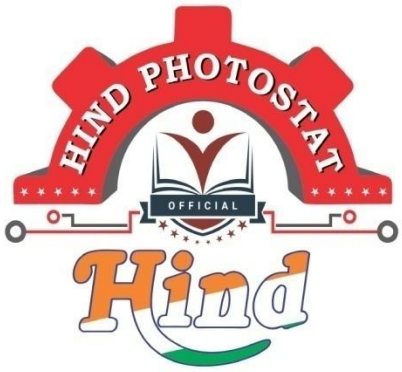

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MADE EASY

ELECTRONICS ENGINEERING

Communication System

By-Reddy Sir

- Theory
- Explanation
- Derivation
- Example
- Shortcuts
- Previous Years Question With Solution

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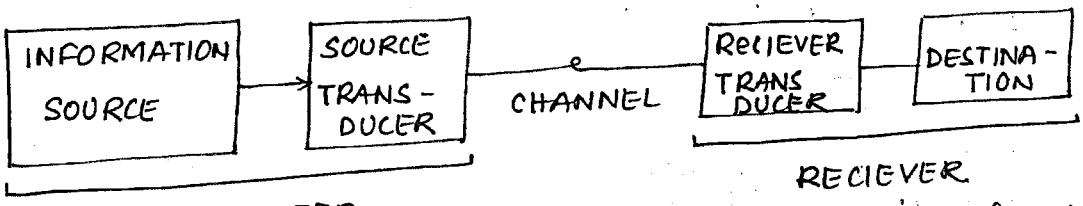
* COMMUNICATION:.

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

* BASIC BLOCK DIAGRAM OF COMMN SYSTEM:.

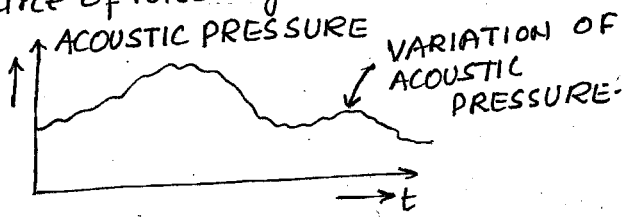


WIRED COMMN SYSTEM → Preferred for short distance

* 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.

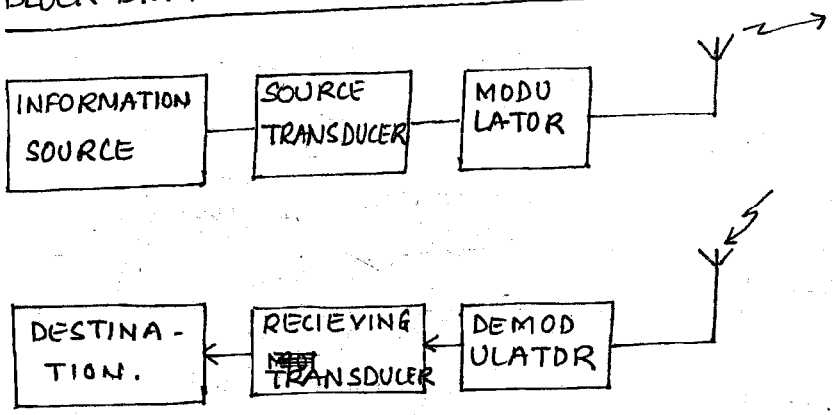
Eg MIC, MICROPHONE.

* Wired communication system is preferred for short distance communication only
* For long distance comm^n wireless transmission is preferred in which signal propagates through free space.

*Recieving 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

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

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

Analysis:

let $f_1 = 15\ KHz$ → 15KHz → MOD. → 1MHz → $f_2 = 1\ MHz$

$$h_t = \frac{c}{4f} = \frac{3\times10^8}{4\times15\times10^3}$$

Practically not possible. → $h_t = 5\ Km$

$$h_t = \frac{c}{4f} = \frac{3\times10^8}{4\times10^6}$$

$h_t = 75$ mehre

↑ Practically can be implemented.

Note:-

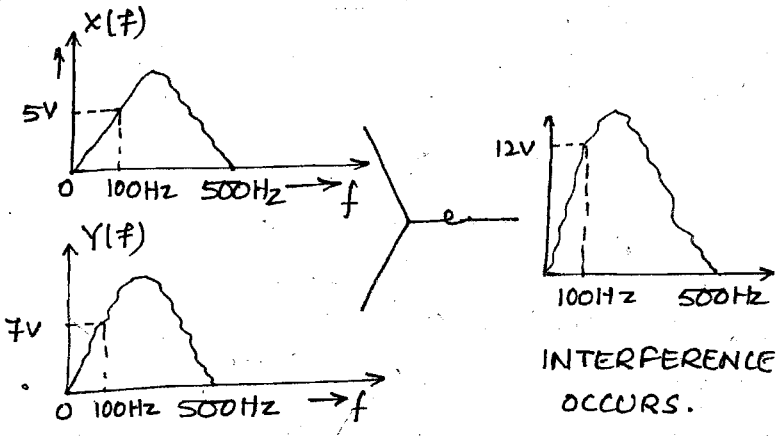
* For faithful Radiation of a Signal, Antenna Height should be atleast of $\lambda/4$.
* Transmitting Antenna converts ELECTRICAL SIGNAL INTO ELECTRO MAGNETIC and resulting signal propagates with light velocity.
* MODULATION is the process of increasing frequency of the signal to reduce Antenna height 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 ie 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, ~~reverse~~ modulation of original signal is done with different carrier frequencies, so that when multiplexed original signal is not lost.

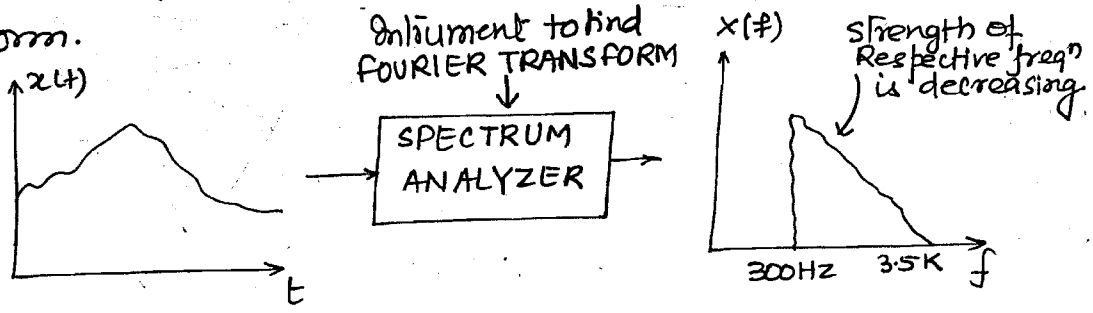
* FOURIER TRANSFORM:

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

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

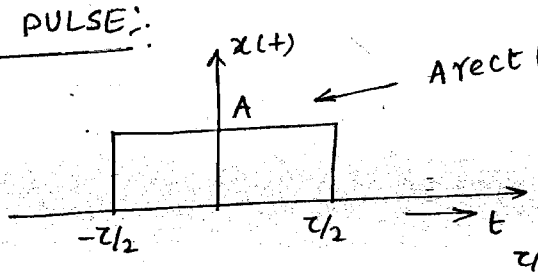
$$X(f) = \int_{-\infty}^{\infty} x(t)\, e^{-j2\pi ft}\, dt$$

* 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:



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

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

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

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

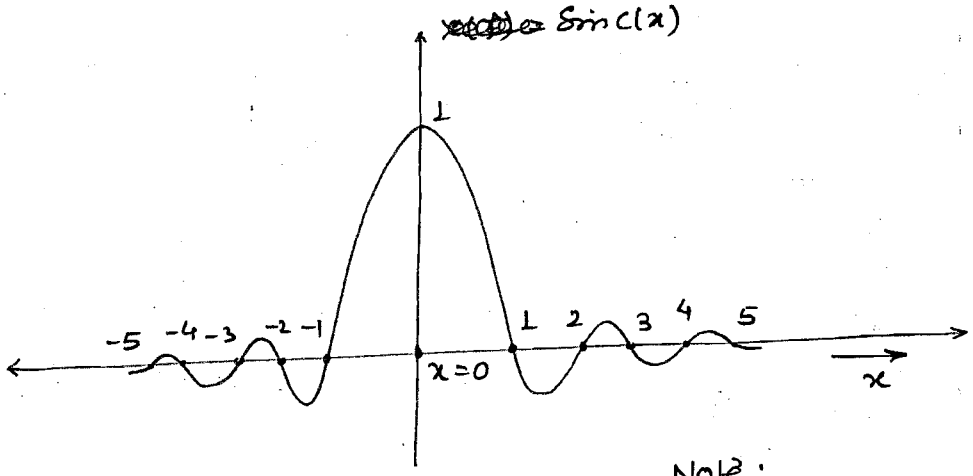
$$X(f) = \frac{A}{\pi f} \sin(\pi f \tau)$$

Note:

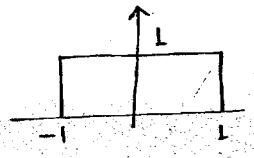
$$Sa(x) = \frac{\sin x}{x}$$

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

$$\text{sinc}(x) = 1 \; ; \; x = 0$$
$$= 0 \; ; \; x = \pm 1, \pm 2 \cdots$$



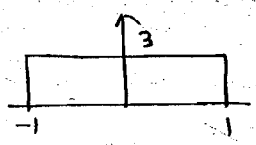
Note:



$\leftrightarrow 2\,\text{sinc}(2f)$

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

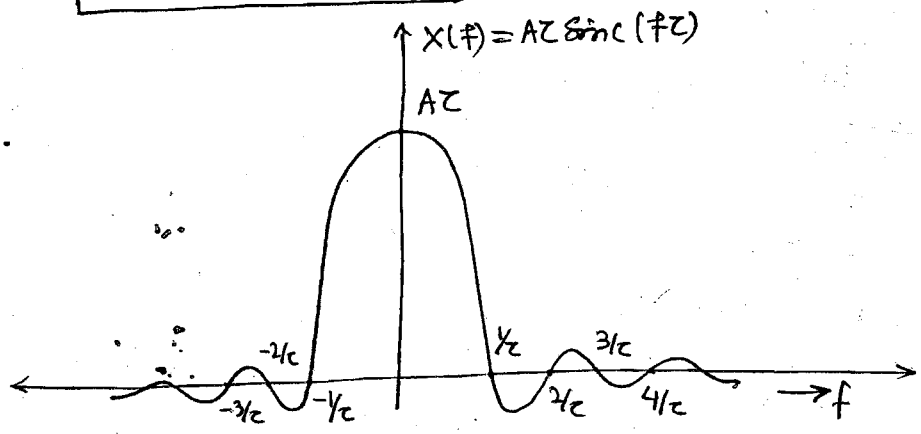
$= A \times \frac{\sin \pi f \tau}{\pi f \tau} \times \tau$

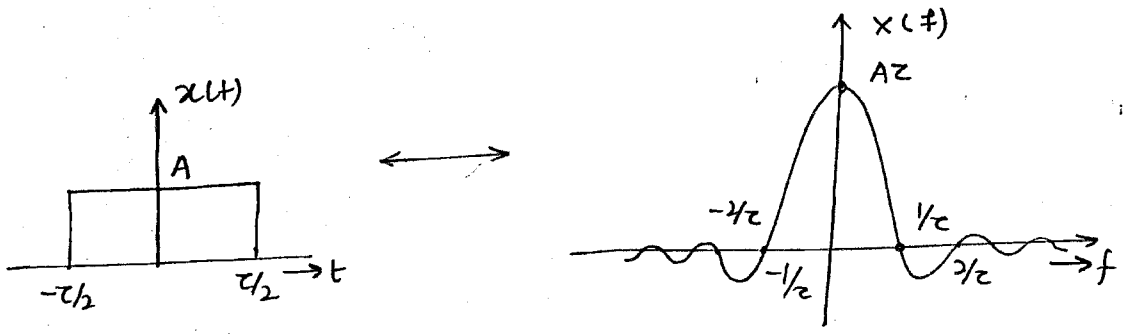


$\leftrightarrow 6\,\text{sinc}(2f)$

***

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





Note:-

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

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

$BW = \infty - 0 = \infty$ ← of Rectangular Pulse (Ideal Bandwidth).

* Always for faithful transmission:-

Bandwidth of channel $\geq$ Bandwidth of Signal ← So that Attenuation doesn't occur.

Note (Bandwidth of some Practical channels)

FINITE BAND WIDTH.

i) COAXIAL CABLE → 0 - 600 MHZ. ← depends on material by which it is made. If material is not good then Bandwidth will be reduced.

ii) PARALLEL WIRE → 0 - 200 MHZ

iii) OPTICAL FIBRE CABLE → FEW GHZ

* Bandwidth of channel also depends on its physical dimension.

* 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:

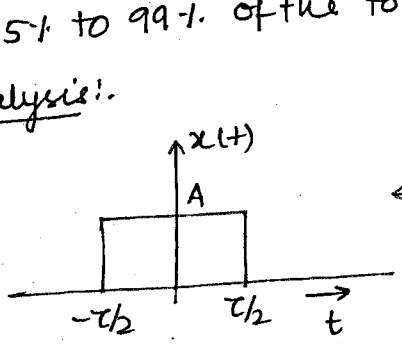
*For Proper Transmission of above signal, channel Bandwidth of ∞ is required.

*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.

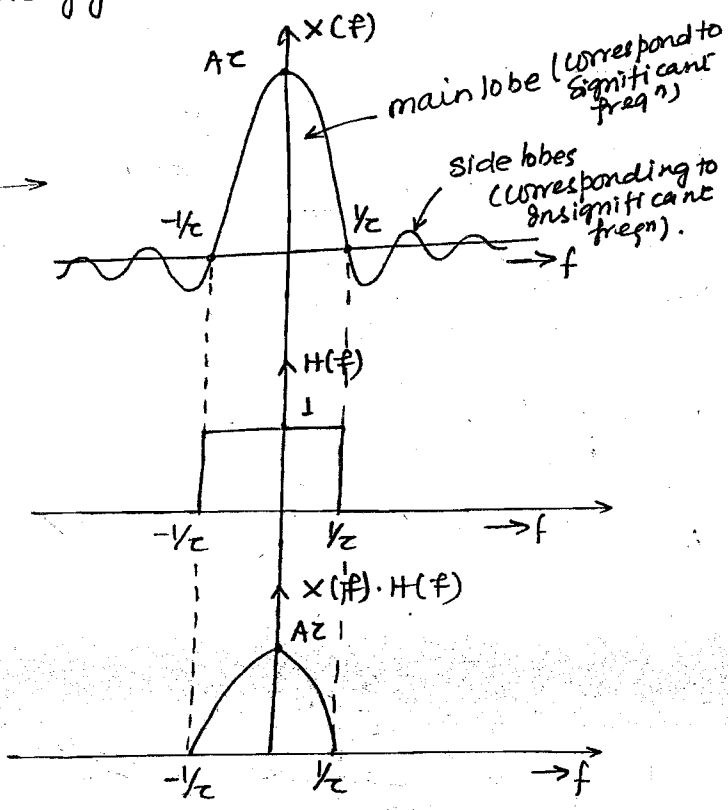
* Significant frequency are those frequencies which contain 95% to 99 %. of the total energy.

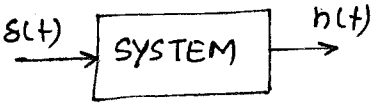
Analysis:



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

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



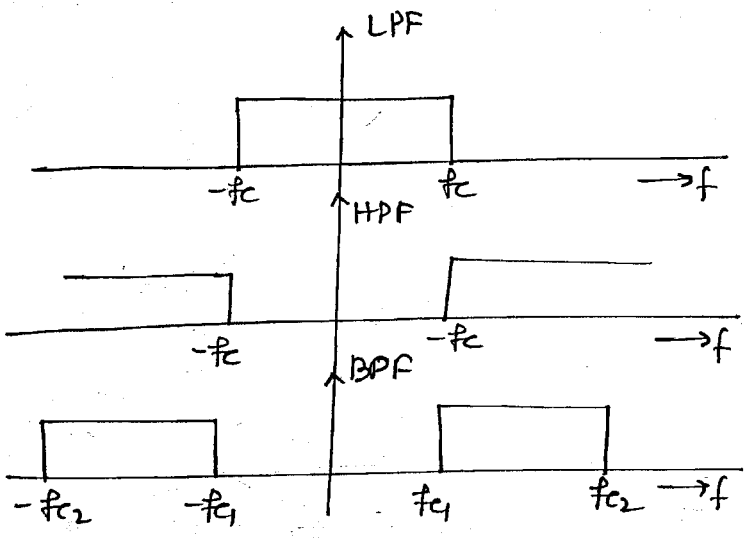


$h(t) \longleftrightarrow H(f)$

BW = $1/\tau$

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

Note:.



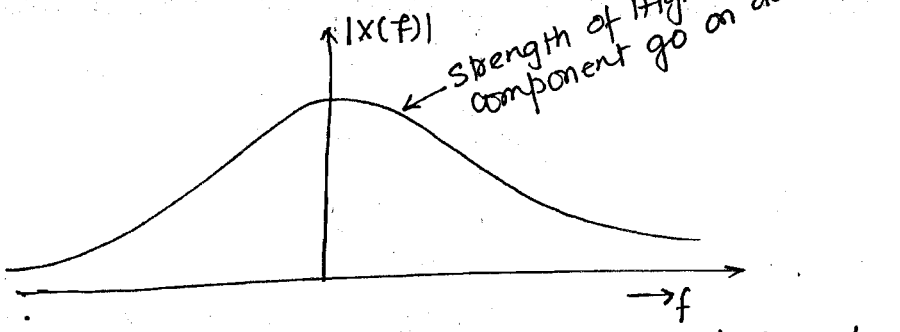
Note:.

* 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:.

$$x(t) = e^{-t}u(t) \longleftrightarrow X(f) = \frac{1}{a+j2\pi f} = \frac{1}{1+j2\pi f}$$

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



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