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Assignment - 01

1) **What is modulation?**
Modulation is defined as the process of changing the characteristics (amplitude, phase, frequency) of high frequency carrier signal according to the instantaneous value of modulating signal.

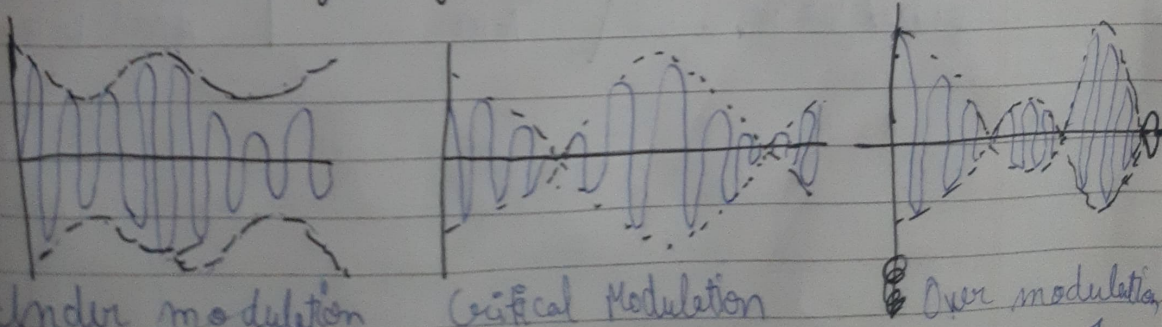
2) **What are various advantages of modulation?**
The advantage of modulation are :-
- Reduction of antenna height.
- Ease of transmission
- Multiplexing
- Reduced Noise
- Narrow bandwidth.

3) **What is Modulation Index? How can it be calculated?**
Modulation index is defined as the ratio of amplitude of message signal to that of carrier amplitude.

$$m = \frac{V_m}{V_c} \quad \text{or} \quad m = \frac{V_{max} - V_{min}}{V_{max} + V_{min}}$$

V_m = amplitude of modulating signal (message)
V_c = amplitude of modulating signal (carrier)

4) **List the various degrees of modulation in AM.**



Under modulation $m < 1$ | Critical Modulation $m = 1$ | Over modulation $m > 1$

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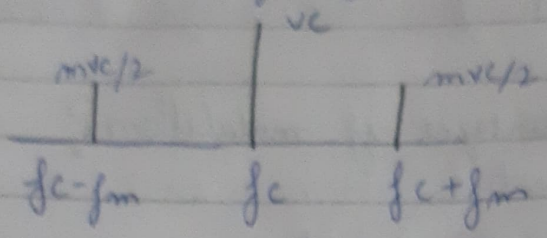
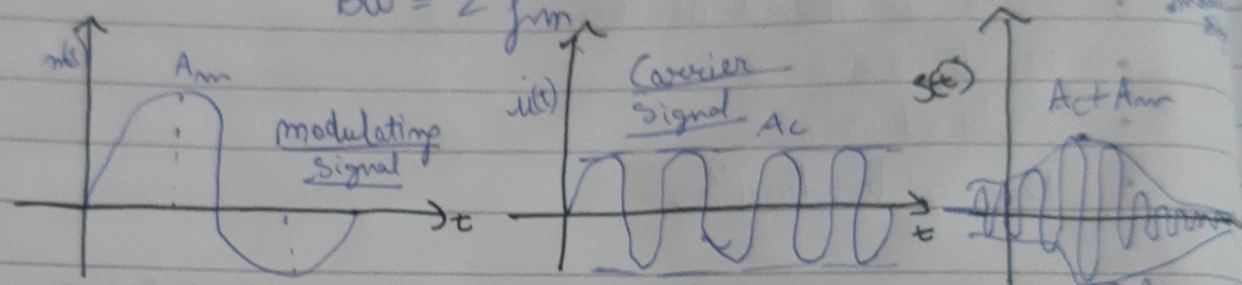
5. Define AM. Draw its time domain representation & frequency spectrum.

Amplitude modulation is defined as the process of changing the amplitude of the carrier signal according to the modulating signal.



fc → Carrier frequency
fc - fm ⇒ LSB "
fc + fm ⇒ USB "

Time domain :-



6. Provide a brief comparison between different AM systems.

AM	DSB-SC	SSB-SC
Bandwidth = 2 fm	Bandwidth = 2 fm	Bandwidth = fm
Contains USB, LSB, carrier.	Contains USB, LSB.	Contains LSB or USB
More power is required for transmission	less power than AM	less than AM & DSB-SC

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7. Calculate the no. of AM broadcast stations provided the carrier frequency is 5 KHz and BW is 100 KHz.

$BW = 2 f_m$
$= 2 \times 5 KHz$
$= 10 KHz$

Total bandwidth is 100 KHz
The number of AM broadcast stations
$= 100/10 = 10$

8. Give the expression of Hilbert transform & list its properties.

$$H[f(t)] = \frac{1}{\pi} \int_{-\infty}^{\infty} \frac{f(t)}{t-T} dT$$

Properties :-
- Even signal gives odd, odd signal gives even results.
- A signal $x(t)$ & its hilbert transform $\hat{x}(t)$ have same energy & both are orthogonal.

9. Calculate the total power in a AM wave having 100 W carrier power & modulation index of 0.6.

$P_t = P_c (1 + m^2/2)$
$= 100 (1 + 0.36/2)$
$= 100 (1.18)$
$= 118$

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10) Discuss the concept of suppressed carrier system. Explain its various types.

- In AM, both transmitted power & bandwidth is wasted.
- The transmitted power wasted in transmitting carrier along with the sidebands which does not contain information.

Advantage:-
Both transmitted power & bandwidth can be saved in suppressed carrier systems.

Types:-
i) DSB SC ⇒ Double sideband suppressed carrier system
ii) SSB-SC ⇒ Single sideband suppressed carrier system

11) Provide the power and current relation of A.M.

$$\text{Power} \rightarrow P_t = P_c\left(1 + \frac{m^2}{2}\right)$$

$$\text{Current} \rightarrow I_t = I_c\left(1 + \frac{m^2}{2}\right)^{1/2}$$

12) Mathematically deduce the expression for efficiency of an AM wave.

$$\% \text{ efficiency} = \frac{\text{Power inside bands}}{\text{Total power}} \times 100$$

$$= \frac{P_{USB} + P_{LSB}}{P_t} \times 100$$

$$= \frac{\frac{m_a^2 V_c^2}{8R} + \frac{m_a^2 V_c^2}{8R}}{\frac{V_c^2}{2R}\left[1 + \frac{m_a^2}{2}\right]} \times 100$$

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$$= \frac{\frac{V_c^2}{2R}\left(\frac{ma^2}{4} + \frac{ma^2}{4}\right)}{\frac{V_c^2}{2R}\left[1 + \frac{ma^2}{2}\right]} \times 100$$

$$= \frac{\frac{2ma^2}{4}}{\frac{2+ma^2}{2}} \times 100$$

$$= \frac{ma^2}{(2+ma^2)} \times 100 \quad , \quad ma = 1$$

$$\Rightarrow \frac{1}{2+1} \times 100$$

$$\Rightarrow \frac{1}{3} \times 100 \Rightarrow 33.33\%$$

13 What do you understand by coherent detection of SSB-SC signal ? Explain its advantages & disadvantages.

The modulating $m(t)$ can be recovered from a DSB-SC by first multiplying with locally generated carrier.

The phase and frequency of locally generated carrier and carrier at the transmitter must be exactly coherent in phase and frequency otherwise the detected signal will be distorted.

Advantage :-

- BW (f_m) is half of that required by DSBSC system.
- Power of the suppressed carrier and sideband is saved.
- Due to narrow BW, effect of noise at the receiver circuit is reduced.
- Better quality of reception

Disadvantages :-

- Transmission and reception of SSB is more complex
- SSB receives require precise tuning than AM receiver and frequency stability is required.

14 What is DSB-SC AM wave? Discuss its meathod of generation.

It is type of AM wave, where both sidebands are transmitted while the carrier signal is completely suppressed or removed.

Ring Modulator (Meathod of generation)

→ It is the most popular meathod of generation
→ 4-diodes are connected to form a ring and the carrier signal is connected b/w the centre taps of input & output transformers
→ No Need of BPF at the output
→ The 4 diodes are controlled by a square wave carrier $V_c(t)$ of frequency f_c.

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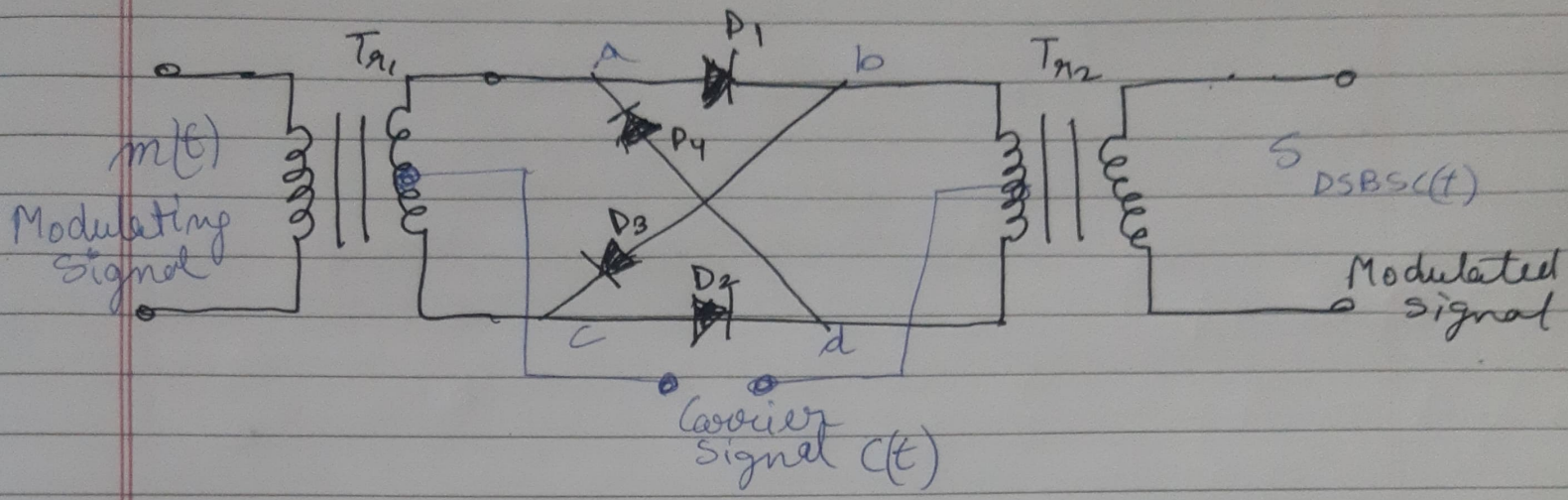

Circuit diagram