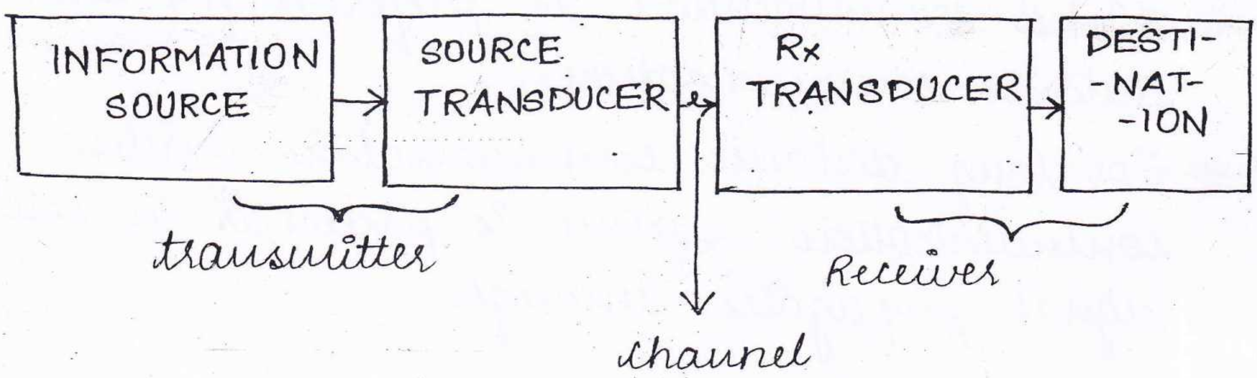
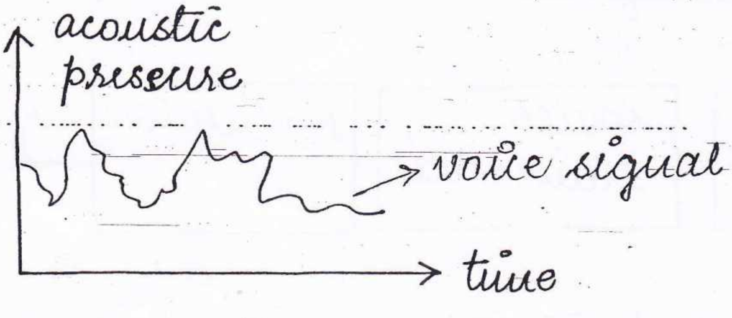
Analog Communications

communication is the process of transformission of information from source to destination and from transmitter to receiver.

Basic Block diagram of communication system



Voice signal → 300Hz – 3.5KHz
audio signal → 20Hz – 20KHz
video signal → 0 – 4.5MHz
satellite communication → 1GHz – 30GHz



For short distance communication, wired communication is used.
wired communication : T_x and R_x phicalls are physically connected

→ Information source is the source of information.

→ Source Transducer converts physical signal into electrical equivalent. eg: microphone.

→ Channel is the medium through which signal propagates from one place to another.

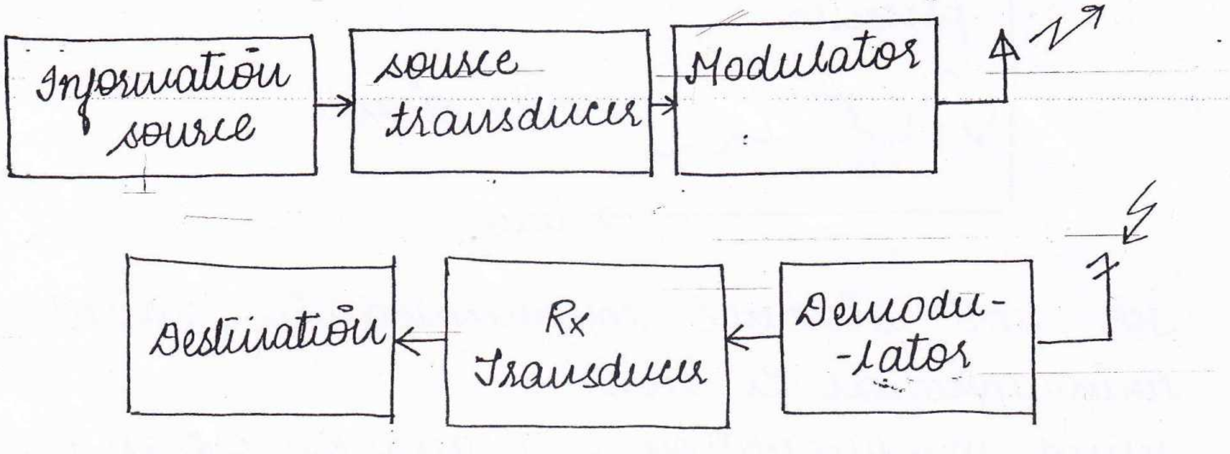
NOTE :-

Wired communication is preferred for short distance communication.

For long distance communication wireless communication system is preferred in which signal propagates through

→ Receiving transducer converts electrical signal into physical eg: loudspeaker.

Block diagram of wireless communication sys.



Generally without modulation long distance communication through free space is not possible.

Need for Modulation

1. Reducing antenna height

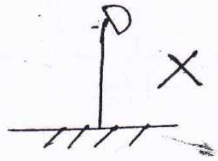
For faithful radiation of signal antenna height should be $h_t = \frac{v}{4f}$

Transmitting antenna converts electrical signal into EM signal and resulting will travels with velocity of light.

$$\lambda = \frac{c}{f} \qquad h_t = \frac{c}{4f}$$

$f = 15\,KHz$

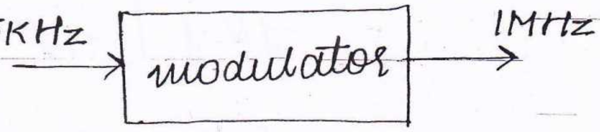
$$h_t = \frac{3\times10^8}{4\times15\times10^3} = 5\,km$$

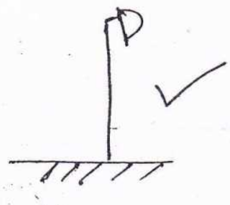


NOTE: Modulation is the process of increasing the freq. of signal to reduce antenna height.

$f = 1\,MHz$

$$h_t = \frac{3\times10^8}{4\times10^6} = 75\,m$$





2. Multiplexing

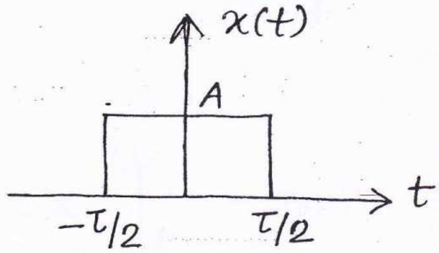
→ It is the process of transmission of multiple no. of signals through a ~~sign~~ single channel at the same time.

→ Generally, without modulator multiplexing is not possible.

→ In wired comm. modulation is required for the purpose of multiplexing.

Fourier Transform

Fourier transform is used to find the freq. contained by the given time domain signal.



$$X(f) = \int_{-\infty}^{\infty} x(t) \cdot e^{-j2\pi f t}\, dt = \int_{-\tau/2}^{+\tau/2} A \cdot e^{-j2\pi f t}\, dt$$

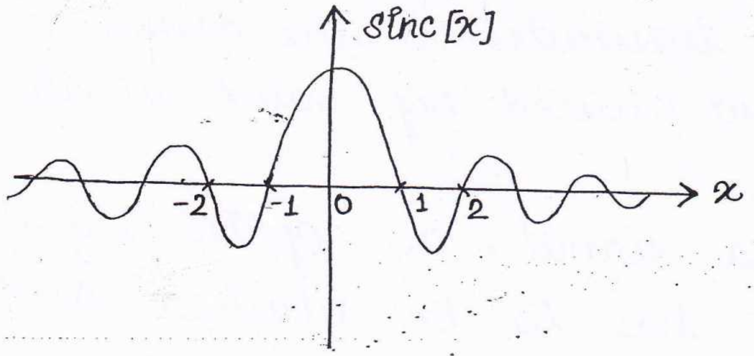
$$= A \cdot \left. \frac{e^{-j2\pi f t}}{-j2\pi f} \right|_{-\tau/2}^{\tau/2}$$

$$= \frac{A}{j2\pi f} \left[e^{-j2\pi f \tau/2} - e^{-j2\pi f(-\tau/2)} \right]$$

$$= \frac{A}{\pi f} \sin(\pi f \tau)$$

$$\text{sinc}[x] = \frac{\sin \pi x}{\pi x}$$

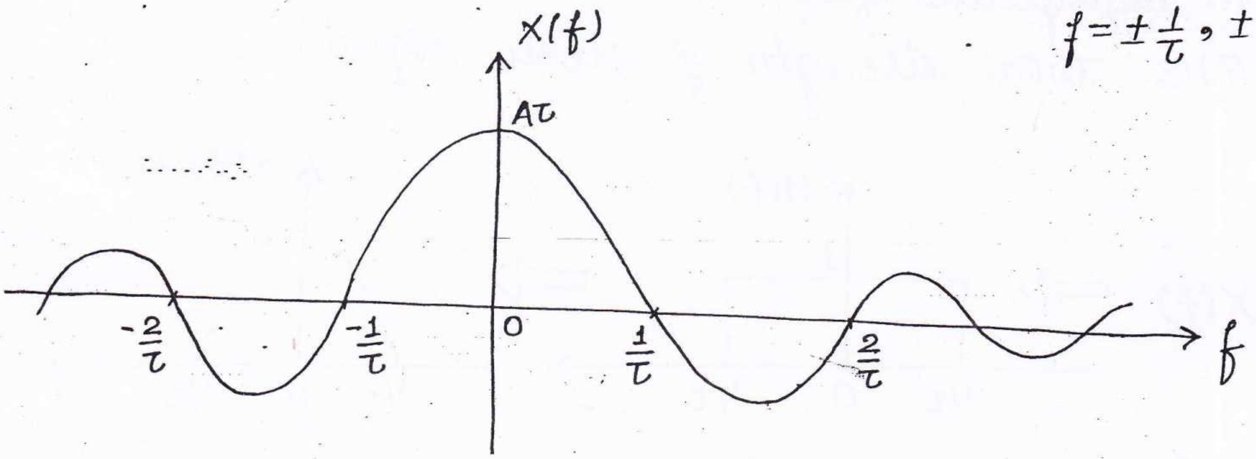
$$\text{sinc}[x] = \begin{cases} 1 & x = 0 \\ 0 & x = \pm 1, \pm 2 \ldots \end{cases}$$



$$\boxed{X(f) = A\tau \,\text{sinc}(f\tau)}$$

$$\text{sinc}(f\tau) = \begin{cases} 1 & ; f = 0 \\ 0 & ; f\tau = \pm 1, \pm 2, \pm 3, \ldots \end{cases}$$

$$f = \pm \frac{1}{\tau}, \pm \frac{2}{\tau} \ldots$$



The fourier transform of $x(t)$, $X(f)$ contains all the possible frequencies.

Signal Bandwidth : heighest (+)ve frequency to lowest (+)ve frequency.

$$= \infty - 0$$
$$= \infty$$

For proper transmission of a signal

channel B.W. > signal B.W.

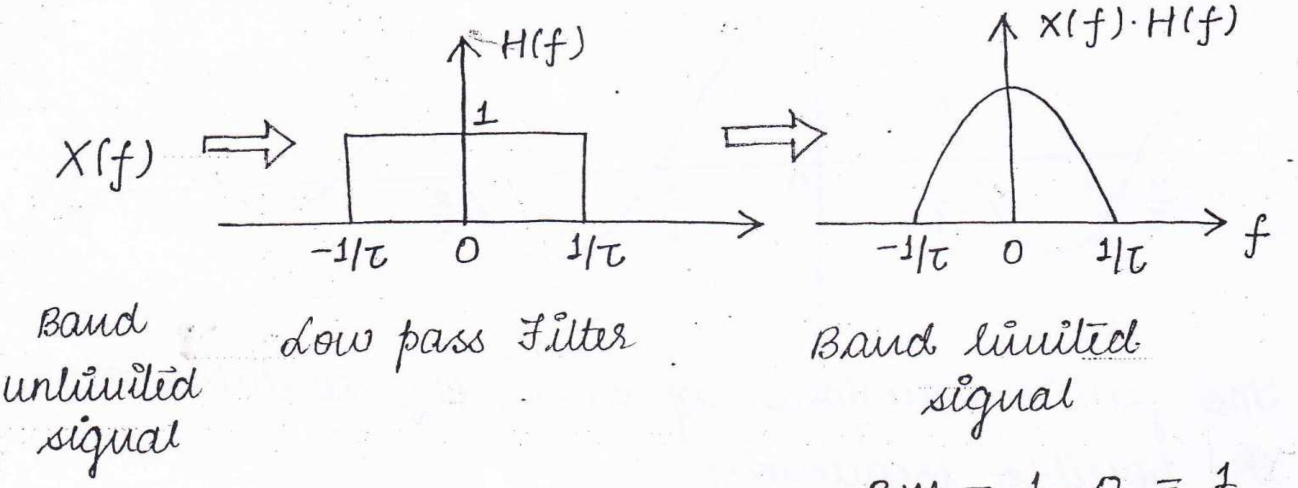
To transmit above signal channel of BW ∞ is required.

→ But for a practical channel BW will be finite.

→ So that before transmission, the above signal should be band limited by band limiting process.

→ To Band limit a signal, all of its significant freq. components has to be retained and insignificant freq. component has to be eliminated.

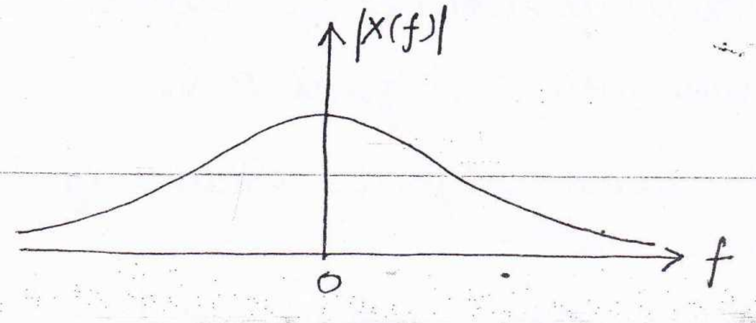
→ To significant freq. contains almost of 95% to 99% total strength of given signal.



$$B.W. = \frac{1}{\tau} - 0 = \frac{1}{\tau}$$

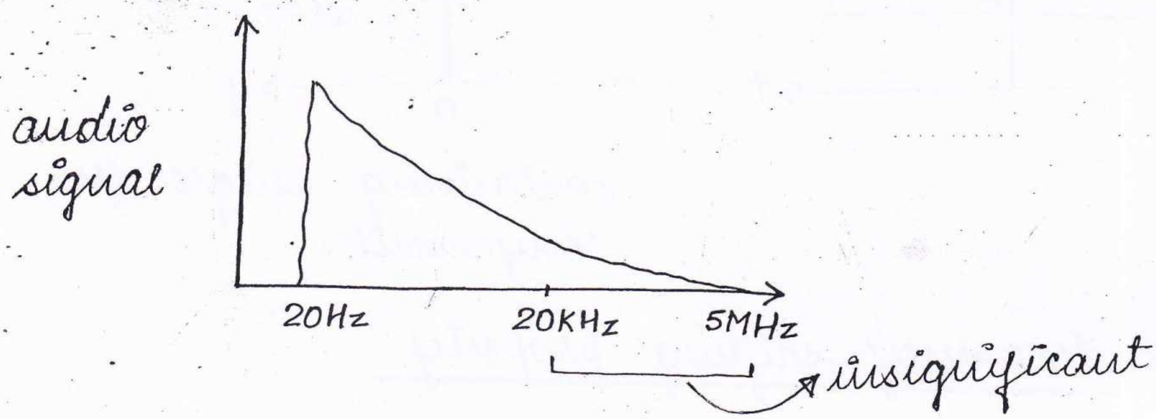
$$x(t) = e^{-t}u(t)$$

$$X(f) = \frac{1}{j2\pi f + 1} \qquad |X(f)| = \frac{1}{\sqrt{4\pi^2 f^2 + 1}}$$



→ Usually, to band limit a signal proper LPF has to be used.

→ For transmission significant freq are given high importance for effective utilization of available channel Bandwidth.

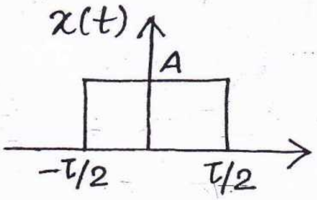


Properties of Fourier Transform

(1) Duality Property

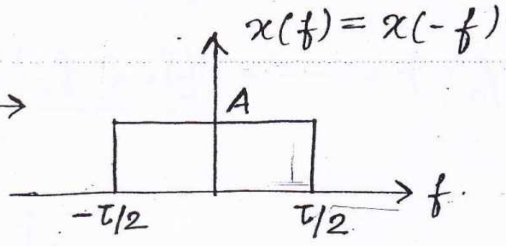
If $x(t) \longleftrightarrow X(f)$

then $X(t) \longleftrightarrow x(-f)$



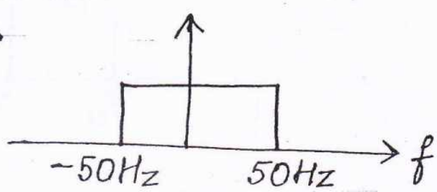
$\longleftrightarrow A\tau \, \text{sinc}(f\tau)$

$A\tau \, \text{sin}(t\tau) \longleftrightarrow$



$\text{sinc}(100t) \longleftrightarrow$

$(\tau = 100)$



— Nyquist freq. = 2 × 50Hz = 100Hz