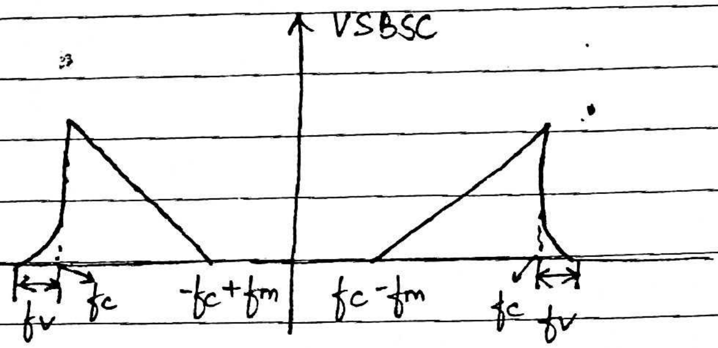


Angle Modulation

Modulation process is anolog modulation process but non linear modulation process. In this we change the total phase angle of $c(t)$ according to $m(t)$ by keeping amplitude constant.

§ Advantages of angle modulation over amplitude modulation:

i) S/N Ratio at R_x S: Signal Power , N: Noise Power.

ii) Higher B_T.

Angle modulation can be classified as:

i) Frequency modulation

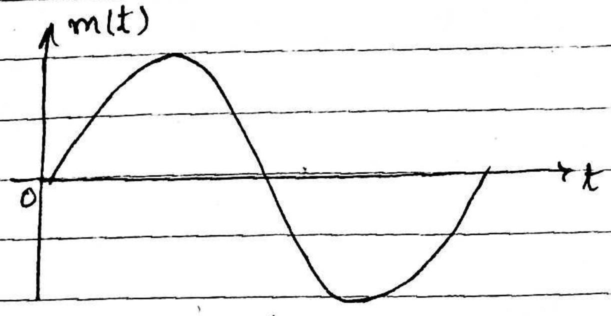
ii) Phase modulation

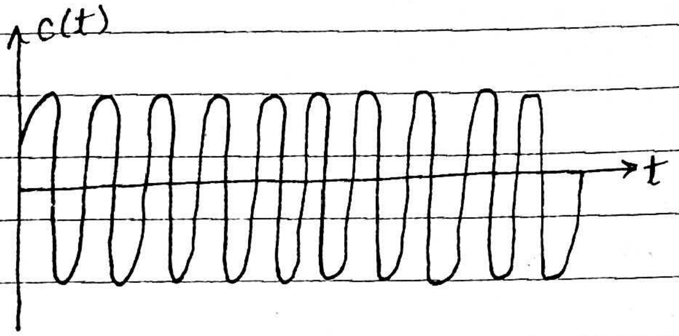
$$\omega_i = \frac{d}{dt}\theta(t)$$

$$\omega_i = \omega_c + \frac{d}{dt}\phi(t) \quad = \text{Frequency deviation}$$

Frequency modulation is a process in which we change the instantaneous frequency of carrier signal according to the amplitude of the message signal.

The amount by which frequency of $c(t)$ is varied to it's unmodulated value is called frequency deviation.





The frequency deviation (δ) :

$$\boxed{\delta = K V_m f_c}$$

where,

V_m = amplitude of m(t)

f_c = frequency of carrier signal.

The instantaneous frequency of F.M :

$$f_i = f_c(1 \pm k V_m \cos \omega_m t)$$

$$m(t) = V_m \cos \omega_m t$$
$$c(t) = V_c \cos \omega_c t$$

If $\cos \omega_m t = 1$ then,

$$f_i = f_c\,(1 \pm k V_m)$$

$f_i = f_c \pm kV_m f_c$

If we consider the +ve side:

$f_H = f_{max} = f_c + kV_m f_c$
$= f_c + \delta$

δ = allowed deviation

If we consider the -ve side:

$f_L = f_{min} = f_c - kV_m f_c$
$= f_c - \delta$

$\therefore \delta = \frac{f_H - f_L}{2}$

Modulation Index for F.M. wave:

$$m_f = \frac{\delta}{f_m} = \frac{\text{Frequency deviation}}{\text{Highest freq. component present in } m(t)}$$

Physical significance of m: How much frequency changes according to amplitude of message signal.

Wave eq^n of FM.:

$s(t) = A_c \sin\theta$

$\theta = \int \omega_i \, dt$

$\theta = \int \omega_c (1 \pm kV_m \cos\omega_m t) \, dt$

$$\theta = \omega_c t \pm \frac{\omega_c k V_m \sin \omega_m t}{\omega_m}$$

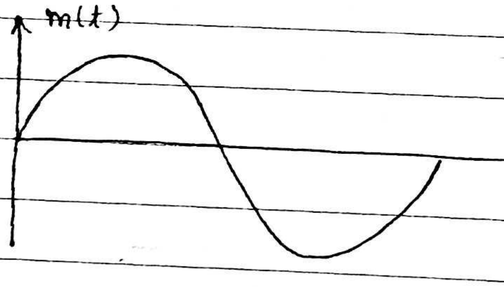
$$= \omega_c t \pm \frac{2\pi f_c \cancel{t}\, k V_m \sin \omega_m t}{\cancel{\omega_m}\, 2\pi f_m}$$

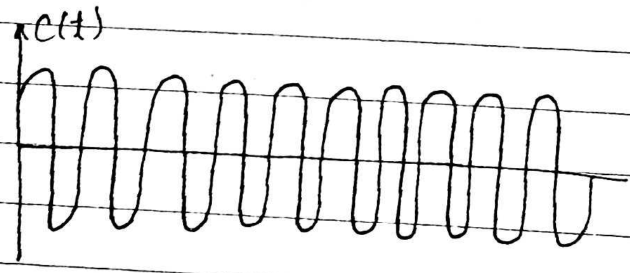
$$= \omega_c t \pm \frac{k V_m f_c \sin \omega_m t}{f_m}$$

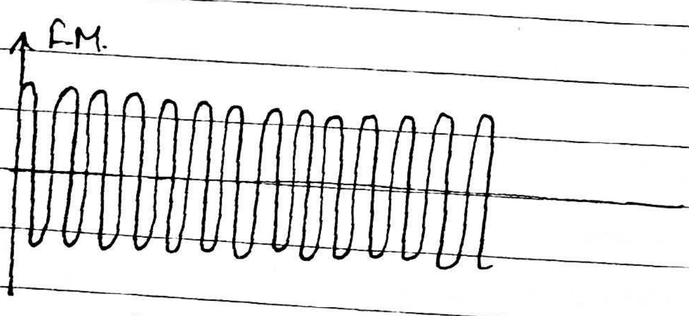
$$= \omega_c t \pm \left(\frac{\delta}{f_m}\right) \sin \omega_m t$$

$$= \omega_c t \pm m_f \sin \omega_m t$$

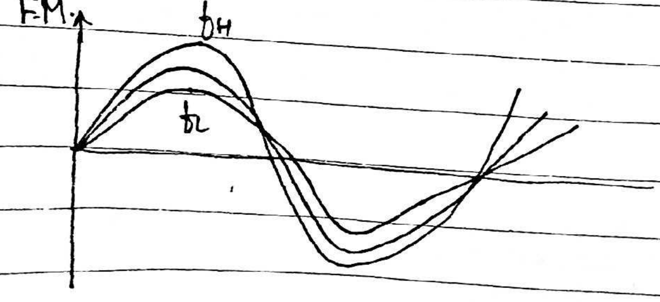
$$s(t) = A_c \sin\left[\omega_c t \pm m_f \sin \omega_m t\right]$$







theoretical



Practical

$$\delta = \frac{f_H - f_L}{2}$$