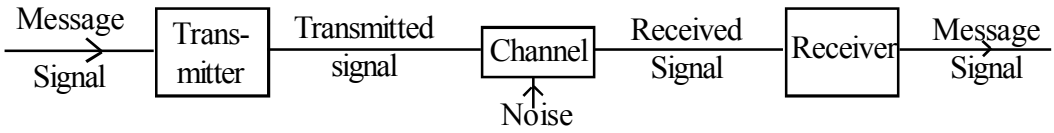
Chapter 15

COMMUNICATION SYSTEM

- What is communication - An act of sharing or imparting information.
- What are the steps of communication - It involves sending, processing and receiving information.
- Electrical and Electronic signals are used for long distance communication. Why?
  It travels at the speed of light.
- What is Communication system. What are they?
  Device which is used for the exchange of information between Sender and Receiver. They are electrical, electronic and optical.
- What are the different parts of communication system -
  1) Transmitter - used to convert information signal in to a form (Electromagnetic wave) suitable for transmission.
  2) Communication Channel - Medium (path) used for communication.
     They are two types,
     (i) Guided channel - Air, two wire communication channel, OFC.
     (ii) Unguided channel - Free space.
  3) Receiver - used to reconstruct recognisable form of the original information.
- Block diagram of communication system



- What are Transducer - A device which converts non-electrical signals (voice, data, video) in to electrical signals (voltage / current)
- Signal - Voltage/current corresponding to the information.
- Microphone is a Transducer - Converts sound energy into electrical pulse.
- Dynamo is a transducer - converts ME in to electrical energy.
- Amplification is necessary for signal communication. Due to attenuation, distortion of signal.
- What is Bandwidth - Frequency range overwhich an equipment can operate.
- What is spectrum - Frequency b and of the Signal OR Arrangement of signals according to their frequency.
- Write frequency band for wireless communication.

AM Radio Broadcast	500 KHz - 1600 KHz
FM Radio Broadcast	88 MHz - 108 MHz
Cellular Phone	896 MHz - 901 MHz - Mobile to Base Station
	840 MHz - 935 MHz - Base station to Mobile.
Satellite Communication	5.9 GHz - 6.4 GHz - Uplink.
	3.7 GHz - 4.2 GHz - down link.

- Administrator of the present system of frequency allocations (spectrum) - ITU (International Telecommunication union)
- TRAI - Telecom Regulatory Authority of India.
- Different frequency range is used for uplink and downlink. Why?

  To avoid interference of signals and to distinguish.
- What is the size of antenna to radiate signals with high efficiency.

  Length of the antenna, $l = \frac{\lambda}{4}$
- For AM broadcast ground based antenna (Tower antenna) is used. Why?

  Length of the antenna will be large.

  eg: Frequency of signal to be transmitted (υ) = 15 KHz.

$$\lambda = \frac{c}{\upsilon} = \frac{3\times10^8}{15\times10^3} = 20{,}000 \text{ m.}$$

$\therefore$ Length of the antenna required, $l = \frac{\lambda}{4} = \frac{20000}{4} . = 5000\text{m}$

- Range of signal - The largest distance over which signals can be viewed.
- What is repetor? What is its use?

  Combination of Transmitter and Receiver - used to extend the range of communication.
- What are the modes of communication.

  1) Communication through wire (point to point communication)
  2) Communication through space (Space communication)
  3) Satellite Communication.
- What is Space communication

  The atmosphere of earth used for communication.

  There are three modes.

  1) Ground wave (Surface wave) propagation - Signals transmitted along the earth surface.
  2) Sky wave propagation (Ionospheric wave) - Signals reflected back to earth by Ionosphere.
  3) Space wave propagation (Tropospheric wave) - Signals reflected back to earth from Troposphere, Space and Earth surface.

  It is also called line of sight communication.
- Microwave is used for line of sight communication.

- Expression for the distance over which Signals can be viewed - (Range of signals)

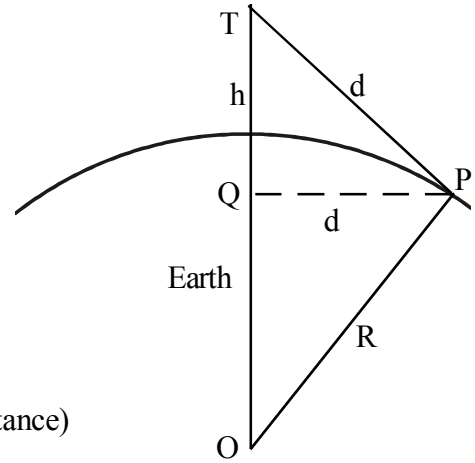
From Δ OPT, $OT^2 = OP^2 + PT^2$

$(R+h)^2 = R^2+d^2$

$d^2 = 2Rh + h^2$ $\quad (\because PT = QP)$

$= 2\ Rh(1+\frac{h}{2R})$ since R>>h

$d = \sqrt{2Rh}$ Since $1+\frac{h}{2R} \sim 1$



(Note : d - Distance to the horizon - line of sight.distance)

$\therefore$ Circular area over which signals can be viewed = π d^2.

- Sky waves are not suitable for TV signal transmission. Why?

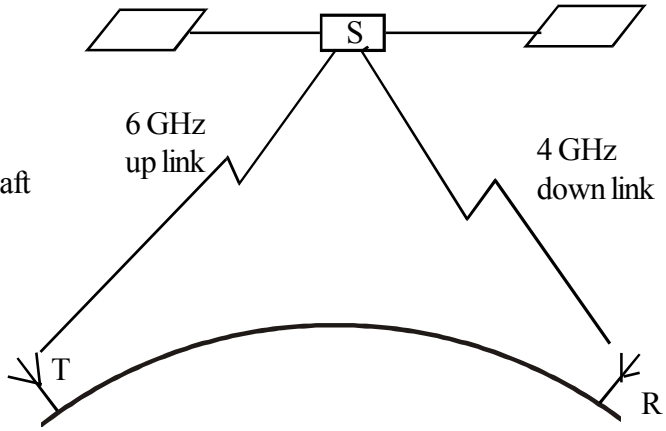
Sky waves are the signals reflected by ionosphere only of frequency below 30 Mhz, TV signals of frequency range (100MHz - 200 MHz) are penetrate through Ionosphere.

- Explain Satellite communication

Space wave (eg.: Microwave) used for satellite communication

Communication Satellite is a space craft which carries on board microwave transmitting and receiving equipment (Transponder).Such a satellite is Geostationery Satellite.

Eg:: INSAT



- What is modulation - The process of super imposing low frequency signals with high frequency signals - The signals obtained after modulation are modulated signals.

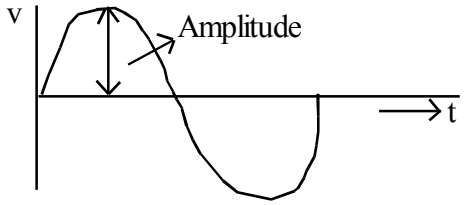
Low frequency signals - Modulating (base band) signal.

High frequency signals - Carries wave.

- What are the needs of modulation-
  - (i) Long distance broad casting
  - (ii) Height of the antena is low as possible
  - (iii) Avoid chances of interference of signals
- Modulated signal for transmission requires high frequency - Why?

  For good transmission of signal high power is required. It is obtained at high frequency ($E\alpha\upsilon$).
- Power rediated from a lenear antena is $(\ell/\gamma)^4$ ℓ - for length of antena, γ -wave length of signal.
- What are the types of modulation-

I Continious wave (sinusoidal) modulation.

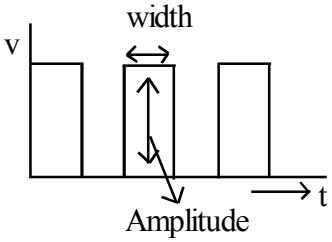


  a) Amplitude modulation (AM)

  b) Frequency modulation (FM)

  c) Phase modulation (PM)

II Pulse modulation



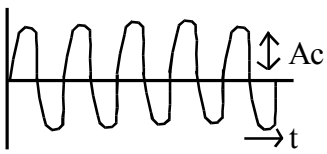
  a) Pulse Amptitude Modulation (PAM)

  b) Pulse Position Modulation (PPM)

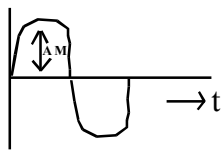
  c) Pulse Width Modulation (PWM)

- Amplitude Modulation (AM)

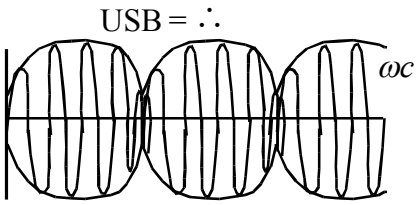
  Variation in amplitude of carrier wave in accordance with base band signal.
- Graphical representation of AM.



$C(t) = A_c \text{ Sin } \omega_c t$
(Carrier signal)



$m(t) = Am \text{ Sin } \omega_m t$
(Base Based signal)



$LSB = \omega c - \omega m$
AM Signal

- Analyse of AM.

  $C(t) = A_c \text{ Sin } \omega_c t$, Carrier Signal

  $M(t) = Am \text{ Sin } \omega_m t$, Base hand signal

  Amplitude modulated signal

  $C_m(t)\ (Ac + Am \text{ Sin } \omega_m t) \text{ Sin } \omega_c t$ (Since Amplitude of AM Signal increases)

$$= A_C \left(1 + \frac{Am}{Ac} Sin\ \omega_m t\right) \text{Sin}\ \omega_c t$$

$$= A_C\ Sin\ w_c t + \mu A_c Sin\ \omega_c t\ Sin\omega_c t$$

$$C_m(t) = A_c Sin\ \omega_c t + \frac{\mu A_c}{2} Cos(\omega_c - \omega_m)t - \frac{\mu A_c}{2} Cos(\omega_c + \omega_m)$$

Where, $\mu = \frac{Am}{Ac}$, Modulation Index,

Percentage of Am, $\frac{Am}{Ac}$ 100%

2SinA SinB = Cos (A-B)-Cos(A+B)

Modulated signal $[(C_m\ C(t))]$ consists of three frequencies,

(i) W_c - Carrier signal frequency

(ii) $W_c + W_m$ = USB, Upper Side Band frequency

(iii) $W_c - W_m$ = LSB, Lower Side B and frequency

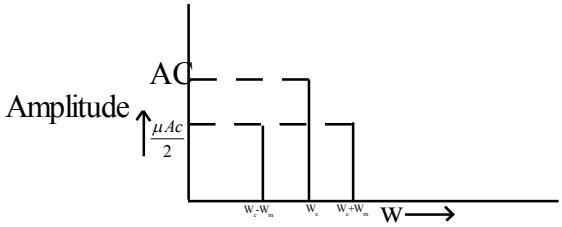
- Expression for Band width (β)

β = USB - LSB

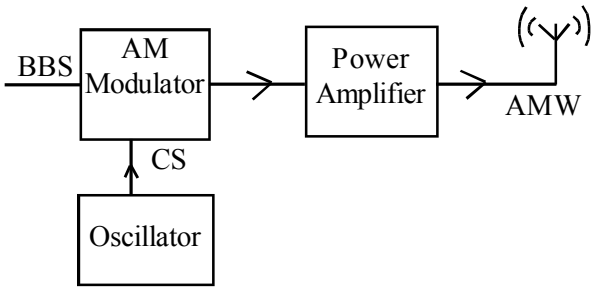
= $W_c + W_m - W_c + W_m$

= 2Wm where Wm = $2\pi\vartheta_m$

- Draw AM Spectrum



- Production of AM wave (Block diagram)



- Use of AM:-

In Radio and TV sound broadcasting.

- Limitations of AM

  (i) Low efficiency (ii) Noisy Reception

  (iii) Small operating range (iv) Lack of audio quality

Eg:- For an AMW the maximum amplitude is 10V while minimum amplitude 2V.

(i) Determine modulation index

AMW, $C_m(t) = (A_c t + A_m \text{ Sin } w_m t) \text{ Sin } w_c t$

Maximum amplitude, $A_c + A_m = M_1$

Minimum amplitude, $A_c - A_m = M_2$

Modulation Index $\mu = \frac{Am}{Ac} = \frac{M_1 - M_2}{M_1 + M_2}$

$$\mu = \frac{8}{12} = 0.67$$

(ii) What would be the value of modulation index (μ) if minimum amplitude is, zero volt

$\mu = 1$

- To avoid distortion of signal (weaking of signal) modulation index, $\mu \leq 1$
- Given $m(t) = 20 \text{ Sin } 2\pi (2000)t$, $c(t) = 80 \text{ Sin } 2\pi (100000)t$.

Determine,

i) Percentage of modulation

ii) Frequency of Baseband and carrier signals

iii) Frequency spectrum of modulated wave.

iv) Band Width

i) Percentage of modulation $= \frac{Am}{Ac} 100$

$$= \frac{20}{80} 100 = 25\%$$

ii) $m(t) = \text{Am Sin } (2\pi \vartheta_m t)$

$m(t) = 20 \text{ Sin } 2\pi (2000)t$

$\therefore \vartheta_m = 2000 Hz$

$C(t) = \text{Ac Sin} 2\pi \vartheta_c t$

$C(t) = 80 \text{ Sin} 2\pi (100000)t$

$\therefore \vartheta_c = 100000 Hz$

(iii) Frequency spectrum of modulated wave

$\vartheta_c = 100000 Hz \Rightarrow 100 KHz$

LSB = $\vartheta_c - \vartheta_m : 10000 - 2000 \Rightarrow 98000Hz \Rightarrow 98KHz$

USB = $\vartheta_c - \vartheta_m : 10000 + 2000 \Rightarrow 102000Hz \Rightarrow 102KHz$

Spectrum is 98KHz - 100KHz - 102KHz

(iv) Band width $\beta = USB - LSB$

= 102 - 98

= 4KHz

- Communication systems are mostly analogue
  - (i) Natural signals are analogue
  - (ii) More complexity for digital systems
- Electric current be used as carrier signal - No - But electro magnetic wave form is used.
- Antena as transmitter converts electrical signals into EM wave, as receiver it converts EM wave into electrical signals.
- At low frequency (Eg. Sound) signal is propagated in all directions - It is not transmitted over distant place due to large absorption of air.
- High frequency signal (Eg: Microwave) travels along a straight line. So for their reception either Geostationary satellite or receiver antena are required.