PRINCIPLES OF COMMUNICATION (BEC-28)

UNIT-3
NOISE

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Content of Unit-3

- **Noise:** Source of Noise, Frequency domain, Representation of noise, Linear Filtering of noise, Noise in Amplitude modulation system, Noise in SSB-SC,DSB and DSB-C, Noise Ratio, Noise Comparison of FM and AM, Pre-emphasis and De-emphasis, Figure of Merit.

Noise in PM

For PM, $\phi(t) = kp*m(t)$. *For convenience, let* $kp*kd = 1$. *Then*

$$v(t) \approx m(t) + \frac{k_d r_n(t)}{A_c} \sin[\psi(t) - \varphi(t)]$$

Post detection LPF passes only those spectral components that are within $(-W, W)$.
Hence the output noise power resulting in,

$$(SNR)_{0,PM} = \frac{P_M}{2W N_0 \left(\frac{k_d}{A_c}\right)^2}$$

$$= \frac{A_c^2}{2W N_0} k_p^2 P_M$$

As, $$(SNR)_{r,PM} = \frac{\left(A_c^2\right)/2}{N_0 W}$$

We have

$$(FOM)_{PM} = \frac{(SNR)_0}{(SNR)_r} = k_p^2 P_M$$

Noise in FM

$$v(t) = \frac{k_d}{2\pi}\frac{d\theta(t)}{dt}$$

$$= k_f k_d m(t) + \frac{k_d}{2\pi A_c}\frac{dn_s(t)}{dt}$$

Again, letting *kf*kd = 1, we have*

$$v(t) = m(t) + \frac{k_d}{2\pi A_c}\frac{dn_s(t)}{dt}$$

output signal power = *PM*

Let $n_F(t) = \frac{k_d}{2\pi A_c}\frac{dn_s(t)}{dt}$

Then, $S_{N_F}(f) = \left(\frac{k_d}{2\pi A_c}\right)^2 |j2\pi f|^2 S_{N_S}(f)$

We can be obtained by passing *ns (t) through a differentiator with the transfer function j 2πf.*

Cont…

$$S_{N_F}(f) = \frac{k_d^2 f^2}{A_c^2} S_{N_S}(f)$$

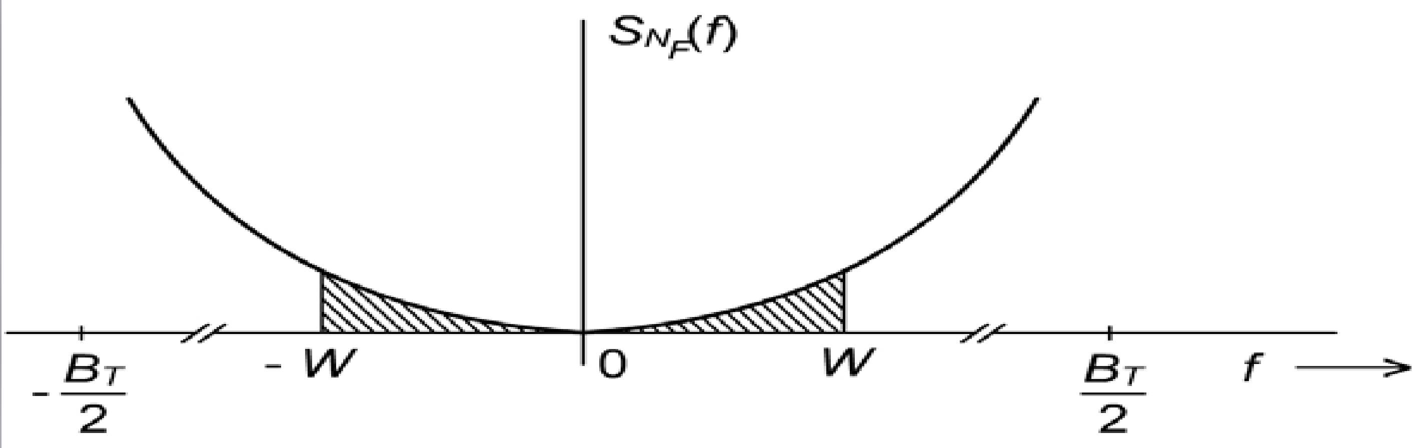


Fig. 7.13: Noise spectra at the FM discriminator output

$$\text{The output noise power} = \int_{-W}^{W} \frac{k_d^2 f^2 N_0}{A_c^2} \, df$$

$$= \frac{k_d^2 N_0}{A_c^2} \left(\frac{2}{3}\right) W^3$$

Examples

1. **For an FM, given**

$$(S/N)_{o/p} = 30\ dB$$

$$(S/N)_{i/p} = 20\ dB$$

Find the value of β

Solution:

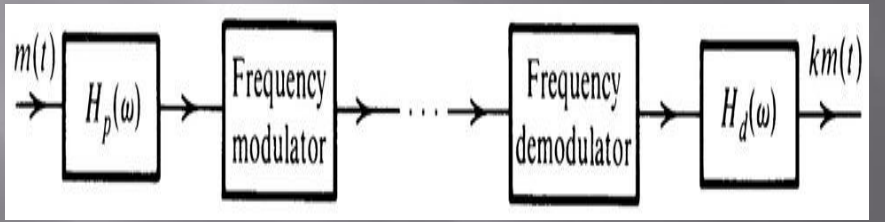
- **2.** Compare the *FOM* of PM and FM when $m(t) = \cos(2\pi \times 5 \times 103)t$. The frequency deviation produced in both cases is 50 kHz.

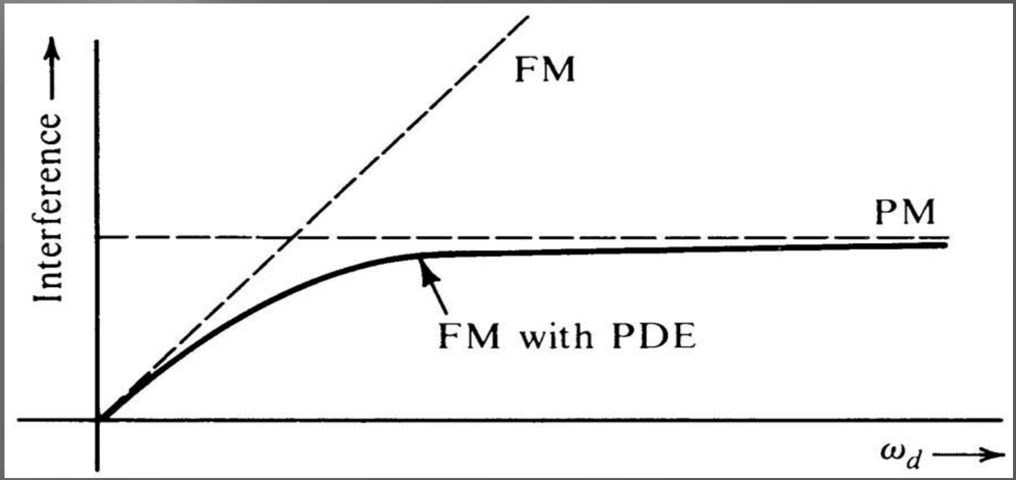
Pre-emphasis & de-emphasis

Pre-emphasis is needed in FM to maintain good signal to noise ratio.

The characteristics of the pre-emphasis and de-emphasis filters depend largely on the PSD of the message process.

The net effect of these filters should be a flat frequency response since the noise component before filtering has a parabolic PSD



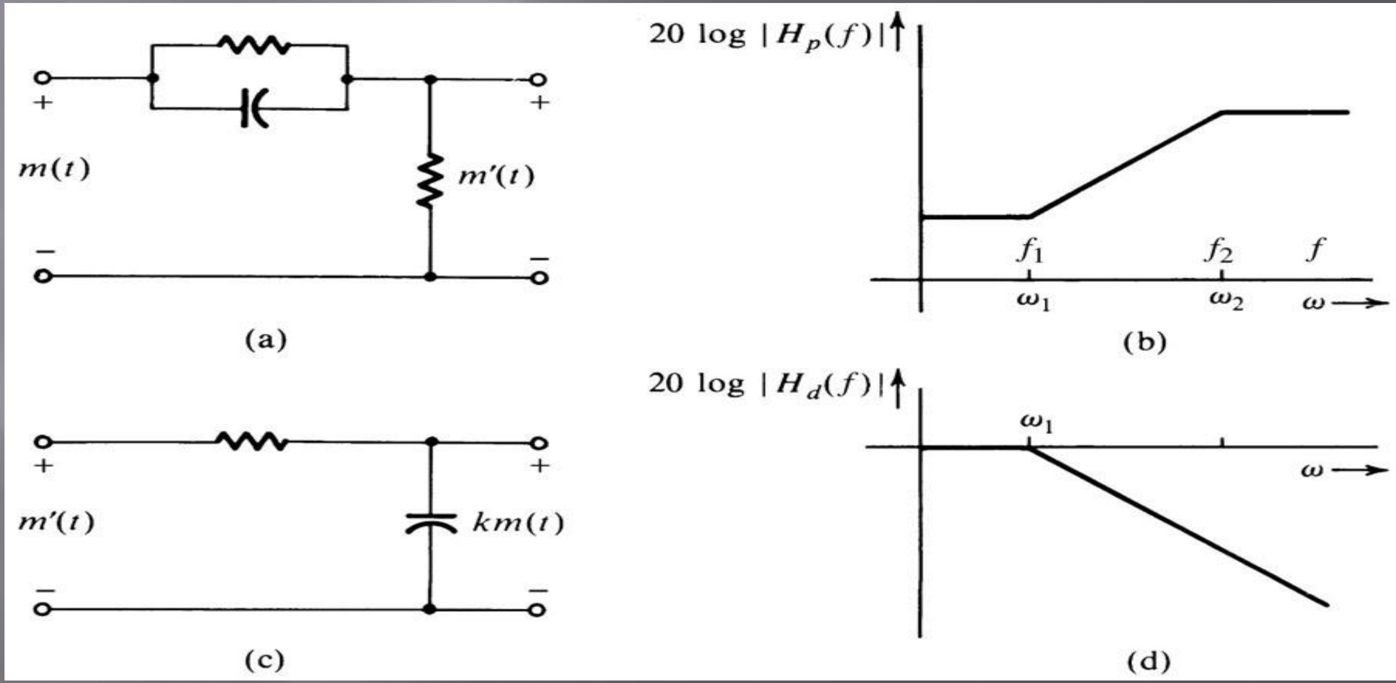


(a) Preemphasis-deemphasis in an FM system

(b) Interference Vs Pre-emphasis & De-emphasis

Pre-emphasis & de-emphasis

- In commercial FM broadcasting of music and voice, 1st order lowpass and high pass RC filters with a time constant of 75 μs are employed.
- $f_o = 1/(2\pi \times 75 \times 10^{-6}) \approx 2100$ Hz is the 3 dB frequency of the filter



Thank you