VELLORE INSTITUTE OF TECHNOLOGY

BECE304L - ANALOG COMMUNICATION SYSTEMS

DIGITAL ASSIGNMENT - II

NAME : RAHUL KARTHIK . S

REG. NO : 21BEC1851

DATE : 4.7.23

① Given,

$$e = 10 \sin(5 \times 10^8 t + 4 \sin 1250 t)$$

By comparing with standard equation,

$$2\pi f_c = 5 \times 10^8$$

$$f_c = \frac{5 \times 10^8}{2\pi} = 79.57 \text{ MHz}$$

Modulation Index $\beta = 4$

$$2\pi f_m = 1250$$

$$f_m = \frac{1250}{2\pi} = 199 \text{ Hz}$$

Frequency Deviation $= \Delta f = \beta \cdot f_m$

$$= 4 \times 199 \text{ Hz}$$

$$= 796.75 \text{ Hz}$$

Power dissipated $P = \frac{V_{RMS}^2}{R}$

$$= \frac{\left[\frac{10}{\sqrt{2}}\right]^2}{5}$$

$$\boxed{P = 10\ W}$$

(2) $s(t) = 100 \cos(2\pi f_c t + 4 \sin 2000\pi t)$

$f_c = 10$ MHZ

Average Transmitted Power $P_{avg} = \frac{A_c^2}{2}$

$$= \frac{100^2}{2}$$

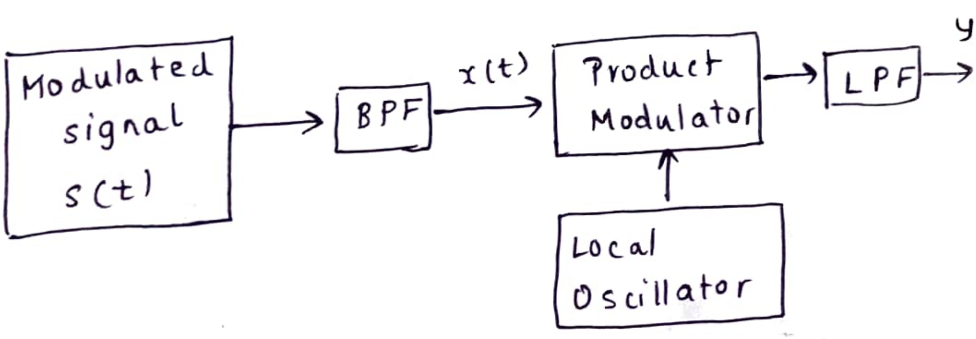
$$P_{avg} = 5\ kW$$

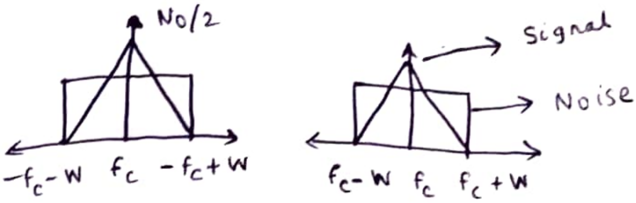
Peak Frequency Deviation $\Delta f = \beta \cdot f_m$

$$= 4 \times 1000$$

$$= 4000\ Hz$$

(3) Noise Performance in DSB-SC system :





* The SNR measured at the input to the demodulator is referred to as "Pre-detection" SNR.

* The SNR measured at the output to the demodulator is referred to as "Post-detection" SNR.

* Figure of Merit $= \dfrac{\text{Post-Detection SNR}}{\text{Pre-Detection SNR}}$

Pre-Detection SNR :

$$x(t) = s(t) + n(t)$$

$$s(t) = A_c\, m(t) \cos(2\pi f_c t)$$

$n(t) =$ Band Pass noise of output filter.

$$E[s^2(t)] = E[A_c\, m(t) \cos^2(2\pi f_c t)]$$

$$= E[(A_c \cos 2\pi f_c t)^2] \times E[m^2(t)]$$

$$= \frac{A_c^2 P}{2}$$

$$E[n^2(t)] = 2 \times \frac{N_0}{2} \times 2W = 2N_0W$$

DSBSC

Pre - detection SNR $= SNR_{pre}$

$$= \frac{A_c^2 P}{4 N_0 W}$$

Post - Detection SNR :

$$x(t) = s(t) + n_i(t) \cos(2\pi f_c t) - n_q(t) \sin(2\pi f_c t)$$

$$= [s(t) + n_i(t) \cos(2\pi f_c t) - n_q(t) \sin(2\pi f_c t)] \cos(2\pi f_c t)$$

$$= \frac{1}{2} A_c m(t) + \frac{1}{2} A_c m(t) \cos(4\pi f_c t) + \frac{1}{2} n_i(t) + \frac{1}{2} n_i(t) \cos(4\pi f_c t) - \frac{1}{2} n_q(t) \sin(4\pi f_c t)$$

$$y(t) = \frac{1}{2} A_c m(t) + \frac{1}{2} n_i(t)$$

$$E[s^2(t)] = E[\tfrac{1}{2} A_c m(t)]^2$$

$$= \frac{1}{4} A_c^2 E\{m^2(t)\}$$

$$= \frac{1}{4} A_c^2 P$$

$$E[n^2(t)] = E\left\{\left[\frac{1}{2} n_i(t)\right]^2\right\} = \frac{1}{4} E[n_i^2(t)]$$

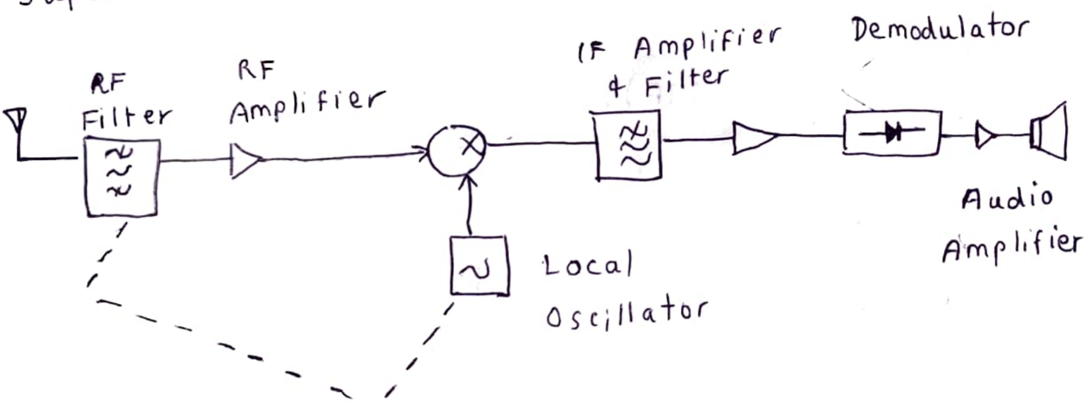
$$= \frac{1}{2}(2 N_0 W)$$

$$\text{Post-detection SNR} = SNR_{post}^{DSBSC} = \frac{A_c^2 P}{2 N_0 W}$$

$$\text{Figure of Merit} = \frac{\text{Pre-detection SNR}}{\text{Post-detection SNR}}$$

$$= 2.$$

(4) Superhetrodyne Receiver :



Various components in the system are :

Antenna : It intercepts the ~~upt~~ incoming electromagnetic wave and converts it to electrical signals.

- **Feeder Cable** : It converts the antenna to the receiver front end.

- **RF Filter** : It selects only one modulated carriers signal from the many received signals at the antenna output.

- **RF Amplifier** : It amplifies the selected signal to the level required to drive the next unit, that is the Mixer.

- **Mixer and Local Oscillator** : This combination converts (modulated carrier) signal frequency into intermediate frequency (IF).

Mixer is basically a non-linear device and it produces infinite number of components in its output.

For example, if f_s is the signal frequency and f_o is the local oscillator frequency, then the mixer output will contain :

$f_s, f_o, f_s - f_o, f_s + f_o, f_s + 2f_s, \ldots$

$f_s - f_0$: Intermediate Frequency,

$f_{IF} = f_s - f_0$

* **IF Filter** : It selects only the intermediate frequency from the mixer output.

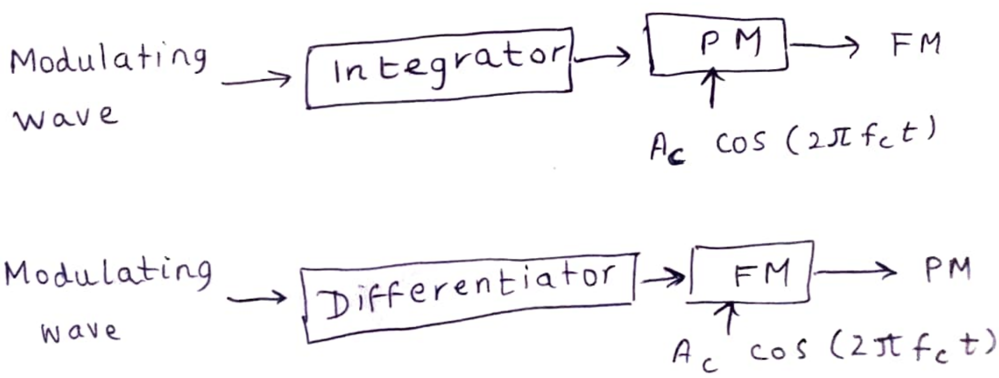
* **IF Amplifier** : It amplifies the IF signal to the level required to drive the demodulator.

* **Demodulator** : It provides demodulation message to the level required to the drive the loudspeaker.

* **Loud Speaker** : It produces the sound corresponding to message signal.

(5) PM obtained from FM and vice-versa :

Block Diagram :



Mathematical Expression for PM and FM :

$$s(t) = A_c \cos(\theta_i)t$$

$A_c \rightarrow$ Carrier Amplitude

$\theta_i \rightarrow$ Angle

In the simple case of ~~a~~ unmodulated carrier,

$$\theta_i(t) = 2\pi f_c t + \phi_c \quad \text{for } m(t) = 0$$

$2\pi f_c t \rightarrow$ Freq.

$\phi_c \rightarrow$ Phase

Phase Modulation is that form of angle modulates in which the phase angle is instantaneous varied Linearly with message m(t) signal.

$$\phi_i(t) = \phi_c + k_p m(t)$$

$k_p \rightarrow$ Phase sensitivity Factor of Modulator (rad/volt)

Phase - Modulated Wave :

$$s(t) = A_c \cos 2\pi f_c t + \phi_c + k_p m(t)$$

If unmodulated carrier phase is taken as zero,

$$s(t) = A_c [\cos (2\pi f_c t + k_p m(t))]$$

This is the equation for PM Wave.

Frequency Modulation (FM) is that form of angle modulation in which the phase angle is instantaneous varied linearly with message m(t) signal.

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

$K_f \rightarrow$ frequency sensitivity factor of modulator. Unit : Hz/volt

Integrating $f_i(t)$ w.r.t time & multiplying by 2π.

$$\theta_i(t) = 2\pi \int_0^t f_i(\tau)\, d\tau$$

$$\theta_i(t) = 2\pi \int_0^t [f_c + K_f m(\tau)]\, d\tau$$

$$\theta_i(t) = 2\pi f_c t + 2\pi K_f \int_0^t m(\tau)\, d\tau$$

$$s(t) = A_c \cos\left[2\pi f_c t + 2\pi k_f \int_0^t m(\tau)\, d\tau\right]$$

- Modulating signal varies the angle of the carrier signal, means an PM wave. If the integrated form of modulating signal varies the angle of the carrier signal, means FM wave.

- FM Wave can be generated by first integrating the message signal with respect to time 't' and then using the using the resulting signal as the input to a phase modulator.

- PM Wave can be generated by first differentiating w.r.t to time t and then using the resulting signal as the input to a frequency modulator.