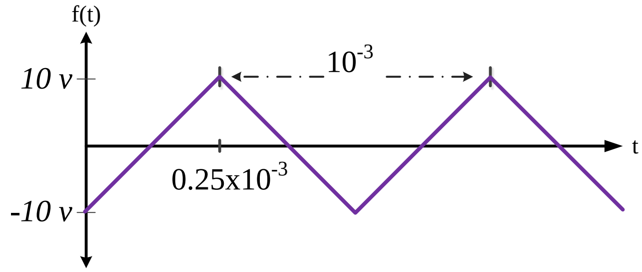
Q17: A modulating signal f (t) shown besides AM modulates a carrier with modulation index = 0.5, find:



a- Total power.

b- Sideband power.

c- Carrier power.

Q18: A certain message having $\frac{\overline{f^2(t)}}{|f(t)_{min}|^2} = 0.09$ is transmitted through a channel having PSD ($10^{-7} w/Hz$ watt/Hz.

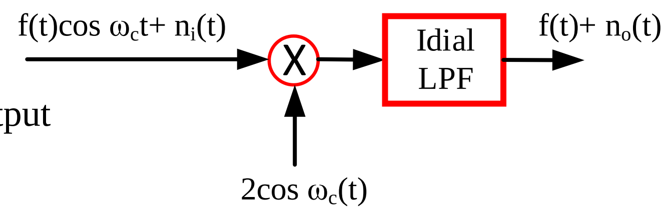
If the signal power at receiver input is 0.1 watt and the signal bandwidth is 3 kHz, find:

(a) SNR_{dB} at Rx input if AM/ DSB – SC Mod. Is used.

(b) 2-SNR_{dB} at Rx output if standard AM Mod. With $m = 0.5$ is used.

Ans: 28.23 dB, 11.66 dB.

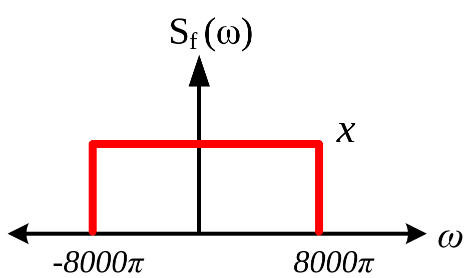
Q19: A DSB – SC receiver shown in figure below. The channel noise PSD is $\eta/2$ with $\eta = 10^{-7}$. The PSD of the modulating signal $f(t)$ is shown in the other figure:



(a) Determine the receiver output noise power S.

(b) Determine the receiver noise output power No.

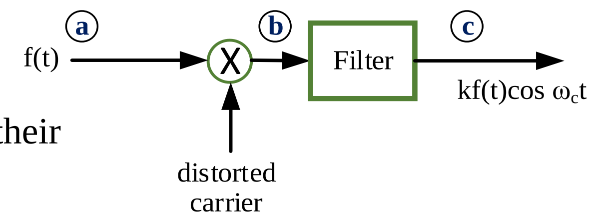
(c) If the output SNR is required to be at least30dB, determine the minimum value of (x) and corresponding power of (t).



Q20: For an AM channel with noise PSD $S_n(\omega) = 10^{-8}\, watt/Hz$. (two- sided), if the receiver output SNR is required to be at least $33dB$. Determine the transmitted power if the modulating signal is a single tone with peak amplitude of 0.1 volt and with frequency of 1 kHz.

Ans: 9.9 *m* watt.

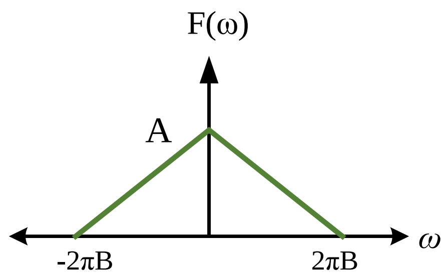
Q21: The figure below shows a DSB –SC modulator. The carrier available at the multiplier is a distorted sinusoid given by $a_1 cos\omega_c t + a_2 cos^2\omega_c t$. The spectrum of f(t) is shown in fig. shown:



(a) Determine the signals and sketch their spectra at points b&c.

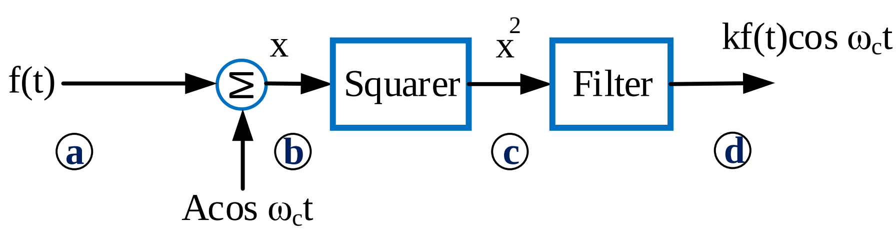
(b) What kind of filter is required in fig?

(c) What is minimum value of ω_c required for this scheme to work



Ans: $4\pi B$ rad/sec.

Q22: Show that the scheme shown in fig. Below can be used to generate DSB-SC signal. Assuming that $f(t)$ is a signal bandlimited to $B\ Hz$, find the signals and sketch their spectra at points a, b, c and d. Explain the nature of filter in this figure.



Q23: An Am communication system with $m = 0.707$ operates in the presence of white noise with two- sided power spectral density $0.25 \times 10^{-14}\, watt/Hz$, and with total path losses of 90 dB. The input bandwidth is 10 kHz. Calculate the minimum required carrier amplitude of the transmitter for a 10 kHz sinusoidal input and 40 dB output SNR. Assume that resistance level is one ohm.

Ans: 63.254 volt.

Q24: A signal $f(t)$ is bandlimited to ω_m. If it is frequency translated by multiplying it by the signal $cos\omega_c t$. Find ω_c so that the bandwidth of the transmitted signal is 1 percent of the carrier frequency ω_c.

Chapter 5

Angle Modulation

Introduction:

It is a type of CW modulation in which the angle of a sinusoidal signal (either frequency or phase) in proportion to the message where amplitude is constant. It gives a high degree of noise immunity by band expansion; it is also wide use in high fidelity music broadcast, also having a constant envelope.

$\emptyset(t) = A\cos\theta(t)$ "Angle Modulation

$\emptyset(t) = f(t)\cos(\omega_c t + \theta_o)$ "Amplitude Modulation"

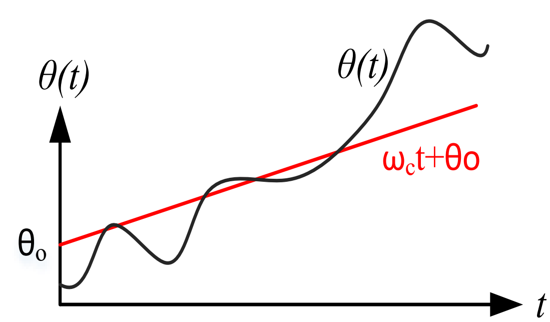
Where $(\omega_c t + \theta_o)$ represents the angle of carrier frequency

For PM

$\theta(t) = \omega_c t + \theta_o + k_p f(t)$

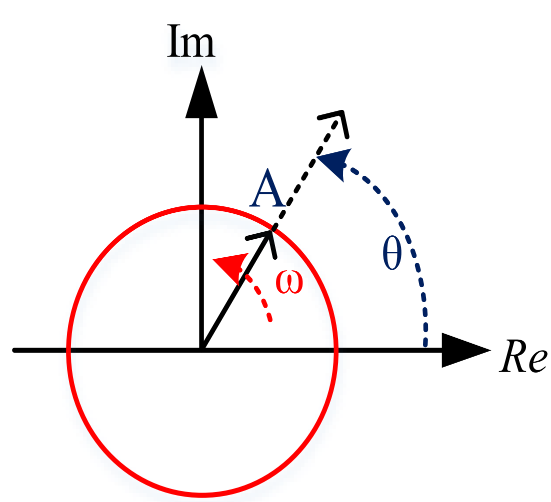
Where k_p is constant (rad/volt)

If $\theta_o=0$



$$\theta(t) = \omega_c t + k_p f(t) \quad \text{...(5-1)}$$

$$\emptyset_{PM}(t) = A_c\cos[\omega_c t + k_p f(t)] \quad \text{...(5-2)}$$



The instantaneous frequency $\omega_i(t)$ is:

$$\omega_i(t) = \frac{d\theta(i)}{dt} = \omega_c + k_p f'(t) \quad \text{...(5-3)}$$

For FM

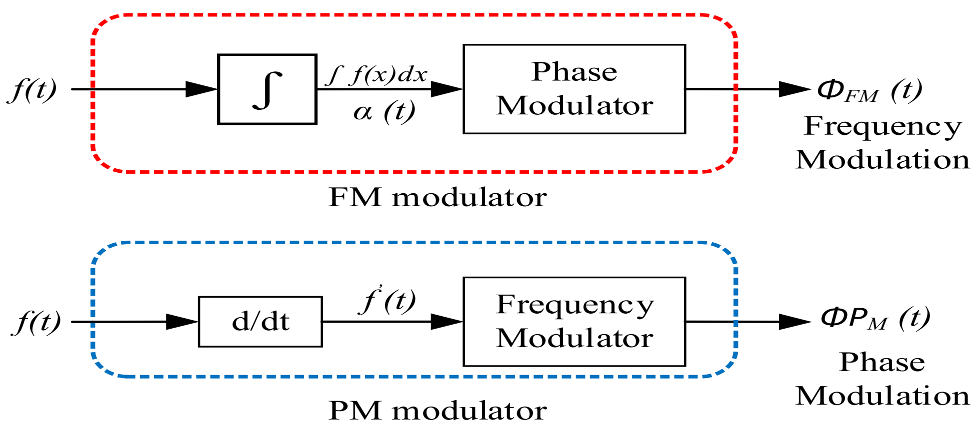
$$\omega_i(t) = \frac{d\theta(i)}{dt} = \omega_c + k_f f(t) \qquad \ldots(5\text{-}4)$$

Where k_f is constant $(\frac{rad/sec}{volt})$ modulation constant

$$\theta(t) = \omega_c t + k_f \int_{-\infty}^{t} f(\propto) d \propto \qquad \ldots(5\text{-}5)$$

$$\emptyset_{FM}(t) = A_c \cos\left[\omega_c t + k_f \int_{-\infty}^{t} f(\propto) d \propto\right] \qquad \ldots(5\text{-}6)$$

We note from $\emptyset_{PM}(t)$ and $\emptyset_{FM}(t)$ that FM and PM are similar [PM corresponds to $f(t)$ and FM corresponds to $f'(t)$]. Where the frequency is the derivative of the phase, or it represents the rate of change in phase.



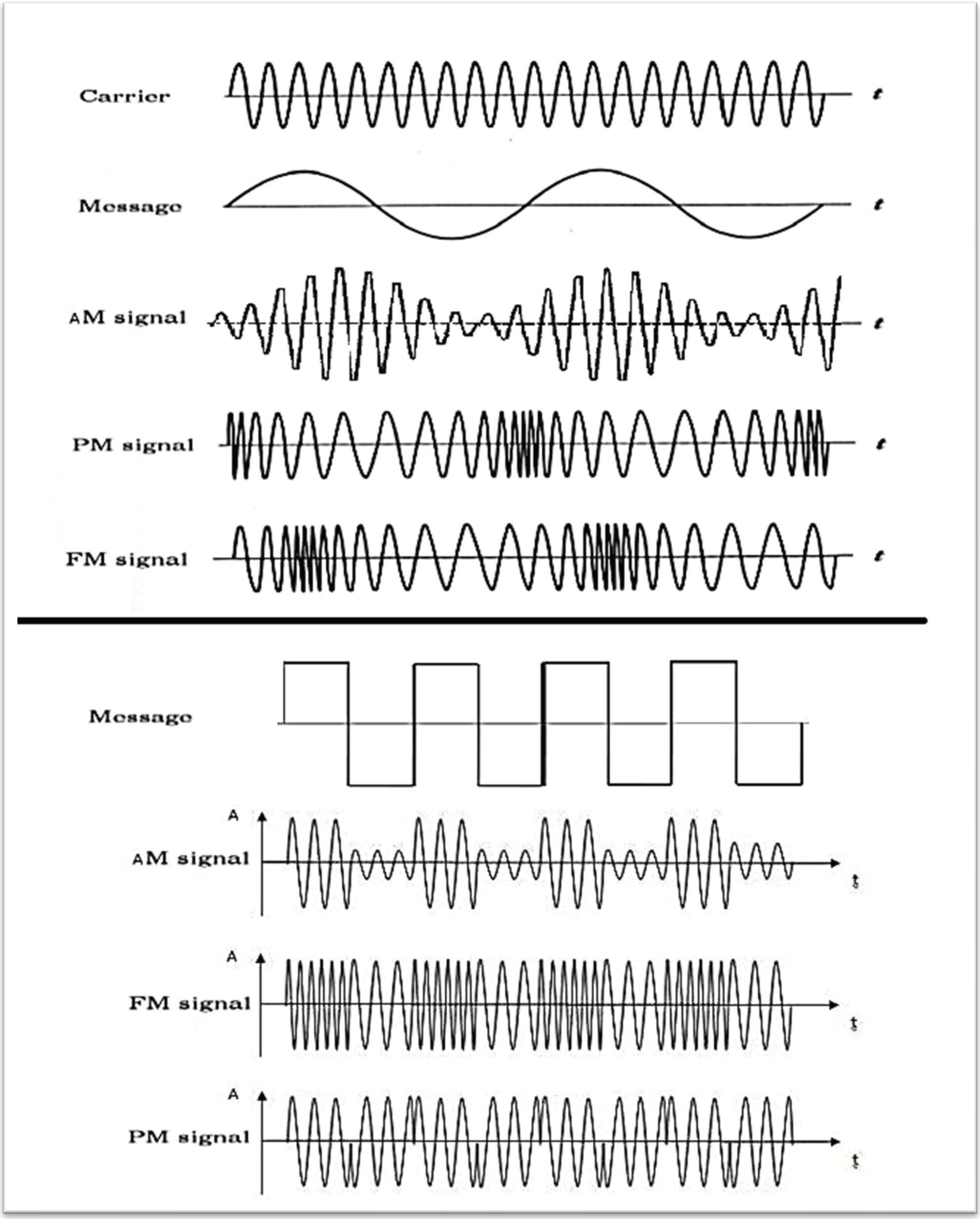
H.W

Write the equation for $\emptyset_{AM}(t), \emptyset_{FM}(t)$ and $\emptyset_{PM}(t)$, if the modulating signal is;

1-$f(t) = 2cos300\pi t + 4cos600\pi t$

2-$f(t) = 2t \ , at\ 0 < t < 1\, msec$

Comparison of time waveforms

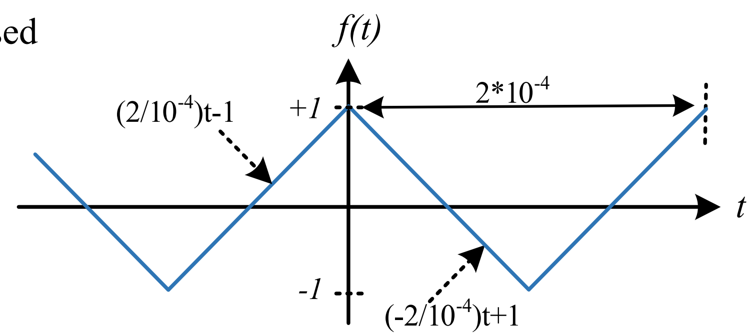


Ex 5-1

Find maximum and minimum instantaneous frequencies resulting from modulating a carrier signal with carrier frequency of f_c=100 MHz by f(t) shown if:

1-$FM\ with\ k_f = 2\pi * 10^5 \frac{rad/sec}{volt}$ is used

2- $PM\ with\ k_p = 10\pi\ \frac{rad}{volt}$ is used



Solution:

For FM

$\omega_i(t) = \omega_c + k_f f(t)$

$f_i(t) = f_c + \frac{k_f}{2\pi} f(t)$

$= 10^8 + 10^5 f(t)$

$f_{i\,min} = 10^8 - 10^5 |f(t)|_{min} = 99.9\ MHz$

$f_{i\,max} = 10^8 + 10^5 |f(t)|_{max} = 100.1\ MHz$

For PM

$f_i(t) = f_c + \frac{k_p}{2\pi} f'(t)$

$f_{i\,min} = 10^8 - 5 * |f'(t)|_{min} = 10^8 - 10^5 = 99.5\ MHz$

$f_{i\,max} = 10^8 + 5 * |f'(t)|_{max} = 10^8 + 10^5 = 100.5\ MHz$

Power of Angle Modulated waves:

Simply from equations:

$$Pt_{FM} = Pt_{PM} = \frac{A_c^2}{2} \quad \text{Watt} \qquad \ldots(5\text{-}7)$$

(assuming R=1Ω, if R is given then $Pt = \frac{A_c^2}{2R}$