BASIC ELECTRONICS & COMMUNICATION ENGINEERING-

Module - 5

Analog and Digital Communication:

*Modern Communication system scheme:.

* Fig (i) shows block diagram of a basic communication system.

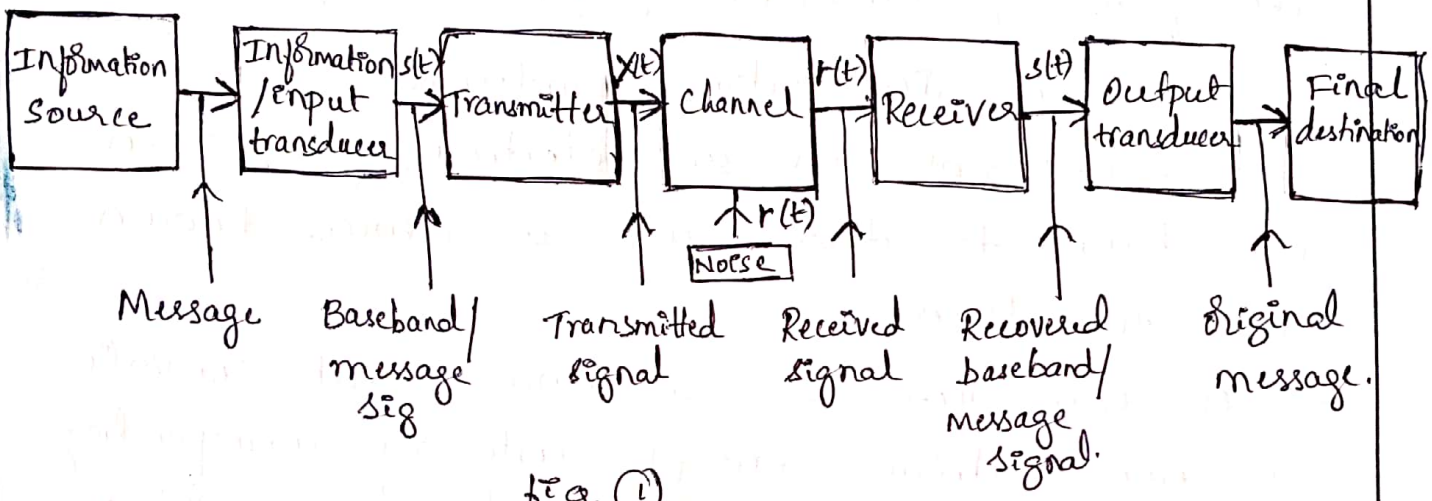

fig (i)

* The main constituents of basic communication system are

i) Information source and input transducer
ii) Transmitter
iii) Channel & medium
iv) Noise
v) Receiver
vi) output transducer and final destination.

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Information Source and Input Transducer:

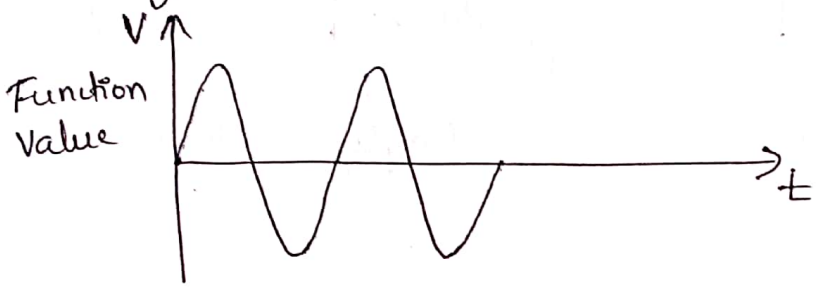
* A communication system transmits information from an information source to a destination and hence the first stage of communication system is the information source.
* A communication system transmits information in the form of Electrical signals or signals.
* If the information produced by the source is not in an electrical form, then we have to ~~devite~~ use a device known as transducer.
* A transducer is a device that converts a non-electrical energy into its corresponding Electrical energy called signal and vice-versa.
* The information produced by the information source is applied to the next stage, known as information or input transducer. This in turn, produces an electrical signal known as baseband signal. Baseband signal is also known as message signal, or an information signal or an intelligent signal or an envelope.
* Baseband signal is denoted by $s(t)$

$\Rightarrow$

* There are two types of signals.
  a) analog signals
  b) digital signals.

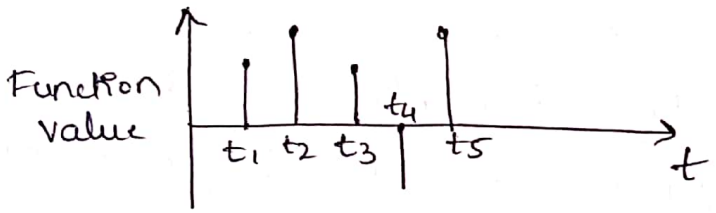
a) analog signal:

* It is a function of time and ... is continuous in nature.
* Analog signal is represented as below:



b) Digital signal:

* Digital signal is discrete in nature.
* Digital signal is represented as below:



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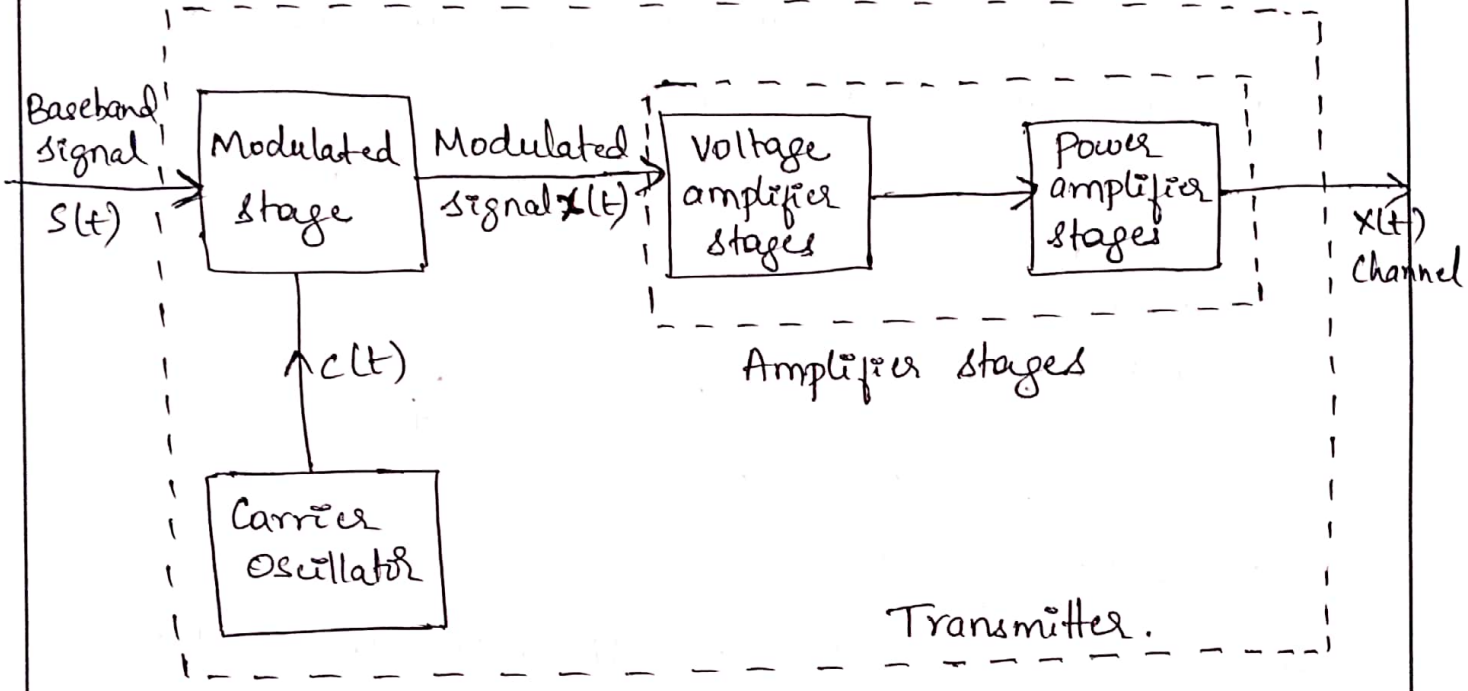
Transmitter:-

* Fig shows the block diagram of a typical transmitter.



* In fig, the baseband signal s(t) is applied to the modulated stage.
* The modulated stage translates the baseband signal from low frequency to high frequency spectrum. This stage also receives another input called the carrier signal c(t), which is generated by a high frequency carrier oscillator. Modulation takes place at this stage, with the baseband and the carrier signals as two inputs. ⇒

* After modulation, the baseband signal is translated to a high frequency spectrum and the carrier signal is said to be modulated by the baseband signal.
The o/p of the modulated stage is called the modulated signal and it is denoted by $x(t)$.
* The voltage of the modulated signal is then amplified and applied to the last stage of the transmitter called the power amplifier stage. This stage amplifies the power of the modulated signal and thus it carries enough power to reach the receiver stage of the communication system.
* Finally, the signal is passed to the transmission medium & channel.

Channel or Medium:

* The transmission medium between the transmitter and the receiver is called a channel.
* Depending on the physical implementations, channel is classified into two groups
  1) Hardware channels
  2) Software channels.

* **Hardware channels:-**
  - This channels are manmade structure.
  - The hardware channel is called as a line communication system.
  - The following three possible implementations of the hardware channels
    1) Transmission lines:-
       Eg:- Twisted pair cables (landline phone)
       Coaxial cables (TV cable)
    2) waveguides:-
       To transmitt ultra high frequency (UHF) waveguides are used as medium. waveguides are hollow, circular or rectangular metallic structure.
    3) optical fiber cables:-
       In optical fiber cables signals are transmitted in the form of light energy in optical fiber cables.

* Software channels:

- The natural resources which can be used as the transmission medium for signals is called software channels.

Eg:- air, open space and sea water.

- There is no physical link between the transmitter and the reciver in communication systems if the software channels are used.

Noise:-

* Noise is defined as unwanted electrical energy of random and unpredictable nature present in the system.

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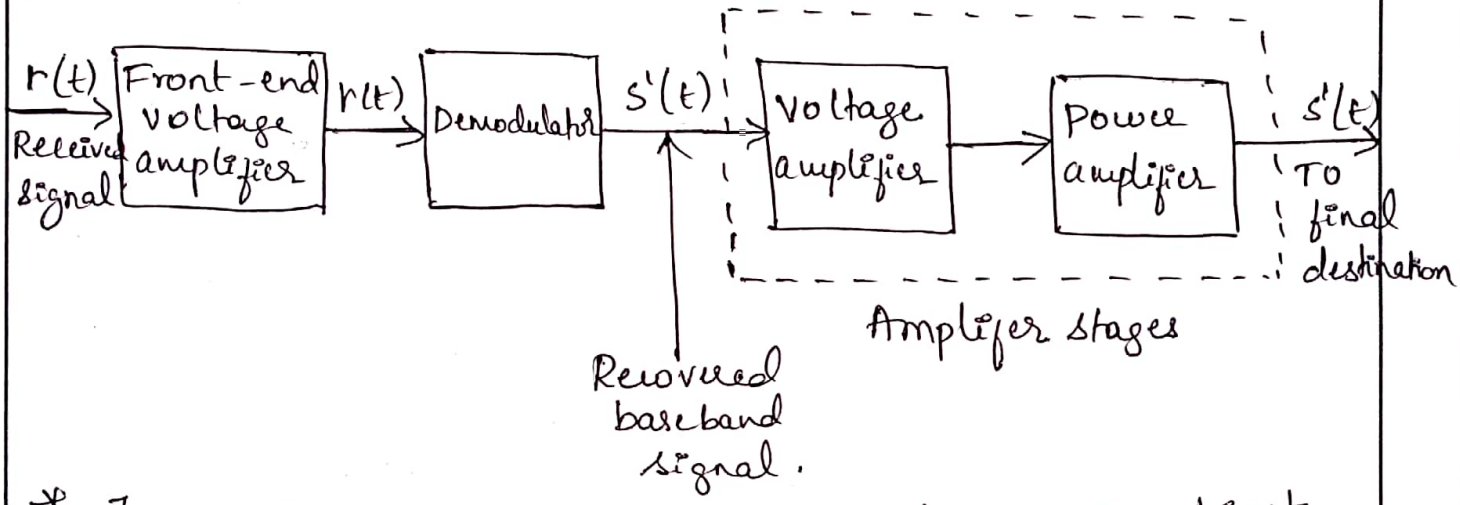
Receiver:-

* The task of the receiver is to provide the original information to the user.
* The function of the receiver section is to separate the noise from the received signal, and then recover the original baseband signal by performing some processing on it.
* The detailed block diagram of a typical receiver section is shown in fig



* From fig, the received signal r(t), is first amplified by the front-end voltage amplifier. This is done to strengthen the received signal.
* Next, the signal is given to the demodulator, which in turn, demodulates the received signal to recover the original baseband signal.

* After recovering the original baseband signal, its voltage and power is amplified prior it to final destination block.

Multiplexing:-

* Multiplexing is a process which allows more than one signal to transmit through a single channel.

Types of Communication Systems:

* There are two types of communication systems
  i) Line communication systems
  ii) communication systems based on signal specifications.

* i) Line Communication systems:-

ii) Communication systems Based on signal Specifications.

* Based on signal specifications, there are two types of communication system,
  - (i) Nature of baseband or informal signal
  - (ii) Nature of the transmitted signal.

* Based on the nature of the baseband signal, there are two types of communication system,
  - (i) Analog communication systems.
  - (ii) Digital communication systems.

* Based on the transmitted signal, there are two types,
  - (i) Baseband communication system,
  - (ii) carrier communication system

* Thus there are four types of communication system categories based on signal specification. They are
  - (i) Analog communication system
  - (ii) Digital communication system
  - (iii) Baseband communication system
  - (iv) Carrier communication system

Modulation:

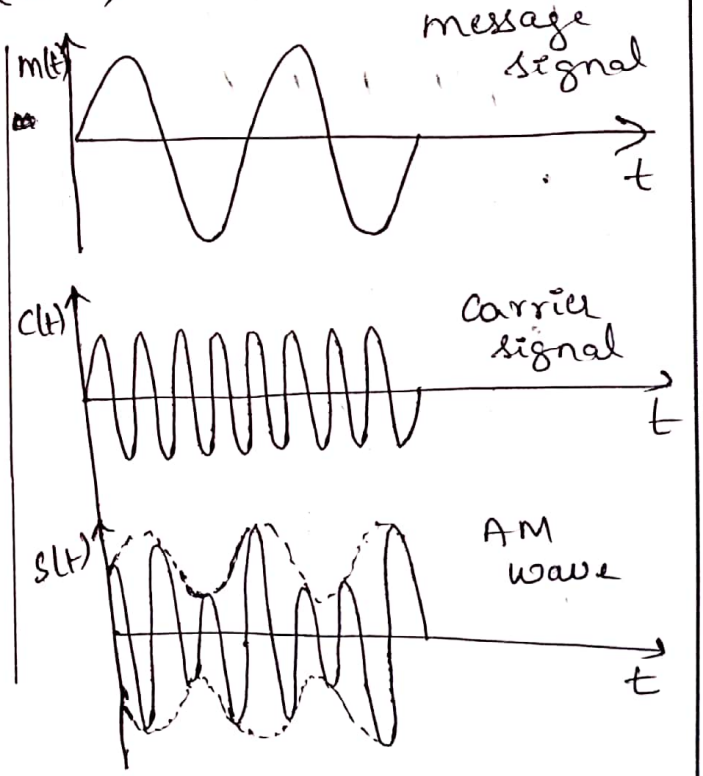
Modulation is a process of changing the characteristics (Amplitude, frequency and phase) of a carrier wave in accordance with message signal.

Types of Modulation:

1) Amplitude Modulation
2) Frequency Modulation
3) phase Modulation.
4) pulse Modulation.

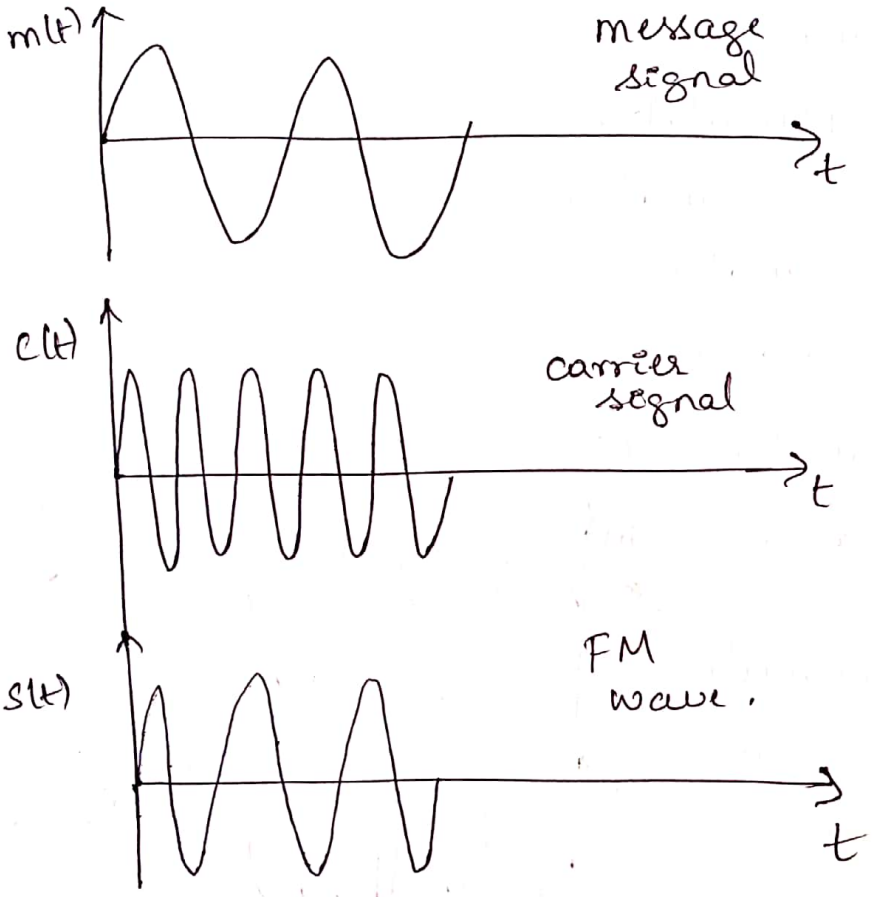
1) Amplitude Modulation: (AM)

Amplitude modulation is a process of changing the Amplitude of the carrier wave in accordance with message signal



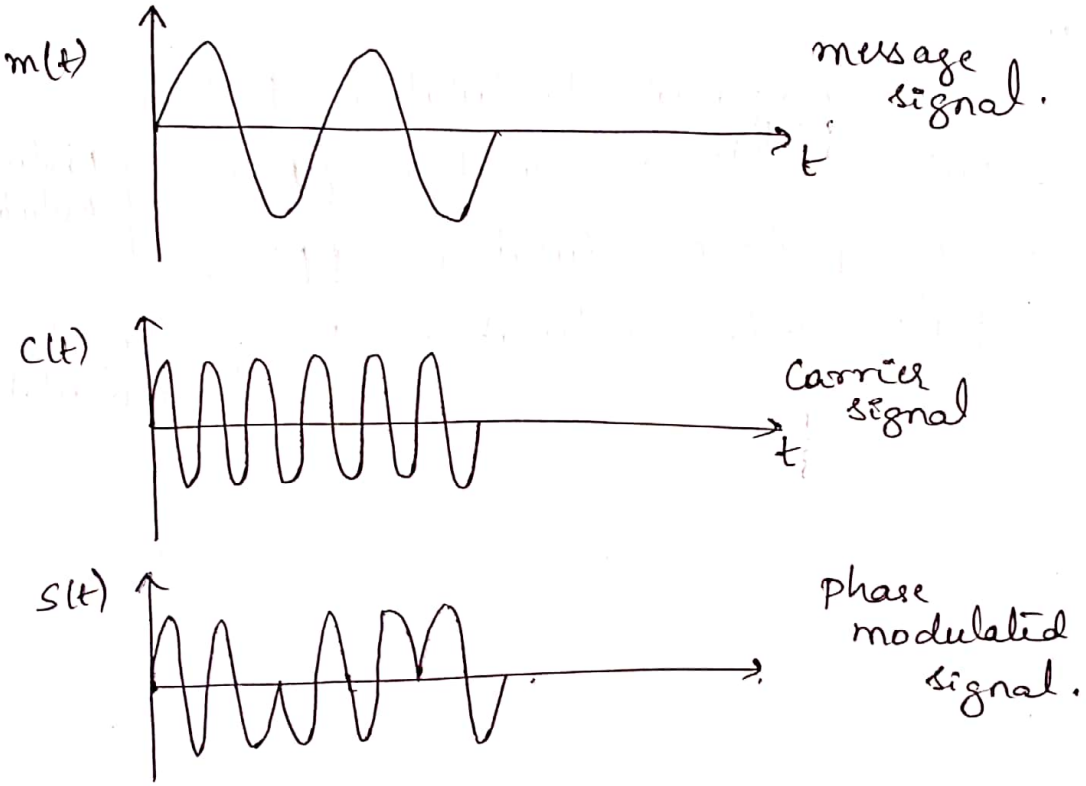
(2) Frequency Modulation :-

It is a form of angle modulation in which the instantaneous frequency of the carrier is varied in accordance with the message signal.



(3) Phase Modulation:

Phase Modulation is a type of angle modulation in the phase of carrier is varied in accordance with the message signal.



Pulse Modulation:

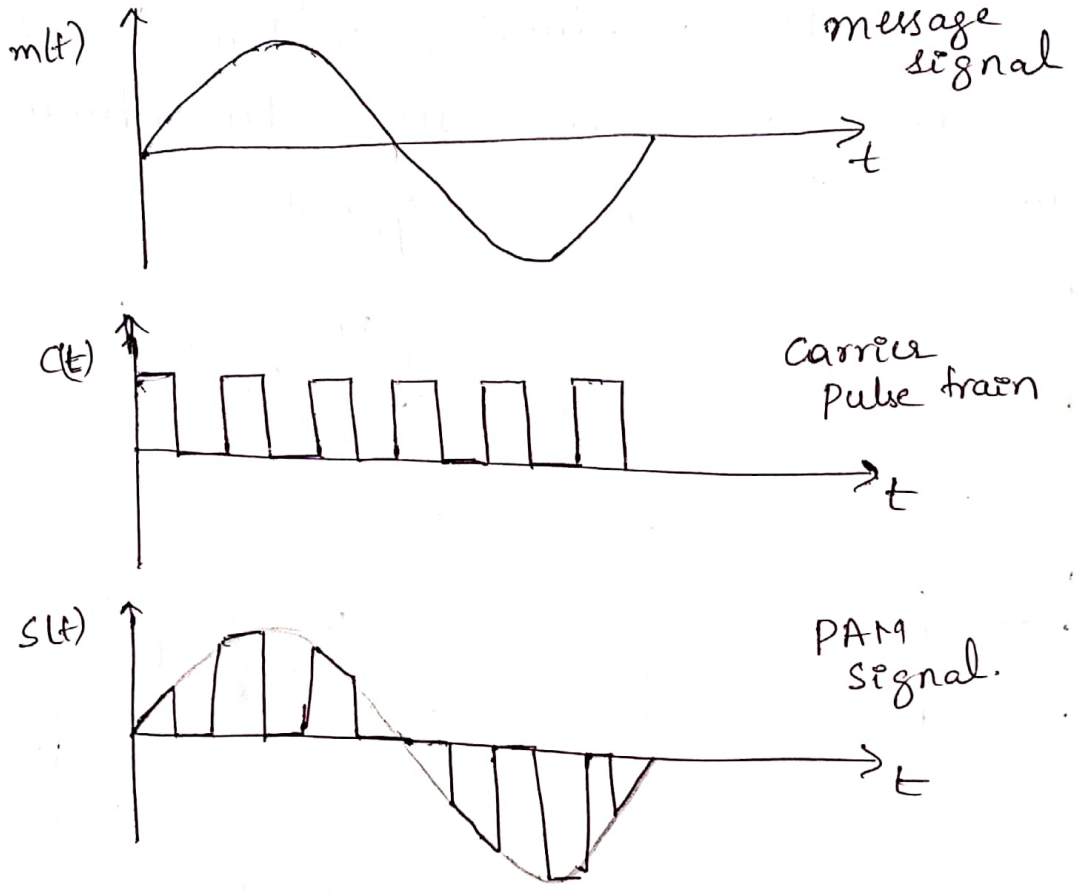
* The process of transmitting signals in the form of pulses by using special techniques is called pulse Modulation.
* The following are the types of pulse Modulation
  - pulse Amplitude Modulation (PAM)
  - pulse width Modulation (PWM)
  - pulse position Modulation (PPM).

  } Analog Modulation

  - pulse code Modulation (PCM) – digital Modulation

Pulse Amplitude Modulation: (PAM)

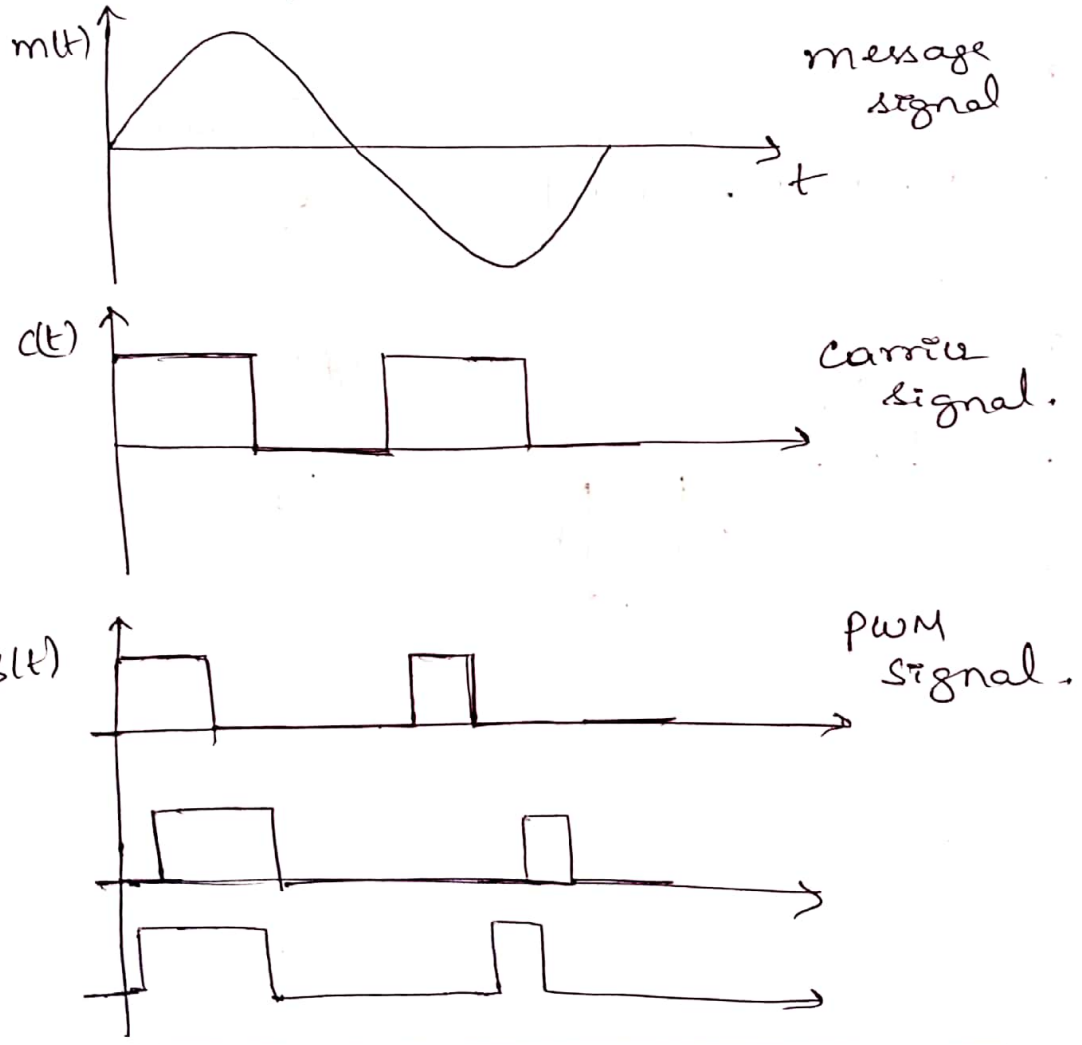
* It is an analog Modulation scheme in which the amplitude of the pulse carrier varies proportional to the instantaneous amplitude of the message signal.



Pulse width Modulation: (PWM).

* Pulse width Modulation (PWM) &
  Pulse duration Modulation (PDM) &
  Pulse Time Modulation (PTM)

* It is a analog modulating scheme in which the width & duration & time of the pulse carrier is varied wrt instantaneous amplitude of the message signal.



Pulse position Modulation: (PPM).

* PPM is an analog modulating scheme in which the amplitude and width of the pulse are kept constant, while the position of each pulse, with reference to the position of a reference pulse varies according to the instantaneous value of message signal.

Pulse-Code Modulation :- (PCM)

* PCM is a digital process in which the message signal is sampled is rounded off to the nearest value of the finite set of allowable values and rounded values are coded.

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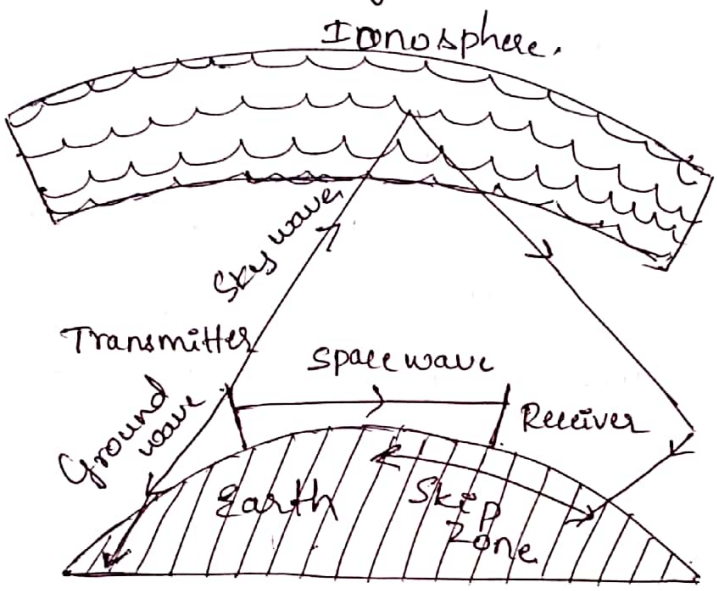
Concept of Radio wave Propagation:-

* The Radio wave propagation can be broadly classified as
  (i) ground & surface
  (ii) space & tropospheric
  (iii) sky.
* Fig shows different modes of propagation used in communication system.



(i) Ground wave propagation:-

* In ground wave propagation, radio waves are guided by the earth and move along its curved surface from the transmitter to the receiver.
* As waves moves over the ground, they are strongly influenced by electrical properties of the ground.

⇒

* As high frequency wave are strongly absorbed by the ground, ground wave propagation is useful only at low frequencies.
* Ground wave transmission is very reliable whatever the atmospheric condition.

(ii) Space & tropospheric wave propagation:-

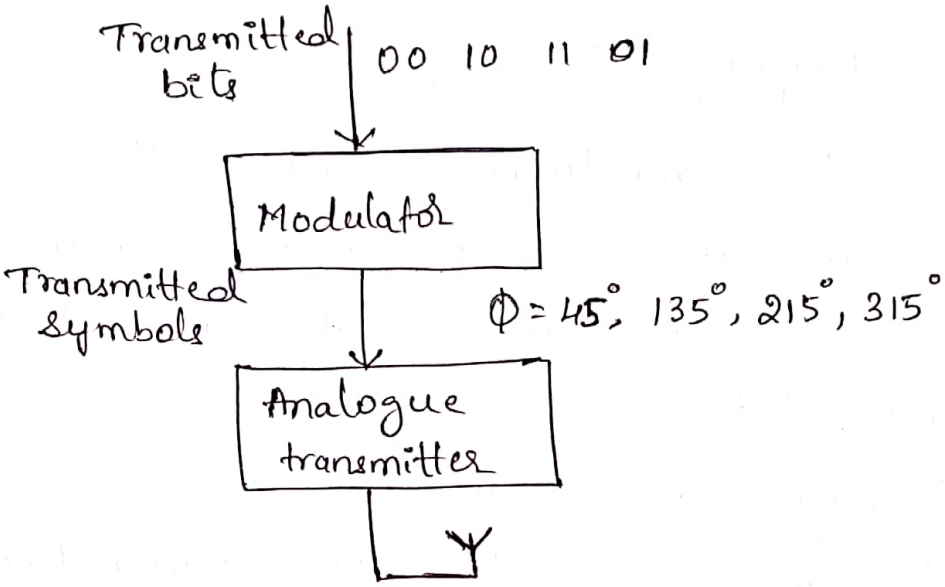
* when a radiowave transmitted from an antenna, travelling in a straight line directly reaches the receiving antenna, it is termed as space & tropospheric wave.
* The space wave is made up of two components
  (i) a direct & line-of-sight wave
  (ii) the ground-reflected wave

(iii) Sky:-

In this mode of propagation, radio waves transmitted from the transmitting antenna reach the receiving antenna after reflection from the ionosphere.

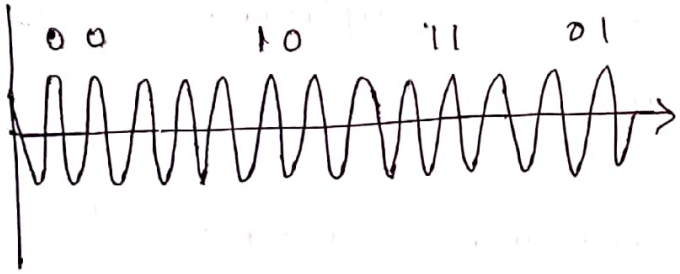
Radio signal transmission:

* Fig (1) shows Architecture of a wireless communication transmitter.

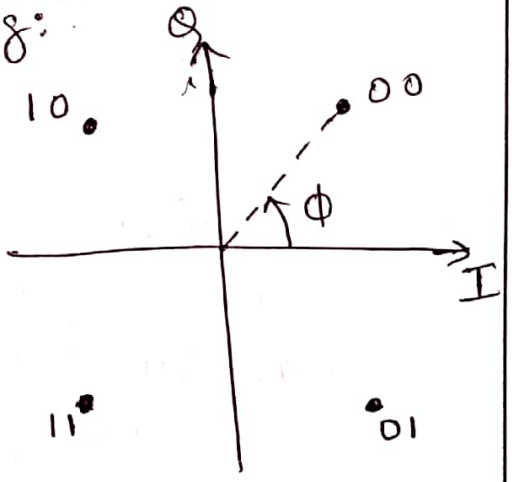


* In the fig, the transmitter accepts a stream of bits.
* It then encodes these bits onto a radio wave, known as the carrier, by adjusting parameters of the wave such as its amplitude or phase.
* The transmitter usually processes the information in two stages
  - In First stage, a modulator accepts the incoming bits.
  - In second stage, it computes symbols that represent the amplitude and phase of the outgoing wave.

* Finally, it passes these to the analogue transmitter which generates the radio wave.
* Fig ① is also known as quadrature phase shift keying (QPSK).
* A QPSK modulator takes the incoming bits two at a time and transmits them using a radio wave that can have four different states.
  i.e They have phase of 45°, 135°, 225° and 315° which correspond to bit combinations of 00, 10, 11 and 01 respectively.
* QPSK waveform and QPSK constellation diagram are shown in below fig:



QPSK wave form.



QPSK constellation diagram.

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Multiple access techniques:-

* Mobile communication systems uses different multiple access techniques:

1) Frequency division multiple access (FDMA)
2) Time division multiple access (TDMA).

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Antenna:

* An Antenna is a device for converting electromagnetic radiation in space into electrical currents in conductors & vice-versa.
* An Antenna must have the following features
  1) strictly defined radiation patterns for a most accurate network planning.
  2) Growing concern for the level of intermodulation due to the radiation of many HF carriers via one antenna.
  3) Dual polarization.
  4) Electrical down-tilting of the vertical diagram.
  5) Unobtrusive design

Types of Antenna:-

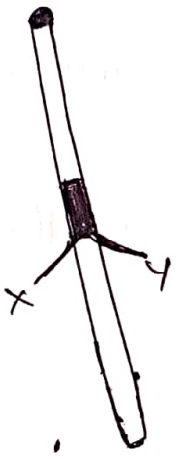
1) Omnidirectional antennas.
2) Dipole antennas.
3) Collinear omni antennas.
4) Directional antennas.
5) Patch antennas.
6) Patch array antennas.
7) Yagi antennas

1) Omni directional antenna:

* An omnidirectional antenna is an antenna that has a non-directional pattern in a given plane with a directional pattern in any orthogonal plane.

2) Dipole Antenna:

* A Dipole Antenna most commonly refers to a half-wavelength ($\lambda/2$) dipole.



(3) Collinear Omni Antennas:

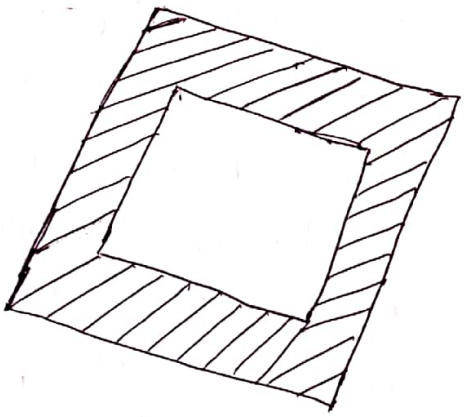
* In order to create an omnidirectional antenna with higher gain, multiple omnidirectional structures can be arranged in a vertical, linear fashion. This is frequently referred to as a collinear array.

(4) Directional Antennas:

* A directional antenna is one that radiates its energy more effectively in one direction than others.
* Directional antennas are used for coverage as well as point-to-point links.

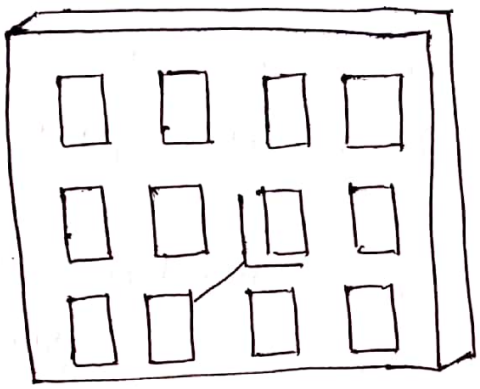
(5) Patch Antennas:

* A patch Antenna is a single rectangular conductive plate that is spaced above a ground plane.
* patch antennas are attractive due to their low profile and ease of fabrication.
* fig shows patch Antenna model.



(6) Patch Array Antenna:

* A patch array antenna is, in general, some arrangement of multiple patch antennas that are all driven by the same source.
* This arrangement consists of patches arranged in orderly rows and columns as shown in fig



(7) Yagi Antenna:

* A yagi antenna is formed by driving a simple antenna, typically a dipole & dipole-like antenna and shaping the beam using a well-chosen series of non-driven elements whose length and spacing are tightly controlled.
* A yagi antenna is shown in fig.