Introduction :- Communication is the basic process of exchanging information between two entity called sender which send the information originating from information source and receiver which accept the data through various information processing.

The electronic equipments which are used for communication purpose are called communication equipments. Different communication equipments when assemble together called communication system.

Typical example :- point to point comm.; Line telephony, radio telephony, mobile communication, computer communication, radar communication, television comm., radio aids to navigation etc.

In recent years, communication has become more widespread with the use of satellites and fiber optics.

Today, there has been an increasing emphasis on the use of computers in comm.

The communication process:-

Processing involve in communication describe as:-

[a]. The generation of thought pattern or image in the mind of an originator.

[b]. The description of that image, with a certain measure by precision, by a set of aural or visual sysmbols.

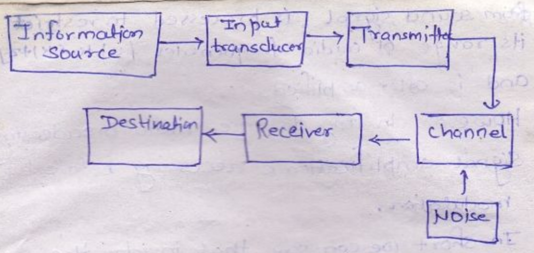
[c]. The encoding of these symbols.

(D). The transmission of encoded symbol to the desired destination.

(e). The decoding and reproduction of original symbols.

(f). The recreation of the original thought pattern or image, with a definable degradation in quality in the mind of recipent.

Fig (1.a). shows the block diagram of communication system.



Block diagram of comm. sys.

Information Source:- In general, there can be various message in the form of words, group of words, code symbols, sound signal etc. However, out of these messages, only the desired message is selected and conveyed or communicated.

Input Transducer:- Transducer is a device which used to convert one form of energy to another form of energy. In a case when message produced by the information source in not electrical in nature, the input transducer is used to convert it into a time varying electrical signal.

Transmitter:- The function of transmitter is to process the electrical signal from different aspects. For example in radio broadcasting the electrical signal obtai from sound signal, is processed to restrict its range of audio frequencies [upto 5KHz], and is after amplified.

However in long distance radio broadcasting signal amplification is necessary before modulation.

In short we can say that inside the transmitter, signal processing such as restriction of range of audio frequencies, amplification and modulation are achieved.

<u>The channel and Noise</u>:- The function of channel is to provide the physical link b/w transmitter and the receiver.

There are two types of channels, namely point to point channels and broadcast channels.

point to point → wirelines, optical fibers. wirelines operate by guided em wave and they are used for local telephone transmission.

Broadcast → satellite in geostationary obtit.

During the process of transmission and ~~resp~~ reception the signal gets distorted due to noise introduced in the system.

Noise is an unwanted form of energy or signal which tend to interfere with signal at any point in communication system. Noise has its greatest effect on the signal in the channel.

Receiver:- The main function of receiver is to obtained or reproduced the message signal in electrical form from the distorted received signal. This is accomplished by the process known as the demodulation or detection.

Destination:- Destination is the final stage which is used to convert an electrical message signal into its original form.

Communication channels:- Normally, we shall consider following channels:-

(i) Telephone channels.
(ii) optical fibers.
(iii) Mobile radio channels.
(iv) Satellite channels.

(i) <u>Telephone channels</u>:- A telephone network makes use of switching mechanism. The switching mechanism is known as circuit switching and it is used to establish an end to end communication link on temporary basis.

In this form of communication, the message source is sound produced by the speaker's voice and destination is the listener's ear.

Telephone channel support only electrical signal.

Telephone channel is essentially a linear, band limited channel. A speech signal is essentially limited to a band from 300 - 3400 Hz frequencies in lying outside this band do not contribute much to articulation efficiency.

(ii) <u>Optical fibers</u>:- An optical fiber is a dielectric waveguide which transports light signal from one place to another just as a metallic wire pair or a co-axial cable . transport electrical signal.

Optical fiber system offer the following unique advantages:-

(a) Enormous potential Bandwidth
(theoretical BW of a light wave system is around 2×10^{13} Hz)

(b). Low Transmission losses. (·2dB/Km).

(c) Imunity to electromagnetic Interference.

(d). Small size and weight.

(e) Ruggedness and flexibility.

(iii) Mobile Radio channels :- It extends the capability of the public telecommunications network by introducing mobility into the network by virtue of its ability to broadcast.

There is no "line of sight" path for communication, rather radio propagation takes place mainly by way of scattering from the surface of the surrounding buildings and by the diffraction over and / or around them.

Therefore, the energy reaches the receiving antenna via more than one path. Therefore in mobile radio environment, we face a problem of multipath phenomena in the sense that the various incoming radio wave reach destination from different direction and with different time delays.

(iv) Satellite channels:- "A satellite channel provides broad-area coverage in a continental as well as intercontinental sense."

In almost all satellite communication system, the satellite are placed in a geostationary orbit.

In a typical satellite communication system, a message signal is transmitted from an earth station via an uplink to a satellite, amplified in a transducer on board the satellite. It is then retransmitted from the satellite via a downlink to another earth station.

In fact satellite work as powerful repeater in sky.

popular freqⁿ band for satellite communication is 6/4 GHz.

A ~~signal~~ single transponder can carry at least one colour television channel signal, 1200 voice circuits or digital data at a rate of 50 Mb/s.

As a matter of fact communication channels may be classified in different way as under:-

(i) A channel may be linear or nonlinear. A telephone channel is linear, whereas a satellite channel is usually nonlinear.

(ii) A channel may be time varying or time invarient.
Optical fiber → Time invarient
Mobile radio channel → Time varying.

(iii) A channel may be bandwidth limited or power limited.
A telephone channel → B.W. limited.
Optical fibers and satellite channel — power limited.

Base band and Pass band Signals:→

The message signal generated from the information source is known as baseband signal. If baseband signal transmitted directly then it called baseband transmission. Baseband transmission does not used modulators and demodulators. It may be digital and analog. It is prefered for short distance and at low frequencies. ISI is major problem associated with Baseband signals.

If the modulated signal is transmitted over the channel, it is known as bandpass or simply passband transmission.

Band pass transmission is generally used at higher frequency and for long distance.

All television and satellite transmission are bandpass type. It may also be digital or analog.

Modulation process:- "Modulation may be defined as the process by which some characteristics of a signal called carrier is varied in accordance with the instantaneous value of another signal called modulating signal."

Signal containing information or intelligence are referred as modulating signals. The signal resulting from the process of modulation is called modulated signals.

Types of Modulation:- Modulation is basically of two types:-

(i) Continous wave modulation:- When the carrier wave is continous in nature, the modulation process is known as continous wave (CW) modulation or analog modulation.

example:- Amplitude modulation.
Angel modulation → frequency modulation, phase modulation.

(ii) Pulse Modulation:- When the carrier wave is a pulse type waveform, the modulation process is known as pulse modulation.

In pulse modulation the carrier ~~wave~~ is ~~a pulse type waveform~~ consist of a periodic sequence of rectangular pulses.

pulse modulation can be analog or digital.

ex:- Analog pulse modulation → PAM
→ PPM
→ PWM.

Digital pulse modulation → PCM.

Need for Modulation :- Modulation serves several purpose in communication system as discussed below:-

(a) Practicality of Antenna:- For efficient radiation and reception, the transmitting and receiving antennas must have lengths comparable to a quarter wavelength of frequency used.

... example in AM broadcast system, the maxim audio frequency transmitted from a ~~audio~~ radio station is the order of 5KHz.

If this message audio signal were to be transmi without modulation then the height of antenna required,

$$l = \frac{\lambda}{4} = \frac{c}{4f} = \frac{3\times10^8}{4\times5\times10^3} \approx 5km.$$

Obviously, it will be totally impracticable to construct and install an antenna of such a height.

This height of the antenna may be reduced by modulation technique and yet effective radiation and reception is achieved.

As an example:- if an audio frequency is translated to a radio frequency carrier of frequency 4MHz, the antenna height required would be

$$l = \frac{\lambda}{4} = \frac{c}{4f} = \frac{3\times10^8}{4\times3\times10^6} = 25\ m.$$

(b) To remove Interference:- Another reason fo not radiating modulation signal itself is tha the frequency range of audio signal is from 20 Hz to 20KHz. In radio broadcasting, there are several radio stations. In case there is no modulation, all these stations

transmit audio or sound signals in the range of 20Hz to 20KHz. Due to this transmission over same range, the programmes of different station will get mix up.
Hence in order to keep the various signals separate it is necessary to translate or shift them to different portion of em wave spectrum.
Thus each station is allocated a band of frequency.

[C] Reduction of Noise:- Noise is the major limitation of any communication. Although noise can not be eliminated completely, but with the help of several modulation schemes, the effect of noise can be eliminated.

* Page No. 8. table 1·1 Radio spectrum and it's uses.

[D]. Frequency Multiplexing:→ Suppose that we have several different signals, all of which encompass the same spectral range. Let it be required that all these signals be transmitted along a single communication channel in such a manner that, at the receiving end, the signals be separately recoverable and distinguishable from each other.
Such multiple transmission i.e. multiplexing may be achieved by translating each one of the original signal to a different freqn range.

MULTIPLEXING:- Multiplexing is a technique in which several message signals are combined into a composite signal for transmission over a common channel.

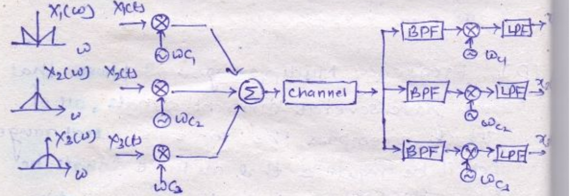
In order to tranmit a number of these signal over the same channel, the signals must be kept apart so that they do not interfere with each other and hence can be separated easily at the receiver end.

Basically it is of two types:-

(i) Frequency division multiplexing (FDM)

(ii) Time division multiplexing (TDM).

(i) FDM:-



FDM.

(ii) TDM:- In case of TDM, the complete channel bandwidth is alloted to one user for a fixed time slot. As an example, if there are ten users, then every user can be given the time slot for one second. This technique suitable for digital signals.

AMPLITUDE MODULATION:- Amplitude modulation may be defined as a system in which the maximum amplitude of the carrier wave is made proportional to the instantaneous value (amplitude) of the modulating or baseband signal.

Let us consider a sinusoidal carrier wave $c(t)$ given as

$$c(t) = A\cos\omega_c t \quad \text{—(1)}$$

Here A is the maximum amplitude of the carrier wave and ω_c is the carrier frequency. For simplicity here we have assumed that the phase of the carrier wave is zero.

Let $x(t)$ denotes the modulating or baseband signal then,

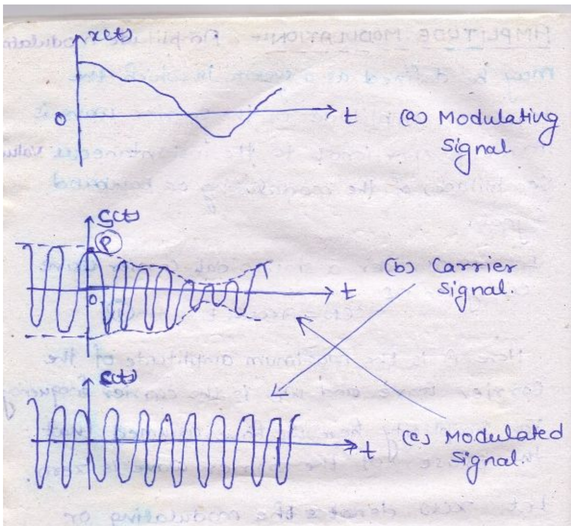
Standard equation for amplitude modulated (AM) wave may be expressed as

$$x(t) = x(t)$$

$$s(t) = x(t)\cos\omega_c t + A\cos\omega_c t.$$

$$s(t) = [A + x(t)]\cos\omega_c t. \quad \text{—(2)}$$

Figure (a), (b), (c) shows the modulating signal or base band signal, carrier signal and modulated signal.



Few points about AM

(a) It may be noted that carrier signal is fix frequency signal. The modulating or baseband signal x(t) contains the informat[ion] or intelligence to be transmitted.
In the process of amplitude modulation, this information is superimposed upon the carrier signal in the form of amplitu[de] variation of carrier signal.

(b) In the process of amplitude modulation, the frequency and phase of the carrier remain constant whereas the maximum amplitude varies according to the instanteous value of information signal.

(c) Equation (2) represents an amplitude modulated wave. This wave has a constant frequency ω_c and amplitude $A+x(t)$. This implies that the amplitude of the wave is changing around A in accourdance with the value of modulating signal $x(t)$.

(d) Figure(c) illustrates the process of amplitude modulation. ~~This wave~~ Upto point P the modulating signal is not applied so there is no modulation and after point P modulating signal is applied. There for AM occurs.

(e) The AM wave has a time varying amplitude called as the envelope of the AM wave, which contain the modulating signal that means that the envelope of the modulated carrier has the same shape as the message signal or base band signal.

$s(t) = [A + x(t)] \cos\omega_c t$

$= E(t) \cos\omega_c t$

where $E(t) = [A + x(t)]$ = envelope.

Modulating signal or baseband signal ma be recovered from an AM wave by detecti the envelope.

Spectrum of AM wave or Freq^n domain Representation:-

AM wave, $s(t) = [x(t) + A] \cos\omega_c t$

$= x(t) \cos\omega_c t + A \cos\omega_c t$ —①

This equation represent AM wave in time domain.

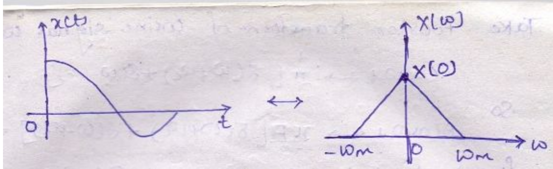
For frequency domain representain take fourier transform of equation①

$S(\omega) = F[s(t)]$

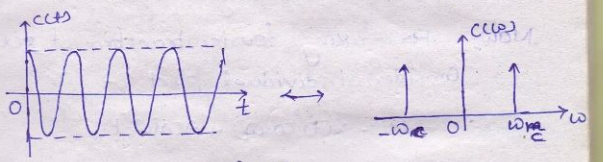
$C(\omega) = F[c(t)]$

$X(\omega) = F[x(t)]$

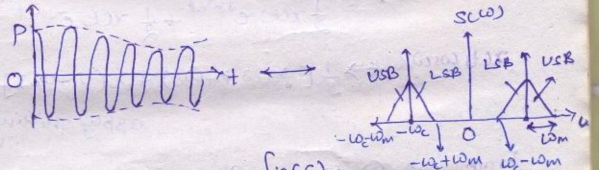
Let modulating signal $x(t)$ and it's fourier transform shown in fig (a).



fig(a).



fig(b).



fig(c).

The modulating signal band limited to ω_m the interval $-\omega_m \leq \omega \leq \omega_m$.

There is no significance for negative frequency. Hence we can say that the modulating signal contain frequencies from 0 to ω_m. or simply Bω of modulating signal is ω_m.

Take Fourier transform of cosine signal "$\cos\omega_c t$"

$$\cos\omega_c t \leftrightarrow \frac{\pi}{2}[\delta(\omega+\omega_c)+\delta(\omega-\omega_c)]$$

So

$$A\cos\omega_c t \leftrightarrow \frac{\pi A}{2}[\delta(\omega+\omega_c)+\delta(\omega-\omega_c)] \quad — ②$$

fig(b) shows the carrier signal $A\cos\omega_c t$ and its fourier transform.

Now, For taking fourier transform of $s(t)$ consider individual part,

$$s(t) = x(t)\cos\omega_c t + A\cos\omega_c t.$$

$$x(t)\cos\omega_c t = x(t)\left[\frac{1}{2}(e^{j\omega_c t}+e^{-j\omega_c t})\right]$$

$$= \frac{1}{2}x(t)e^{j\omega_c t} + \frac{1}{2}x(t)e^{-j\omega_c t}$$

$$x(t)\cos\omega_c t \Leftrightarrow \frac{1}{2}[X(\omega-\omega_c) + X(\omega+\omega_c)] \quad — ③$$

apply shifting pr

From eqn ①, ② and ③.

$$S(\omega) = \frac{1}{2}[X(\omega-\omega_c)+X(\omega+\omega_c)] + \frac{\pi A}{2}[\delta(\omega+\omega_c) + \delta(\omega-\omega_c)] \quad — ④$$

Thus the spectrum of modulated signal contai shifted spectrum of modulating signal and the spectrum of carrier signal as shown in fig(c).

(a) The band of frequency which is lying abo the carrier frequency ω_c is known as the upper side band (USB) whereas the