4.4. Evaluation of power:-

Total average normalized power of a bandpass waveform $v(t)$ is

$$P_v = \langle v^2(t) \rangle = \int_{-\infty}^{\infty} P_v(f)\,df = \frac{1}{2}\langle |g(t)|^2 \rangle$$

where normalized implies that the load is equivalent to 1Ω.

$\therefore P_v(f) =$ PSD of the waveform

4.5. Bandpass Sampling Theorem:

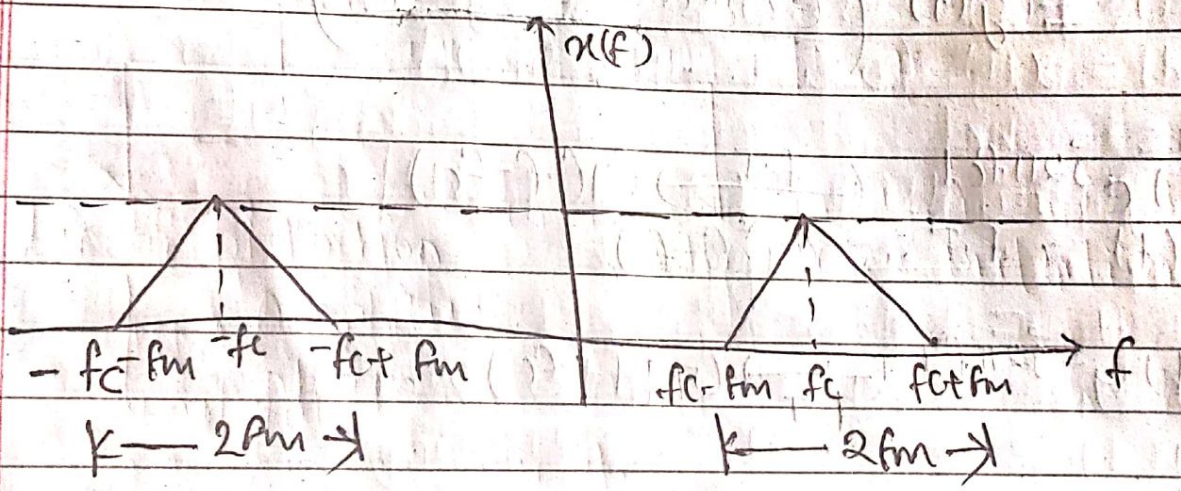


Fig. Spectrum of bandpass signal $x(t)$.

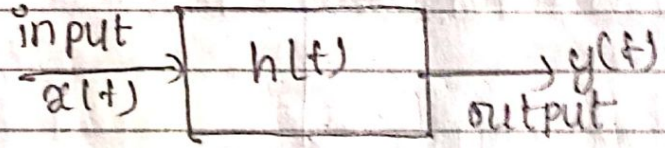
Bandpass signal $x(t)$ whose maximum bandwidth is $2f_m$ can be completely represented into and recovered from its samples if its sampled at the minimum rate of twice the bandwidth ie;

Sampling rate for bandpass signal $f_s > 2 * 2f_m$

$$\therefore \boxed{f_s \geq 4f_m}$$

Where f_m is the maximum frequency component present in the signal $x(t)$.

Transfer function / frequency response :-



for a continuous time, LTI system input and output relationship is given by convolution integral as

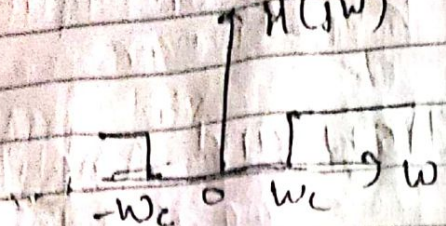
$$y(t) = \int_{-\infty}^{\infty} x(\tau) h(t-\tau) d\tau \Rightarrow \text{Convolution Integral}$$

$$= \int_{-\infty}^{\infty} x(t-\tau) h(\tau) d\tau$$

$$\Rightarrow y(t) = x(t) * h(t) \quad \text{---(1)}$$

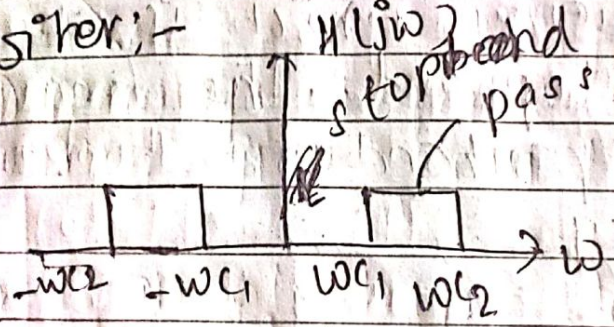
where $x(t)$ is input signal $y(t)$ is output signal & $h(t)$ is impulse response.

(II) High pass filter (HPF)



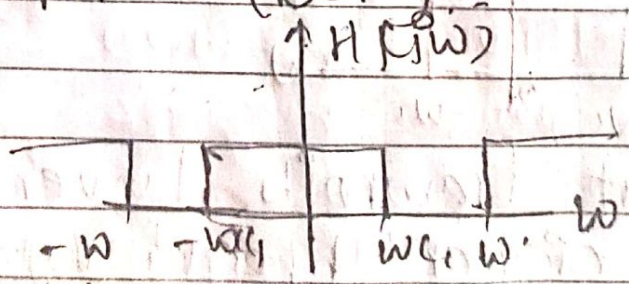
The filter that transmits higher frequency and reject lower frequencies is known as high pass filter.

(III) Bandpass filter:-



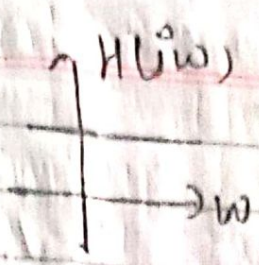
The filter that transmit a band of frequencies and rejects other frequencies outside the band is known as Bandpass filter

(IV) Band stop filter (BSF):-



The filter that rejects certain band of frequencies and transmits all the frequency outside the band is known as bandstop filter.

v) All pass filter:-



The filter that transmits all the frequencies is called as pass filter.

Based on Component Use :-

Filters can be active or passive.

① Active filter :-

It uses active components such as transistor, OP Amplifier in addition to regi resistor and capacitor RLC in the construction of filter

ii) passfilter

It uses passive components such as RLC in the construction of filter.

Based on Ideality :

It can be of two types

① Ideal filter :-

The filter that passes all the range of frequencies.

② Non-Ideal filter :-

The filter that donot passes all the range of frequencies.

$Y(j\omega) = X(j\omega) \cdot H(j\omega)$

$\rightarrow H(j\omega) = \frac{Y(j\omega)}{X(j\omega)}$ is the Transfer function

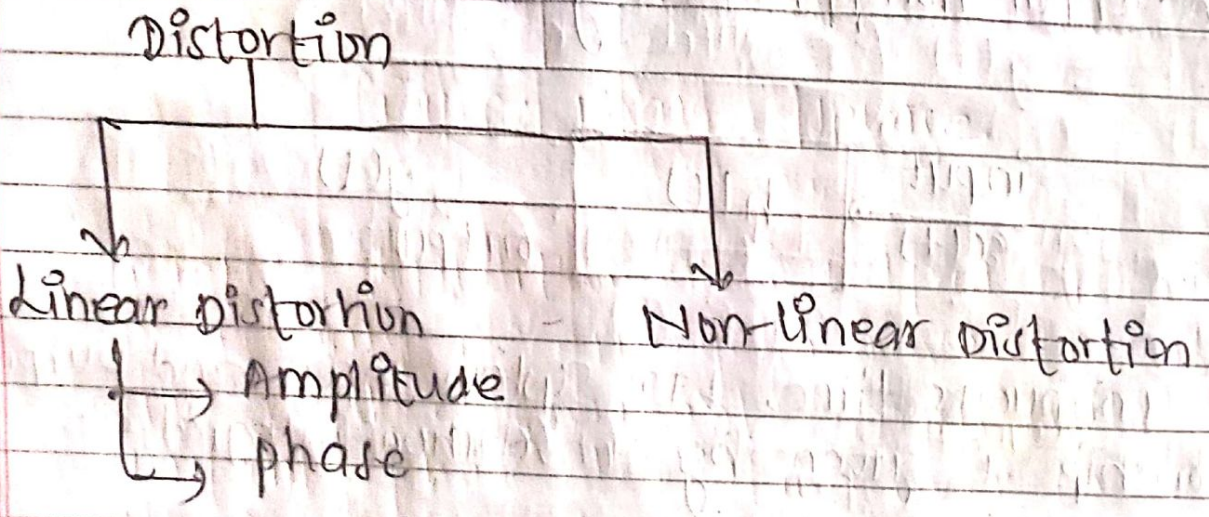
Now

$H(j\omega)$ can be represented as

$H(j\omega) = |H(j\omega)| e^{j\theta(j\omega)}$

where $|H(j\omega)|$ is magnitude response and $\theta(j\omega)$ is phase response.

4.6 Bandpass Filtering and Linear Distortion:



Note
distortion
Attenuation

Distortion:-

Any undesirable changes in any waveform or electrical signal passing through a ckt or other transmission medium is referred as distortion. It is deterministic and caused by the internal characteristic of the system itself. It can be compensated by using a device called equilizer and process is called equilization.

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Linear Distortion :-

Linear distortion is caused by non ideal characteristics of amplitude (magnitude), phase or both.

Distortionless Transmission :-

The transmission of a signal through a system is said to be distortion less if output signal is exact replica of input signal. A constant change in magnitude and constant time delay in the output not treated as distortion.

An input signal $x(t)$ is said to be transmitted without distortion if the output signal $y(t)$ is defined as

$$y(t) = K\,x(t - t_0) \quad -(1)$$

where K is constant represents the constant change in magnitude and t_0 is constant time delay occur in the output. Taking fourier transform of (1)

$$Y(j\omega) = K\,X(j\omega)\,e^{-j\omega t_0} \quad \text{[shifting prop]}$$

∴ For distortionless transmission,

$$H(j\omega) = \frac{Y(j\omega)}{X(j\omega)} = K e^{-j\omega t_0} \quad -(11)$$

Condition for distortionless transmission :-

$$H(j\omega) = \begin{cases} K\,e^{-j\omega t_0} & \text{for } -B \le \omega \le B \\ 0 & \text{otherwise i.e. } |\omega| > B \end{cases}$$

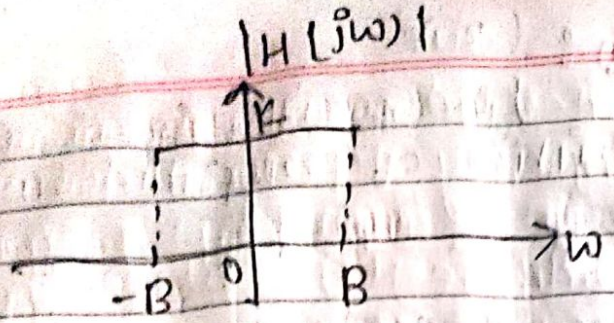

figure: magnitude Response

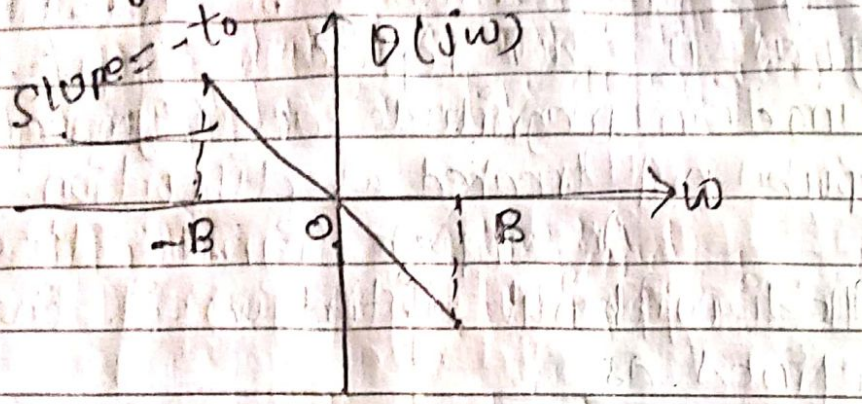

figure: phase response.

Therefore distortionless bandpass transmission, it is only necessary to have transfer function with a constant amplitude and constant phase deviation over the bandwidth of a signal.

Amplitude Distortion

It occurs when amplitude is not constant within the frequency band of interest

phase distortion

It occurs when the phase is not linearly changing within the frequency band of interest.

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Non-linear Distortion :-

Non-linear distortion occurs when the relationship between input signal and output signal can is not linear.

4.8 Classification of filters and Amplifiers.

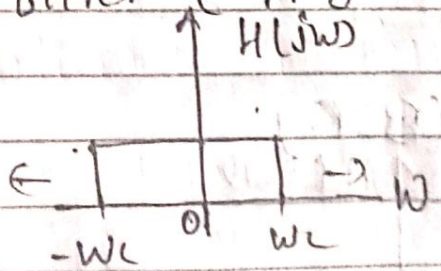
Filters and its types:-

Filter is a frequency selective device. The range of frequency which is passby is filter is known as passband where as range of frequency which is shoped by filter is known as stopband. The frequency which seperates band passband and stopband is called cutoff frequency.

Types of filter:

Based on range of frequency pass or stop, filters can be

1) Low pass filter (LPF):



The filter that transmits lower frequency and reject higher frequency is known as lowpass filter.

Amplifier

Linear Amplifier

Used for the low signal levels

Non-linear Amplifier

difficult to get accuracies

① memory - Depends on past values
② memoryless - only depends on present value

Amplifier is an electronic device that increases or amplify voltage or current or power of a given signal