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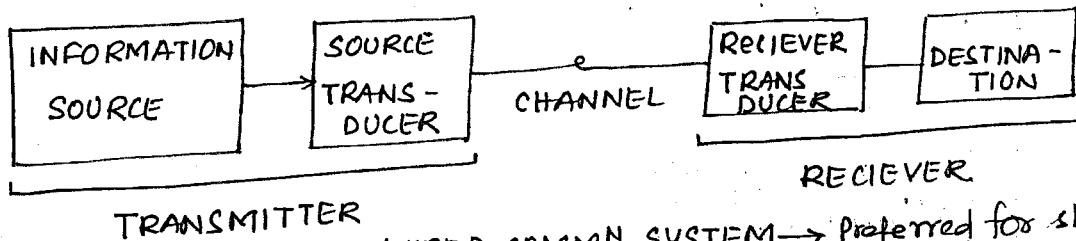
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* COMMUNICATION:

* It is the process of transmitting information from source to Receiver.

* BASIC BLOCK DIAGRAM OF COMM^N SYSTEM:



WIRED COMM^N SYSTEM → Preferred for short distance

* NOTE:

i) VOICE SIGNAL: → Vocal cord is source of voice signal.

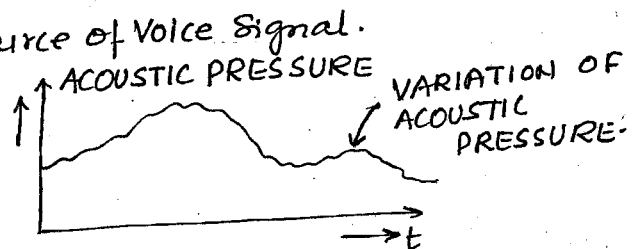
Range: 300HZ to 3.5 KHZ

ii) AUDIO SIGNAL:

Range: 20HZ to 20KHZ.

iii) VIDEO SIGNAL:

Range: 0 to 4.5MHZ



* VOICE SIGNAL is a subset of Audio signal.

* Whatever sound that we can hear is the source of Audio signal.

* VIDEO SIGNAL → variation of light intensity with time.

Note:

* Information source is the source of the information.

* Source Transducer converts physical signal into electrical equivalent.

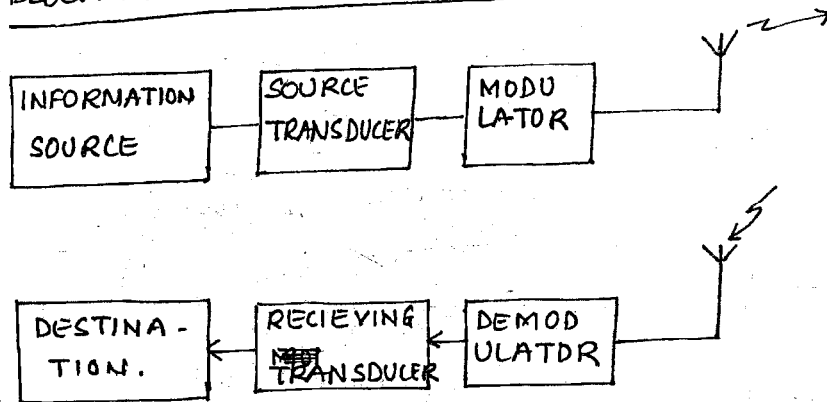
Eg MIC, MICROPHONE.

* Wired communication system is preferred for short distance communication only.

* For long distance commⁿ wireless transmission is preferred in which signal propagates through free space.

* Receiving Transducer converts Electrical signal into Physical equivalent.
 Ex: LOUDSPEAKER.

* BLOCK DIAGRAM OF WIRELESS COMM^N SYSTEM:



* Long distance communication cannot be done without modulation.

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

* NEED FOR MODULATION:

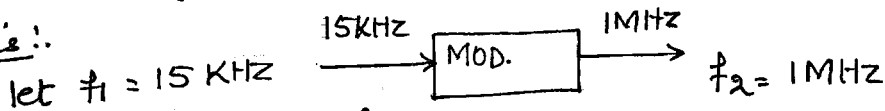
i) Reducing Antenna Height

* For faithful Radiation the height of Antenna should be

$$h_t = \frac{\lambda}{4} \quad ; \quad \lambda = \frac{c}{f} \quad \Rightarrow \quad h_t = \frac{c}{4f}$$

* Faithful Radiation means that the Properties of the Transmitting signal should not change.

Analysis:



let $f_1 = 15 \text{ KHz}$

$$h_t = \frac{c}{4f} = \frac{3 \times 10^8}{4 \times 15 \times 10^3}$$

$f_2 = 1 \text{ MHz}$

$$h_t = \frac{c}{4f} = \frac{3 \times 10^8}{4 \times 10^6}$$

Practically not possible. \rightarrow $h_t = 5 \text{ Km}$

$$h_t = 75 \text{ m or } \bar{e}$$

\uparrow
 Practically can be implemented.

Note!

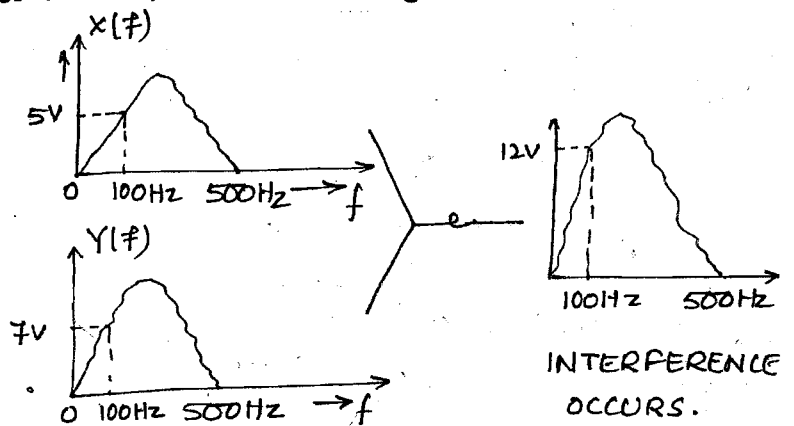
- * For faithful Radiation of a signal, Antenna Height should be atleast of $\lambda/4$.
- * Transmitting Antenna converts ELECTRICAL SIGNAL INTO ELECTRO MAGNETIC and resulting signal propagates with light velocity.
- * MODULATION is the process of increasing frequency of the signal to reduce Antenna height requirements.

ii) MULTIPLEXING!

- * Generally without modulation, multiplexing is not possible.
- * MULTIPLEXING is the process of transmitting multiple no. of signals through a common channel.
- * Generally without modulation, multiplexing is not possible.

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

$$y(t) \longleftrightarrow Y(f)$$



Note!

- * Due to interference only the interfered signal will be obtained and the original signal is lost in the process.
- * Interference process is IRREVERSIBLE. once it occurs, it can't be reversed i.e. individual signal can't be obtained back.
- * During interference individual frequency components of the original signals are added.
- * Due to interference, Multiplexing is failed.
- * To avoid this, ~~multiplexing~~ ^{modulation} of original signal is done with different carrier frequencies; so that when multiplexed original signal is not lost.

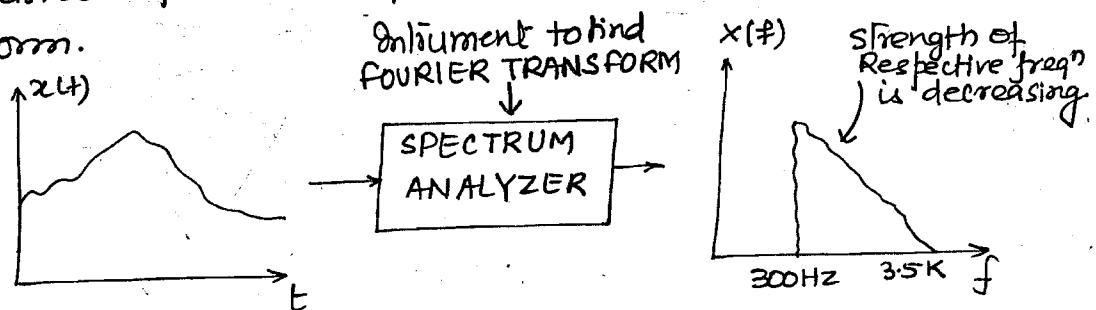
* FOURIER TRANSFORM!

* used to convert time domain signal $x(t)$ to frequency domain signal $x(f)$

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

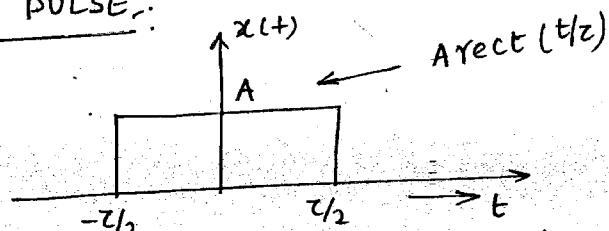
$$x(f) = \int_{-\infty}^{\infty} x(t) e^{-j2\pi ft} dt$$

* To obtain the frequencies present in $x(t)$ we do its Fourier transform.



* FOURIER TRANSFORM is basically used to find Frequencies presented in the given TIME DOMAIN SIGNAL.

* RECTANGULAR PULSE:



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

$$= A \frac{e^{-j2\pi ft}}{-j2\pi f} \Big|_{-\tau/2}^{\tau/2}$$

$$= \frac{-A}{j2\pi f} \left\{ e^{-j2\pi f \tau/2} - e^{+j2\pi f \tau/2} \right\}$$

$$= \frac{A}{\pi f} \left\{ \frac{e^{j\pi f \tau} - e^{-j\pi f \tau}}{2j} \right\}$$

$$x(f) = \frac{A}{\pi f} \text{sinc}(\pi f z)$$

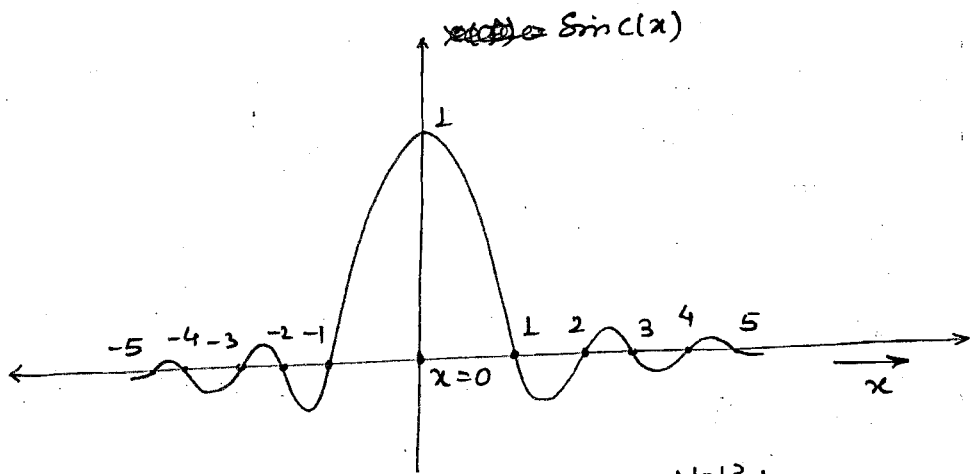
Note:

$$\text{Sa}(x) = \frac{\sin x}{x}$$

$$\text{sinc}(x) = \frac{\sin \pi x}{\pi x}$$

$$\text{sinc}(x) = 1; x=0$$

$$= 0; x = \pm 1, \pm 2, \dots$$

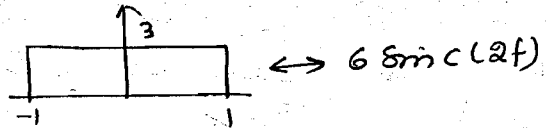
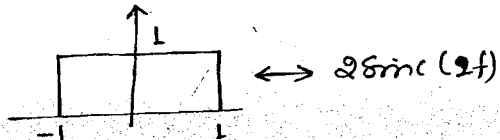


Note:

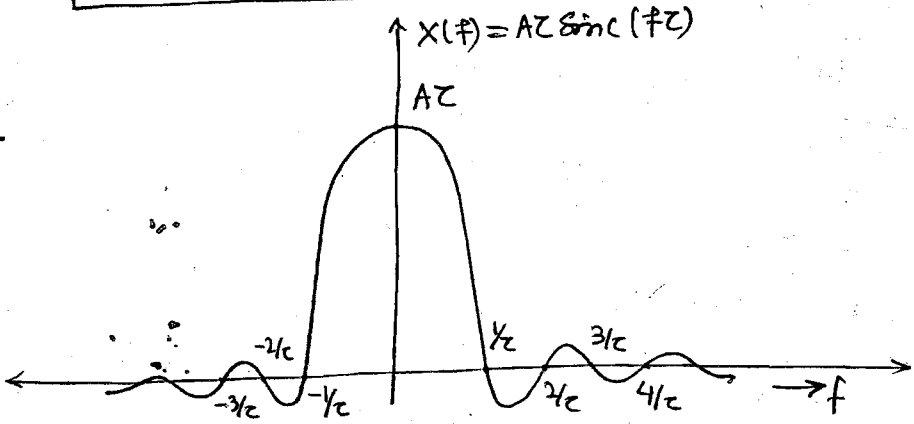
Now,

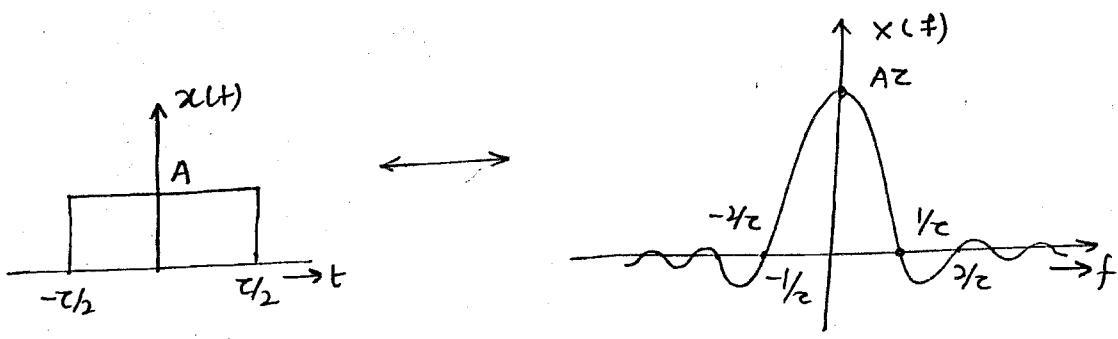
$$x(f) = \frac{A}{\pi f} \sin \pi f z$$

$$= A z \frac{\sin \pi f z}{\pi f z} \times z$$



$$x(f) = A z \text{sinc}(f z)$$





- Note:
- * Practically only the +ve frequency exists.
 - * $x(f)$ contains all possible frequency from 0 to ∞ .
 - * Bandwidth of $x(f)$ is given as:

$$BW = (\text{Highest +ve Frequency}) - (\text{Lowest +ve frequency})$$

$$BW = \infty - 0 = \infty \leftarrow \text{of Rectangular Pulse (Ideal Bandwidth).}$$

* Always for faithful transmission:

$$\text{Bandwidth of channel} \geq \text{Bandwidth of signal} \leftarrow \text{so that Attenuation doesn't occur.}$$

Note (Bandwidth of some Practical channels)

- | | | | |
|--------------------|---|--|---|
| FINITE BAND WIDTH. | } | i) COAXIAL CABLE \rightarrow 0-600MHZ. | \leftarrow depends on material by which it is made. If material is not good then Bandwidth will be reduced. |
| | | ii) PARALLEL WIRE \rightarrow 0-200 MHZ MHZ | * Bandwidth of channel also depends on its physical dimension. |
| | | iii) OPTICAL FIBRE CABLE \rightarrow FEW GHZ | |

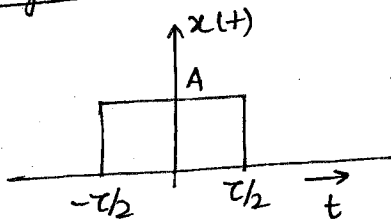
* Every channel (wired) has FINITE BANDWIDTH. Hence the BW of $x(f)$ has to be reduced.

* BW of FREE SPACE is ∞ . Since it is having ∞ BW hence $x(f)$ can be sent to free space but generally not done since in free space there are various frequencies available and then $x(f)$ will get interfered with all those frequencies and will get lost in the process.

Note:

- * For Proper transmission of above signal, channel Bandwidth of ∞ is required.
- * But BW offered by practical channel will be finite only, so that before transmission above signal should be BANDLIMITED by using "BANDLIMITING PROCESS".
- * Only those frequency component which contain 95 to 99% of the Energy/Power (total) are kept and rest are discarded during the Bandlimiting Process.
- * Significant frequency are those frequencies which contain 95% to 99% of the total energy.

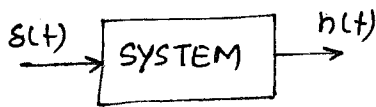
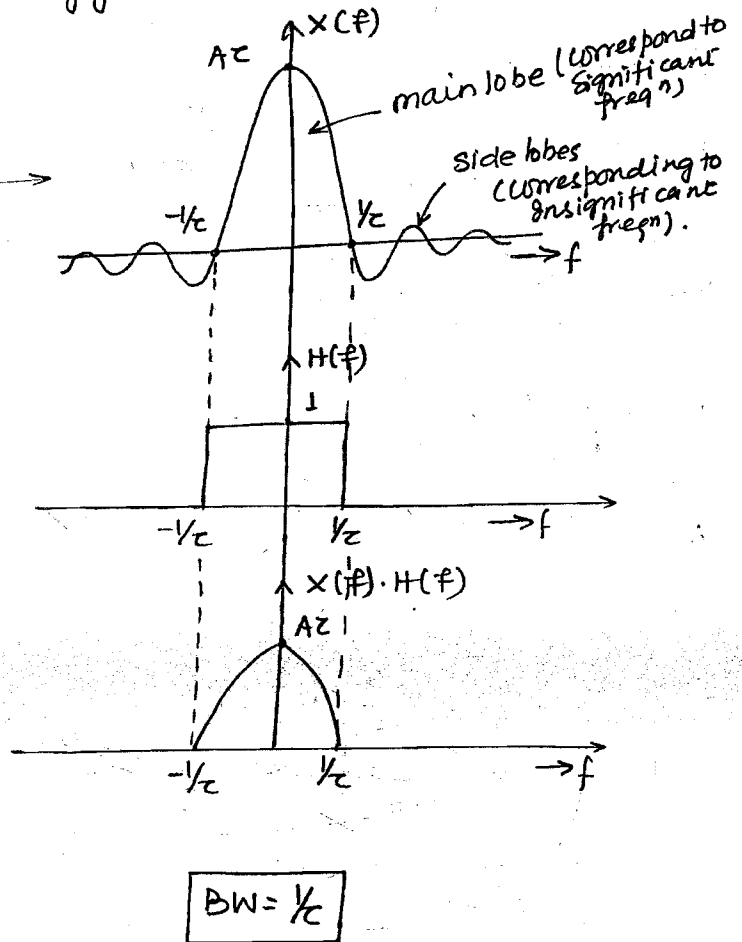
Analysis:



$$E = \int_{-\infty}^{\infty} x^2(t) dt = A^2 \tau$$

Also,

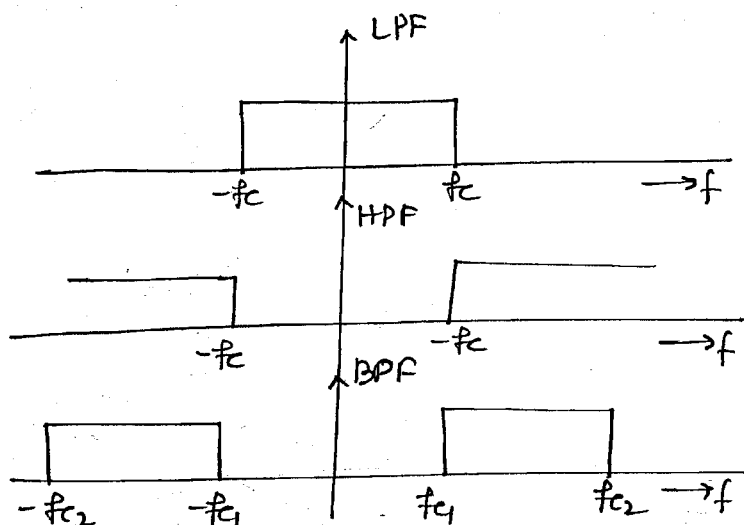
$$E = \int_{-\infty}^{\infty} |x(f)|^2 df$$



$$h(t) \leftrightarrow H(f)$$

* In Filter Analysis, we take -ve frequency into ~~consideration~~ consideration but in reality they donot exist.

Note :-

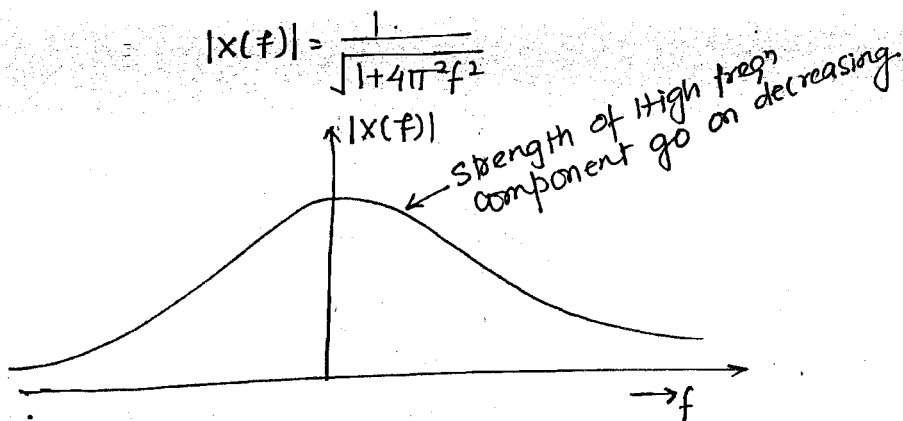


Note :-

- * In Practical cases only the significant frequencies are to be transmitted. We don't transmit insignificant frequency.
- * To Band Limit a Signal, significant frequencies only should be retained and insignificant frequencies should be eliminated.
- * SIGNIFICANT FREQUENCY CONTAINS 95% to 99% of total strength of signal.

* Analysis :-

$$x(t) = e^{-t} u(t) \longleftrightarrow X(f) = \frac{1}{a + j\pi f} = \frac{1}{1 + j\pi f}$$



- * Strength of any Naturally generated signal always decreases as frequency increases.
- * Naturally occurs; no mathematical proof.