i) Multiplexing Technique by which more than one signal can be transmitted over the channel without any distortion or overlapping.

↳ There are two types of multiplexing

↳ FDM → freq. Devision multiplexing where the signals are separated in freq domain by using different Carrier Signal.

↳ TDM :- Time Domain multiplexing

In TDM the signals are separated from each other with different time domain.

↳ usually FDM is used in AC & TDM in DC.

ii) To design an antenna of practical height

$h = \lambda/2$ or $\lambda/4$

Let $f_m = 3$ kHz

$\lambda = c/f_m = \frac{3\times 10^8 \text{ m/s}}{3\times 10^3 \text{ Hz}} = 10^5 \text{ m} = 100 \text{ km}$

$h = \lambda/2$ or $\lambda/4$ = 50 km / 25 km

after modn

$f_m \pm f_c$

$f_c = 10$ MHz $= 10\times 10^6$ Hz.

(300 Hz to 3.4 KHz)

$\lambda = \frac{c}{f_m + f_c} = \frac{3\times10^8 \, m/s}{10\times10^6 \, Hz} = 30m$

$h = \lambda/2$ or $\lambda/4$ $= 15m$ or $7.5m$

If we want to transmit a signal directly without any modulation, the height of antenna is too large to be design.

→ hence by the help of a high freq. carrier signal we can transmit the message signal with an antenna of required length which can be designed easily.

(iii) Narrow binding :-

Adding carrier signal

$300Hz < f_m < 3.4KHz$ $+10^6$

1 MHz

$\lambda_1 = \frac{c}{300Hz} = 10^6$

$h_1 = \lambda_1/2$

$\frac{h_1}{h_2} = \frac{10^6/2}{10^5/2}$

$\frac{h_1}{h_2} = 10$

$\lambda_2 = \frac{c}{3KHz} = 10^5$

$h_2 = \lambda_2/2$

when we added the carrier signal (10^6) with msg signal

$\lambda_1 = \frac{3\times10^8}{300Hz + 10^6}$

$\lambda_2 = \frac{3\times10^8}{3KHz + 10^6}$

continuous wave mod^n! —

Amplitude modulated eqn! —

carrier waveform in is continuous nature

$c(t) = A_c \cos 2\pi f_c t$ — amp, freq, phase

m(t) → amp / freq / phase

It is a process inwhich the amplitude of the carrier signal is changed in accordance to message signal in accordance to amplitude of message signal.

Freq. Mod — It is a process in which the freq. (phase) of the carrier signal is changed in accordance to message signal in accordance to amplitude of message signal.

Similarly for phase

AM eqn

$m(t)$ = message signal

$c(t) = A_c \cos 2\pi f_c t$

$A_i(t)$ = Instantaneous car...

$v(t) = m(t)\,c(t)$

↳ freq. translation of signal

→ $v(t) = m(t)\,A_c \cos\omega_c(t)$

FT of $v(t)$ is

$$v(t) = m(t)\,A_c \left(\frac{e^{j\omega_c t} + e^{-j\omega_c t}}{2} \right)$$

$$v(t) = m(t)\,e^{j2\pi f_c t} + m(t)\,e^{-j2\pi f_c t}$$

$$\rightarrow v(t) = \frac{A_c}{2}\left[m(t)\,e^{j2\pi f_c t} \ldots \right]$$

FT of both side

$$V(f) = \frac{A_c}{2}\left[M(f-f_c) + M(f+f_c) \right]$$ ↔ freq. translation

→ : f_m

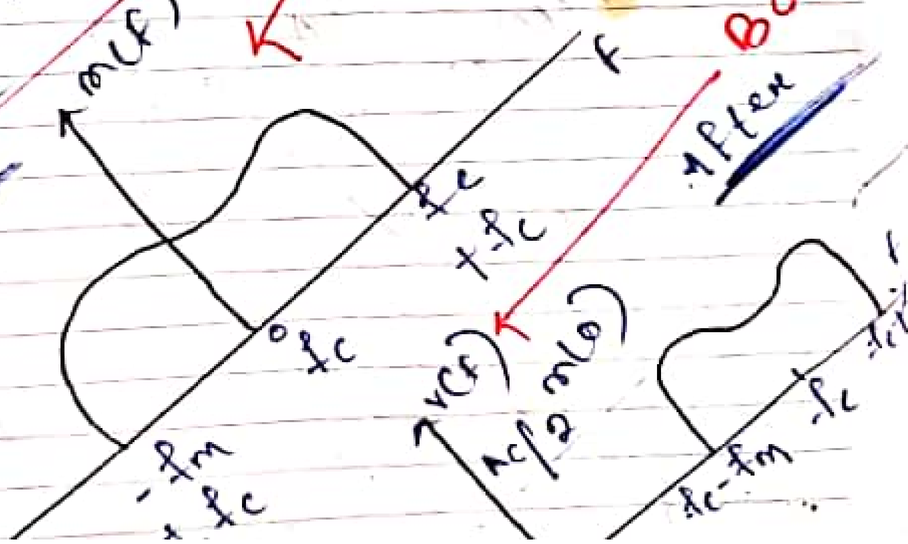
← Low pass

Band pass

before modulation

low freq.

After



msg signal (low freq) —translate the→ high freq. → by adding carrier freq.

Demodulation → Receiver →
↳ low pass filter.

which ↳ freq. translation is a process in a message signal of low freq. will translate the high freq. by adding a carrier signal. This is also called upward freq. translation.

∴ It takes place of the modulatn end (or at the transmitter)

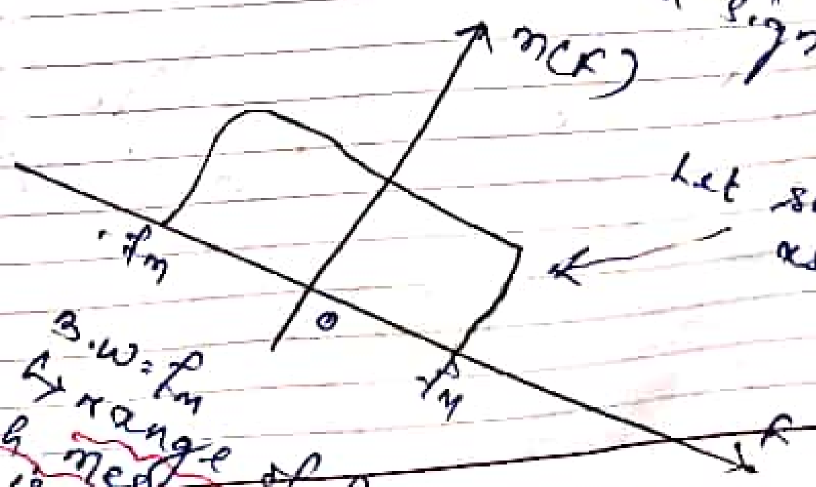
Similarly at the Demodulatn translation is takesplace downward freq.

In upward freq. translat. Base band signal converted to Band pass/ Pass band signal.

$m(t)$ → Message signal

$c(t)$ → $A_c \cos w_c t$ = carrier signal.

$m(t) \leftrightarrow M(f)$



Let shape is assuming

B.W = fm
↳ range of freq in which message signal is present.

... is used in the Modulatn.

WK	M	T	W	T	F	S	S
18					1	2	3
19	4	5	6	7	8	9	10
20	11	12	13	14	15	16	17
21	18	19	20	21	22	23	24
22	25	26	27	28	29	30	31

FM $\{ f_i(t)$ = instantaneous freq $= f_c + K_f m(t)$

$\theta_i(t) = \theta_c(t) + K_p m(t)$

PM ← $\theta_i(t)$

$S_{AM}(t) = A_i(t)\cos 2\pi f_c t$ → after modulation for amplitude modulation?

$S_{AM}(t) = (A_c + K_a m(t))\cos 2\pi f_c t$

If $m(t) = A_m \cos 2\pi f_m t$ → message signal → any signal then

$S_{AM}(t) = (A_c + K_a A_m \cos 2\pi f_m t)\cos 2\pi f_c t$

$= A_c\left(1 + \frac{K_a A_m}{A_c}\cos 2\pi f_m t\right)\cos 2\pi f_c t$

$\frac{K_a A_m}{A_c}$ → μ or modulation index or depth of modulation.

$S_{AM}(t) = A_c(1 + \mu \cos 2\pi f_m t)\cos 2\pi f_c t$

$\mu = \frac{K_a A_m}{A_c} \simeq \frac{A_m}{A_c}$ → message amplitude / carrier amplitude [if $K_a = 1$]

K_a → amplitude sensitivity (V^{-1})

F.M :→

Frequency modulation

freq and phase modulatⁿ are called angle modulatⁿ because in this case either freq. or phase of the carrier are varied in accordance to the amplitude of the msg. signal.

FM eqn :→

In freq. modulatⁿ the freq. of carrier is changed in accordance to amplitude of the msg. signal.

$m(t)$ = msg. signal

$c(t) = A_c \cos 2\pi f_c t$ = carrier signal

→ carrier phase

In AM : $A_i(t) = A_c + K_a m(t)$

here freq. and phase const

In FM : $f_i(t) = f_c + K_f m(t)$

$m(t) = -ve$

freq. of carrier = decrease

PM : $\theta_i(t) = \theta_c(t) ...$

For FM

$f_i(t) = f_c + K_f m(t)$

$\theta = \omega t$

$\theta_i(t) = 2\pi f_i t$

$\frac{d\theta_i(t)}{dt} = 2\pi f_i$

$f_i = \frac{1}{2\pi} \frac{d\theta_i(t)}{dt}$

$\Rightarrow \frac{1}{2\pi} \frac{d}{dt} \theta_i(t) = f_c + K_f m(t)$ — (1)

$\frac{d\theta_i(t)}{dt} = 2\pi f_c + 2\pi K_f m(t)$

$\theta_i(t) = \int (2\pi f_c + 2\pi K_f m(t)) \, dt$

[illegible] $2\pi K_f \int_0^t m(t) \, dt$

[illegible] $\int_0^t m(t) \, dt]$

WK	M	T	W	T	F	S	S
40				1	2	3	4
41	5	6	7	8	9	10	11
42	12	13	14	15	16	17	18
43	19	20	21	22	23	24	25
44	26	27	28	29	30	31	

Relⁿ b/w FM and PM :→

$\theta_i(t) = 2\pi f_c t + k_p m(t)$

$S_{PM}(t) = A_c \cos\theta_i(t)$

$S_{PM}(t) = A_c \cos(2\pi f_c t + k_p m(t))$

here phase varies directly but freq. will derivative of msg. signal

PM

$\theta_i(t) = \theta_c(t) + k_p m(t)$

Phase directly.

→ here freq. by derivatⁿ

$\frac{1}{2\pi}\frac{d\theta_i(t)}{dt} = \frac{d}{dt}(\theta_c(t) + k_p m(t))$

$= \frac{d}{dt}(2\pi f_c t + k_p m(t))$

$f_i(t) = 2\pi f_c + k_p \frac{d\, m(t)}{dt}$

→ In phase modulatⁿ the phase of the carrier varies directly with the msg. signal.

→ and the freq. varies with differentiatⁿ of the msg. signal.

$f_i = \frac{1}{2\pi}\frac{d\theta_i(t)}{dt}$

FM

freq varies directly and phase by integratⁿ of msg.

$f_i(t) = f_c + k_f m(t)$

$\theta_i(t) = 2\pi f_c t + 2\pi k_f \int_0^t m(t)\,dt$

// freq. varies directly & phase by integratⁿ

→ In freq. modulatⁿ the freq. of carrier varies directly with the msg. signal but the phase of the carrier varies with integratⁿ of the msg. signal.