] → [Receiver] → Message Destination.

Any communication system comprises of following three blocks.

(i) Transmitter - [I/p Transducer, Amplifier, Modulator, Transmitting antenna].

(ii) Channel - [Guided (Metallic wire, Metallic cable, optical fiber), Unguided (Air vaccum Radio, satellite)

(iii) Receiver = (Receiving antenna, Demodulator, Amplifier, O/p Transducer).

3. (i) Classification of communication based on nature of channel.

- (i) Wired on line communication.
- (ii) Wireless or Radio communication.

(ii) Classification of communication based on nature of modulating signal:-

(i) Analog communication.
(ii) Digital communication.

(iii) Classification of communication based on distance between Rx and Tx:-

(i) Short distance communication.
(ii) Long distance communication.

(iv) Advance communication:-

(i) Optical communication.
(ii) Satellite communication.
(iii) Cellular communication (Transmitters and receivers distance can change).

4. Types of communication system:-

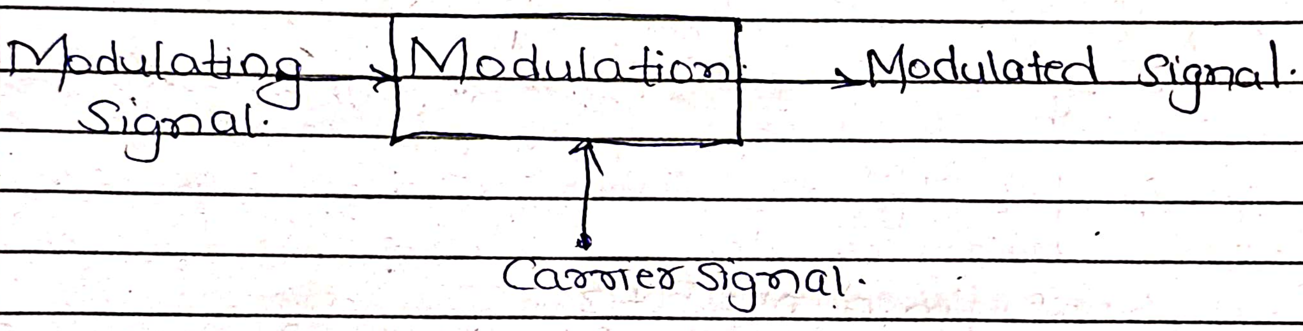
(i) Simplex communication system.
(ii) Semiduplex communication system.
(iii) Duplex communication system.

5. Modulation:- The process of making message signal suitable for transmission is called modulation. OR.

The process of varying one of the characteristics of carrier signal in accordance with instantaneous value of modulating signal is called Modulation.

* The characteristics of carrier signal:-
(i) Amplitude
(ii) Frequency
(iii) Phase.

The resultant signal after completion of modulation process is called modulated career signal or modulated signal or modulated career.



* Need of modulation:-

(i) To get practical height of antenna.
(ii) To avoid overlapping of messages during propagation through common channel.
(iii) To transmit entire range of frequency of a message source through single antenna.

B.E.R (Band Edge Ratio) :- $\frac{f_{max}}{f_{min}}$

for $h_{min} = \frac{\lambda}{4} = \frac{c}{4f}$ $\left[\lambda = \frac{c}{f}\right]$.

(iv) To increase the range of transmission.
(v) To reduce the noise.

Message source :- 50Hz to 5KHz.

$h = \frac{\lambda}{4}$

$= \frac{c/f}{4} = \frac{c}{f} \times \frac{1}{4}$

$$\boxed{h = \frac{c}{4f}}$$

Where, $f_m(min) = 50Hz$

$h = \frac{3\times10^8}{4\times50} \Rightarrow \frac{3\times10^8}{2\times10^2} \Rightarrow 15\times10^5 m.$

$\Rightarrow 1500\times10^3 m$

$\Rightarrow 1500 km.$

When $f_m(max) = 5000.$

$h = \frac{3\times10^8}{4\times5\times10^3} \Rightarrow \frac{3\times10^8}{2\times10^4} \Rightarrow 15\times10^3 m$

$= 15 km.$

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for B.E.R.

$$\frac{fm(max)}{fm(min)} = \frac{5000}{50} = 100 = B.E.R.$$

$$\frac{hmax}{hmin} = \frac{\cancel{1500}^{100} \times \cancel{10^3}}{\cancel{15} \times \cancel{10^3}} = 100\ B.E.R.$$

$$\boxed{\frac{fm(max)}{fm(min)} = \frac{hmax}{hmin} = B.E.R}$$

$fc = 50MHz$

$fmax = 50MHz + 5KHz.$

$\Rightarrow 50 \times 10^3 \times 10^3 + 5 \times 10^3.$

$= 50000000 + 5000$

$\Rightarrow 50005000 Hz.$

$fmin = 50MHz + 50Hz$

$= 50 \times 10^3 \times 10^3 + 50$

$= 50000000 + 50$

$50000050 Hz.$

$$\frac{fm(max)}{fm(min)} = \frac{50005000}{50000050} \simeq 1$$

$$\frac{fm(max)}{fm(min)} = \frac{hmax}{hmin} = 1.$$

$\boxed{hmax = hmin}$ for different frequency antenna height.

Types of Modulation:-

- Modulation
  - Continuous modulation
    - Analog continuous Modulation
      - AM
      - FM
      - PM
    - Digital continuous modulation
      - ASK
      - FSK
      - PSK.
  - Pulse modulation.
    - Analog pulse modulation
      - PAM
      - PWM / PDM
      - PPM
    - Digital pulse modulation
      - PCM
      - DPCM
      - DM
      - ADM

Baseband & Passband signal:-

→ All the modulating signal or message signal is called base band signal.

→ All the modulated signal is called passband signal.

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UNIT- I

1 Digital communications:-

A Type of communication in which the nature of modulating signal is digital type is called digital communi-cation.

Types:-

There are two types of Digital communicatio
They are:-

1) Continuous Digital communication.
2) Pulse Digital communication.

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1 Pulse Code Modulation :—

Pulse code modulation is the first step towards digital communication. Most of the message signal in original forms are analog in nature. But digital communication has lot of advantages over analog communication in which the modulating signal is digital in nature.

The process of sampling, Quantization and encoding done with the analog ~~(continuous) signal to~~ (continuous time) signal to get digital signal is called pulse code modulation.

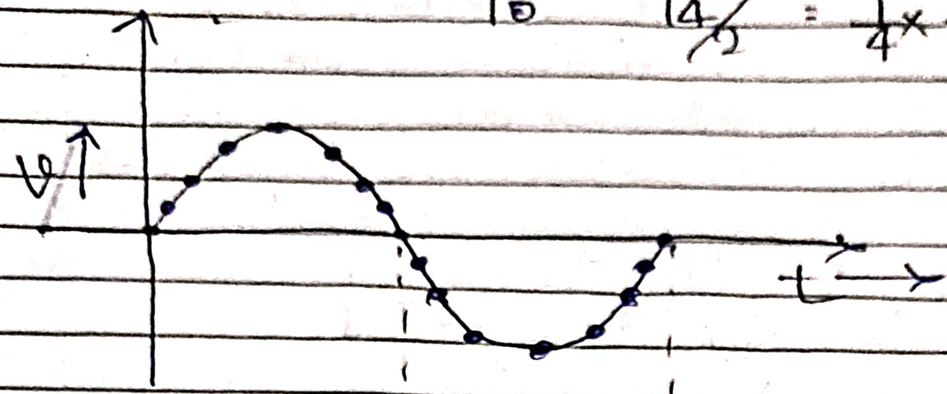
Hence, the following process are to be explained now:

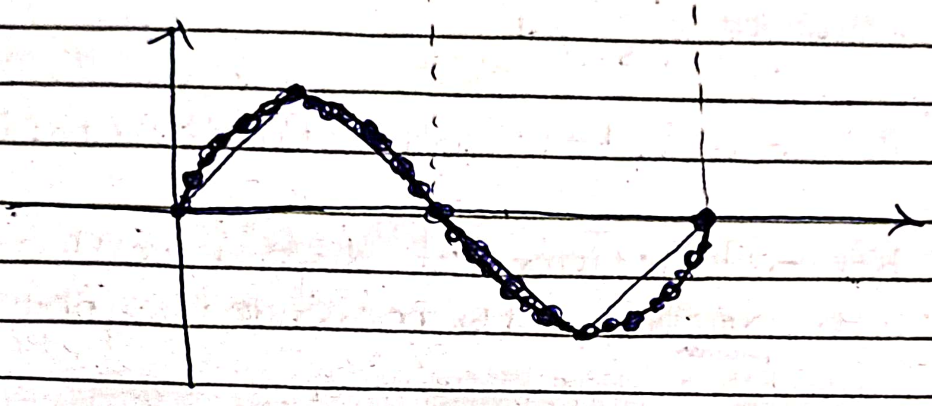
(i) Sampling
(ii) Quantization.
(iii) Encoding.

(i) Sampling :—

The process of discretization of continuous time ~~signal~~ (analog) signal in time domain is called Sampling.

$T_0 \quad T_{4/2} = \frac{T}{4} \times \frac{1}{2} = \frac{T}{8}$





Sample value:— The values of the amplitude of signal at different time points are called sample values or samples.

Sampling theorem:— For a band limited finite energy signal to be transmitted must be sampled following the condition below.

$$\boxed{f_s \geq 2f_m}$$

f_s = Sampling frequency = No of samples per second

f_m = Maximum frequency of the message signal.

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The minimum sampling rate is known as Nyquist rate and the minimum sampling frequency is called nyquist frequency which is denoted as by f_N.

i.e; $\boxed{f_N = 2 f_m}$

Case (1) When $f_s < f_N$

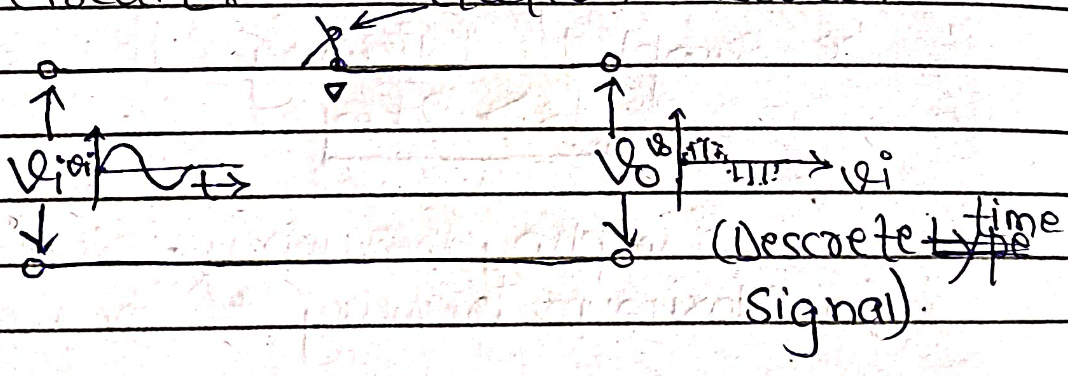
This case is known as undersampling.

Result = Reconstruction of signal will not be true with respect to message signal.

Case (2) When $f_s > f_N$

This case is known as oversampling. Result :- Reconstruction of signal will be true with respect to message signal.

Sampler Circuit :- Electronic switch.



Aliasing Error:- When the input message signal is undersampled during the process of sampling, the frequency spectrum of lower frequency signal takes the identity of the frequency spectrum of higher frequency signal, and viceversa. then such error is called aliasing error.

This error can be removed by using a low pass filter before sampler whose highest cut-off frequency (f_H) should be kept 50% switching speed of sampler.

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(ii) Quantization:- The process of rounding off the sample values produced by a sampler circuit to the nearest predefined voltage level (Quantized level) is called Quantization.

The electronic circuit responsible for this process is called Quantizer.

Quantization Error:- The difference between any sample value and its nearest Quantized level is called Quantization Error.

Quantization Error = Sample Value or level − The nearest quantized level or value.

Quantization:- The process of descretization of sampled signal in amplitude axis is known as Quantization.

Minimization of Quantization Error:-
Quantization error can be minimized by increasing the number of Quantized levels by 10 times between consecutive predefined voltage levels

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(iii) Encoding :-

The process of assigning binary code words to each quantized level of a message signal is called encoding.

Transmission Bandwidth of PCM system :—

Let 'q' be the no of quantized levels and 'v' be the no of bit required encode each quantized value. But the following condition must satisfied.

$$\boxed{2^{v} \geq q}$$

No of bits transmitted per second by a PCM transmitter = No of bits per sample × No of samples per second.

$$\Rightarrow \frac{\text{Bits}}{\cancel{\text{Sample}}} \times \frac{\cancel{\text{Samples}}}{\text{Second}} = \text{bits per second} = \text{bps}$$

1 Kbps = 1000 bps
= 1×10^{3} bps

1 Mbps = 1×10^{6} bps
= 10 lakh bps

1 Gbps = 1×10^{9} bps

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No of bits per sample x No of sample/sec.
$= v \times 2f_m$ (Using minimum sampling rate i.e; Nyquist Rate)

$= 2vf_m$ bps. ——— (i)

No of bits transmitted per ~~son~~ second is called signaling rate or bit rate.

~~Sing~~ Signaling rate is denoted by 'r'.

Hence, equation (i) can be rewritten as :-

$$r = 2vf_m \text{ ——— (ii)}$$

Requirement of ~~bandwidth~~ minimum transmitted bandwidth will always be half of the signaling rate.

$$\therefore BW\Big|_{PCM} = \frac{r}{2} \quad \text{(iii)}$$

Now, putting the value of equation (ii) in equation (iii) we get:-

$$\boxed{\text{Minimum Tx } BW\Big|_{PCM} = vf_m \text{ Hz.}}$$

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Line Encoding :- The process of assigning ~~electrical s~~ the bits of a codeword as electrical signal is called line encoding.

The electronic circuit which is responsible for line encoding is called line encoder.

* Following Digital signaling formats are used by the line encoder :-

(i) Unipolar (RZ & NRZ).
(ii) Polar (RZ & NRZ).
(iii) Bipolar (NRZ) - AMI (Alternate Mark Inversion)
(iv) Split Phase Manchester